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DIE BELEGGINGS-NAVORSERS TYDSKRIF

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Omvattende verandering het gedurende die afgelope vyf-en-twintig jaar in die teorie en praktyk van beleggingsontleding voorgekom. Ontwikkel uit 'n basies beskrywende aktiweiteit, wat grootliks op 'n ad hoc basis in die vernaamste finansiële sentra in die wêreld toegepas was, het die dissipline, vanweë sy wetenskaplik-georiënteerde verfyndheid, universieel 'n groter toepassingswaarde verkry en is dit ook met 'n besondere voorspellingsvermoë beklee. Daar is ook 'n beroepsamehorigheid onder ontleders geopenbaar wat organisatoriese uitdrukking gevind het in die rigting van verenigings, (soos ons eie) toegewy aan die sistematisering van kundigheid en die verbetering van tegniese standaarde en optrede van sy lede.

Drie beginsels en verwante faktore was verantwoordelik vir die verandering op hierdie gebied, naamlik:

1. die algemene verandering wat voorgekom het in die ekonomiese en finansiële omstandighede van die meeste Westerse lande, as gevolg van die vooruitgang van tegnologie en institusionalisering van spaar- en beleggingsaktiwiteite;
2. die verandering wat voortgespruit het uit die ontwikkeling van nuwe analitiese hulpmiddels en metodes; en,
3. die verbetering in die openbaarmaking van inligting wat noodsaaklik is vir behoorlike waardering van maatskappye en sekuriteite.

Elk van hierdie faktore is van belang vir die ontleder in sy doelstelling om geld te maak (òf vir sy kliënt òf vir homself) en by te dra tot 'n meer effektiewe toedeling van skaars kapitaalbronne. Daarom sal hierdie Tydskrif sy primêre aandag op hierdie faktore vestig. Dit is egter belangrik om hierdie doelstelling verder toe te lig. In die Verenigde State, Brittanje en in ander lande, bestaan daar reeds tydskrifte wat die studie van beleggingsontleding oor die algemeen doeltreffend dien. Die regverdiging vir die instelling van 'n suiwer plaaslike publikasie moet dus die behoefte wees om sake en faktore van Suidelike Afrikaanse belang te behandel en sodoende iets by te dra, tot die totale literatuur oor die onderwerp sonder om te dupliseer.

Die Redakteur

THE INVESTMENT ANALYSTS JOURNAL

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Over the past twenty five years a great change has occurred in the theory and practice of investment analysis. From a principally descriptive activity practised largely in major world financial centres and generally employed in an ad hoc fashion, it has acquired a new predictive importance, has spread greatly in geographical application and has become dominated by a scientifically orientated sophistication. Indeed, a professionalism has manifested itself amongst analysts and this has found organisational expression in the establishment of analytical societies (like our own) dedicated to the systemisation of knowledge and the improvement of technical standards and behaviour.

Three principal and related factors have been responsible for the change in the field, namely:

1. the general change that has occurred in the economic and financial environments of most Western countries because of the advance of technology and the institutionalisation of saving and investment activity;
2. the change that has occurred with the development of new analytical tools and methods; and
3. the increase in the disclosure of information vital to a proper evaluation of companies and securities.

Each of these matters is of concern to the analyst in his aim of making money (either for his client or himself) and contributing to a more efficient allocation of scarce capital resources. It is to these matters, therefore, that his Journal will primarily direct its attention. However, it is important to add a word of explanation to this statement. Journals already exist in the United States, Britain and other countries that serve the study of investment analysis generally and do so very adequately. The justification for the establishment of a purely local publication must, thus, lie in the need to deal with issues and matters of Southern African interest and in so doing to add something, not duplicated elsewhere, to the total literature of the subject.

The Editor

CAPITAL INVESTMENT AND RISK ANALYSIS FOR A NEW MINING PROJECT

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Capital investment and risk analysis for new mining ventures is not a new technique. It has been practised here (Krige, 1955) and overseas (Michelson & Polta, 1969) in some form or another for almost two decades. However, the more sophisticated applications of these techniques only became practical with the improvement in the standard and scope of computer facilities in recent years. This technique has developed into what is essentially a computer application based on statistical - cum - financial simulation models of the proposed mining, metallurgical, marketing and financing operations.

The computer has in fact become an indispensible tool in effecting such analyses in view of:

(i) the complexity and time-consuming nature of the efforts involved in doing only one complete exercise manually starting with ore tonnage and grade estimates and ending up with the estimated return on the capital investment required,
and

(ii) the practical impossibility of repeating such exercises many hundreds of times in order to cover all the possible combinations of assumptions and estimates which can be made.

This paper is based on a model developed and used extensively during the last eighteen months for the new Prieska Copper Mine of the Anglovaal Group.

MAIN OBJECTIVES OF THE ANALYSIS

Being a tool to assist top management in making critical decisions, investment and risk analyses for a new mining, or any other, venture should be designed and used to provide meaningful answers to the following questions:

(i) Is the project viable?
How does it compare with alternative avenues of investment?
What are the risks of part or the whole of the investment being lost, or of not obtaining some specified minimum return thereon?

(ii) What is the best broad production and marketing plan for the venture?
What is the optimum initial scale of production, and programme of expansion?
In what form should the product be sold, e.g. should the mine sell concentrates or erect its own smelter?
Which of the possible alternative marketing schemes should be accepted?

(iii) How can the project be financed to best advantage?
What is the likely total capital investment required for any given equity-loan ratio, and what are the risks of not being able to come to production on the likely figure?
What are the best loan term combinations of repayments, interest rates, etc., as linked with currency risks if any?
How are the vendors' interests affected by variations in the gearing ratio, loan terms, etc.?

These questions do not always arise in the above sequence and are frequently interlinked, necessitating a reiterative procedure.

CRITERIA FOR ASSESSING RETURNS ON INVESTMENT

No single criterion can provide management with a complete answer. The criterion or criteria to be selected must depend on the status and activities of the vendor(s), such as liquidity, alternative avenues for investments and their timing, etc. For this reason the Prieska model was based on three separate criteria for the return on the equity investment:

(i) Discounted Cash Flow (or compound interest) rate of return. This is most generally used and is the equivalent compound interest rate required to be paid on the capital investment to allow for a schedule of interest plus capital repayments equivalent to that of the estimated dividends over the life of the project. The D.C.F. rate provides a relative measure for alternative investments and is also directly comparable with ruling rates of interest paid by banks, etc., after allowing for any differential tax effects on receipts.

(ii) The present value(s) of the estimated dividends (or the estimated share values) at a stipulated rate(s) of discount. For that interest rate at which the market is likely to discount estimated future earnings, the present value provides an estimate of the market valuation and hence of the potential capital gain or loss on sale of the equity.

(iii) Payback period for the equity capital, and the likely average dividend p.a. over the remaining life. This measure is important where the timing schedule of the return on the investment is of vital interest to the vendor(s). This measure is also most readily understood, even where the capital is invested piece-meal as the average payback for each unit of capital can be calculated.

Apart from these criteria, a further useful measure of the extent to which a base metal proposition exceeds a critical level is provided by break-even calculations, expressed in metal price(s), during any loan repayment period or subsequently.

Experience has shown that this combination of criteria serves to highlight all the necessary angles of the return on the capital investment.

DEFINITION OF THE UNCERTAINTIES OR RISKS

The uncertainties to be catered for fall into two broad categories, viz:

(i) **Decision factors** for which specific alternatives have to be examined and in respect of which decisions have to be taken either at the outset or as the project develops, e.g.
Final level of production. Each level examined could also cover the necessary capacities to permit future expansion—e.g. shaft capacity, water pipe line, township freehold, etc.
Nature of products to be produced, i.e. concentrates or metals.
Structure of the finance to be provided, i.e. equity-loan ratio.
Choice between alternative sales contracts, after allowing for the effect on risk of having only one or two buyers as against several in different countries with a spread of currency risks.

(ii) **Risk factors** subject to errors of estimation, e.g.
Ore grades, tonnages and waste dilution factors.
Metal prices.
Working and capital costs.
Cost and price escalation rates including cost escalation under different sales contracts which differ from contract to contract or from country to country.
Date of commencement of production and build-up rate.
Plant recovery factors.
Working capital required to cover stores, debtors, creditors and stocks.

For the factors under (i) above there is no alternative to an examination and comparison of each of the possibilities at the appropriate stage(s) of the project in order to take a decision(s) based on the best available information and analyses. To do this effectively, proper cognizance has to be taken of the effects of all the possible combinations of risk factors under (ii) above, and for this purpose the technique of risk analysis is used.

Of the risk factors listed, only the in situ ore grades and tonnages can be estimated with limits of error which can be calculated objectively using statistical theory. Due to the cost factor only a limited number of boreholes are drilled from surface to define the boundaries of the orebody and these provide ore samples for grade estimates, and for metallurgical tests; the borehole cores also give some indication of likely mining conditions, waste dilution in mining, etc. The best drilling policy to balance the cost of additional boreholes against the decrease in risk involves exploration analysis outside the scope of this paper.

The variations in grade within the orebody are analysed statistically

by establishing the value distribution patterns (usually skew and lognormal) and this knowledge allows of:

(*a*) an improvement in the quality of the grade estimates,

(*b*) an estimate of the limits or error for the likely grades, or preferably probability distributions for the grade estimates, and

(*c*) where selective mining of ore blocks is practical, an estimate of the likely grade improvements which would result from selective mining.

The uncertainties associated with the other factors under (ii) above, except possibly for plant recovery factors, cannot be defined in a completely objective way. Human judgement unavoidably plays the major part in assessing these uncertainties and the quality of the final answer obtained therefore depends critically on the quality of the judgements involved at this stage. For the purpose of a risk analysis the uncertainties for each variable have to be defined in the form of a probability distribution. This is normally done by estimating the likely value with lower and upper limits for the variable (judged at levels representing say only a 5% or 1 in 20 chance of the variable having an even lower value and a similar chance of having an even higher value respectively) and then fitting a distribution curve either symmetrical in shape (Normal Curve) or Skew (usually accepted as lognormal) to these 3 values. Such a probability distribution if now subdivided into say 20 equally sized areas under the curve would indicate the 20 equally probable values which the variable could take, e.g.

Metallurgical recovery of metal in concentrating process:

likely percentage	80%
judgement of lower limit	70%
judgement of upper limit	90%

The symmetrical Normal distribution is used and this suggests that the following 20 values for the recovery percentage are equally likely, where each value in effect covers the range about halfway to its two neighbouring values:

67,5	71,2	73,0	74,3	75,4	76,4	77,2	78,1	78,8	79,6
80,4	81,2	81,9	82,8	83,6	84,6	85,7	87,0	88,8	92,5

i.e. for practical purposes it can be assumed that each of these 20 values has a 5% chance of being realised.

THE FINANCIAL MODEL

Having thus established for each of the **risk**-variables its probability distribution in the form of 20 values, all equally probable, a risk analysis can be performed by selecting, at random, one value out of the 20 for each variable and using this set of values in a detailed calculation of the cash flow, etc., for the venture for a given set of **decision factors.** This process is repeated for a new selected set of risk-variables until say 100 cases have been calculated giving 100 cash flows, D.C.F.s and other measures of return on the capital investment. This is clearly impossible on a manual basis and can only be done by computerising the logic for a complete financial model of the project.

The logic for such a model would cover the following:

(*a*) **Preproduction period:**
Equity
+loan capital raised less raising and other fees less capital expenditure
±changes in working capital (stores and creditors)
±interest paid or received less loan repayments if any
±balance of funds brought forward from previous year
equals cash balance carried forward.

(*b*) **Production period:**
Ore tons mined year by year at estimated grades
plus waste dilution in mining
less plant losses
equals estimated tons milled and metals recovered in concentrates
less handling losses in transport
less percentage of metal content not paid for by smelters and refiners
equals metal tons sold.
Gross revenue from sales,
less selling commission,
less smelting and refining charges,
less transport, loading, port and freight charges and insurance,
less mining and milling costs,
±stock adjustments
±changes in debtors including revenue from sales not yet received,
less further capital expenditure,
±interest paid or received,
±changes in stores and creditors,
less taxation as and when payable,
±balance from previous years
less loan repayments
equals amount available for dividends,
less dividend declared,
±dividends declared but not yet paid
equals cash balance at year end.

(*c*) **Return on investment:**
From the dividends declared up to the end of the mine's life, and after adding the net breakup, the D.C.F., Present (share) Values and Payback figures are calculated.

The above is the broad framework of the logic for the financial model. Many of the steps above are interrelated and involve complicated internal loops such as:

The smelting and refining charges for all the individual contracts involved,

the tax calculation which has to allow for the effect of the quantity of concentrates not exported on the processing allowance and hence on rate of capital redemption allowed,

the dividend declaration logic which must allow where necessary for the cancellation or reduction of a dividend(s) in a previous year(s) in order to build up funds to cover a heavy capital expenditure or loan repayment commitment in the current year, etc.

The Prieska model allows for the stipulation of the number of random sets of risk-factors to be selected and calculated, e.g. 50 or 100; also for a summary of the corresponding returns indicated as well as the probability distribution of each type of return, e.g. D.C.F., Present Values at 8%, 10% and 12% p.a., etc., as well as of the estimated shortfall, if any, of capital funds during the preproduction period and/or the first few years of production build-up. As an alternative, where a full risk analysis is not required but only estimates for one specific set of risk and other factors the printout will cover a detailed year by year cash flow analysis as well as the indicated returns on the investment.

PRACTICAL APPLICATIONS OF THE MODEL

These will be covered briefly in relation to the three main questions raised earlier, with examples which are purely illustrative of the principles involved and do not relate to the Prieska mine.

(i) **Is the project viable?**
Where this answer has to be given before the structure of the capitalisation has been crystalised, it can be handled either on the basis of assuming only equity capital, or on the assumption of loan funds up to a level and on terms considered realistic for the venture in the ruling economic climate. Although the returns indicated for these alternatives will not be the same they can both be used effectively and can be reconciled after allowing for the "gearing" effect of the loans.

Figure 1 shows diagramatically what the answers could be for the D.C.F. return on the investment in a base metal mine firstly on a 100% equity basis and secondly on a 50% equity/50% loan at 10% p.a. basis. The first half of the Figure shows the frequency distributions and the second half the cumulative frequency distributions.

The interpretation of such graphs would be as follows:

	All Equity	50/50 *Structure*
Likely D.C.F.	12% p.a.	15% p.a.
Chances of return exceeding a basic 10% p.a. (see cumulative graph)	70%	85%
Chances of return exceeding 15% p.a.	15%	50%
Chances of return exceeding 8% p.a.	90%	90%

(The crossovers between the two sets of graphs is at about 8% p.a. and not at 10% p.a., i.e. the interest rate on the loans,

CAPITAL INVESTMENT AND RISK ANALYSIS

A = 100% Equity capital
B = 50% Equity 50% loan @ 10% p.a.

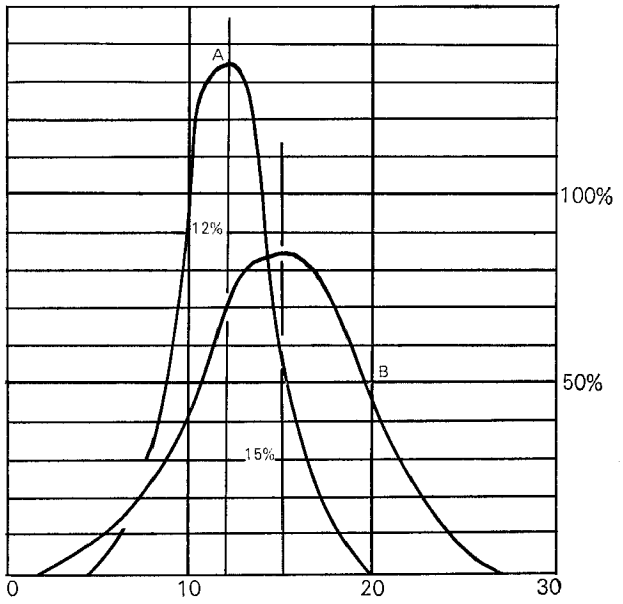


Fig. 1–Viability

because loan interest is allowed for tax purposes and therefore costs the company effectively only 6% p.a.; with tax in any case deferred for say 10 years the saving in D.C.F. is somewhat watered down and in this example the effective cost is about 8% p.a.)

Similar graphs are prepared for the present (share) values and for the relevant payback figures.

With such a set of graphs, management can assess the viability of the proposition and compare it with alternative avenues of investment against the background of the inherent risks and the chances of success.

(ii) **What is the best physical plan?**

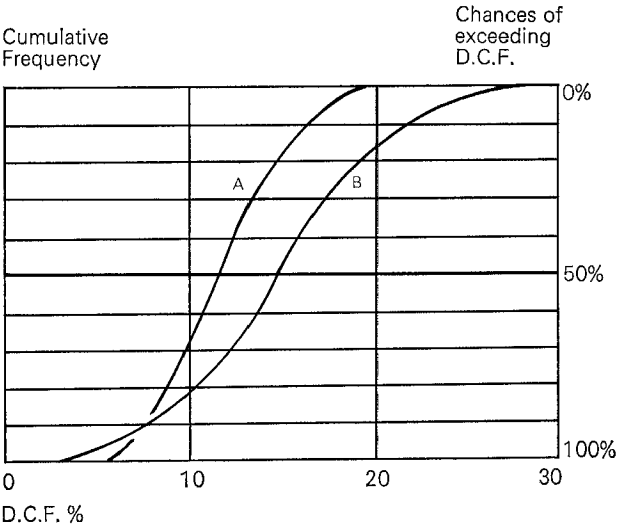
The exercise under (i) above would have been done on a reasonable initial estimate of the eventual level of production. Whether or not that exercise gave a positive answer, it is essential to analyse the effect of different levels of production on the likely return and on the overall risks to be faced. The exercise under (i) would, therefore, be repeated for several feasible levels of production, each with its appropriate estimates of capital cost, working costs, production build-up schedule, etc. The typical results of such an exercise are shown on Figure 2.

The highest D.C.F.s indicated (e.g. 15% p.a. for a 50% chance of exceeding this return) corresponds to a production level of 4 million tons p.a. However, the magnitude of the capital investment to be made and the differences in payback period (not shown), etc., might influence management to decide rather to go ahead on the 3 million tons p.a. level.
A similar procedure is now followed to show the effect of:

(*a*) investing a further R10 million on a local smelter, and

(*b*) of all the possible alternative schemes of marketing the products, e.g. sales contracts with various combinations of overseas smelters and refineries each with its own terms, possibly linked with loan finance, etc.

The results of (*a*) and (*b*) might necessitate a re-examination of the best level of production and hence new sets of analyses in order to enable management to arrive at the best combination of decisions on the broad physical planning of the venture.



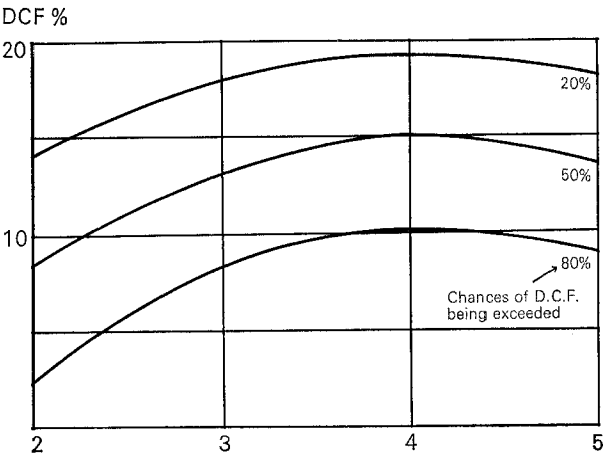


Fig. 2–Scale of production

(iii) **How can the project be financed to best advantage?**

(*a*) *Gearing ratio*

The analyses under (i) and (ii) above will have been done on two bases of capitalisation, i.e. 100% equity and/or 50/50 equity and loans. In general a high gearing of the equity capital is to the advantage of the vendors, provided the loans can be raised on reasonable terms and provided the return indicated is relatively high. However, where the potential return is mediocre and in addition linked with a large measure of uncertainty (or risk), the chances of the capital not all being repaid and hence the equity holders actually losing some of their invested capital after allowing for the priority of loan repayments, could be significant, and such that a lower gearing could be preferred.

This aspect is covered diagrammatically on Fig. 3. In this example the indicated likely D.C.F. return improves from 11% p.a. for 20% of the capital in loans to 14% for 70% loans, but the corresponding chances of not getting all the equity capital repaid in full increases from a negligible level to some 25%. Such an analysis, carried out within the practical limitations of the levels of equity capital available for investment by the vendors and the possible levels of loan funds which could be raised, will enable a logical decision as to the desirable gearing ratio to be aimed at.

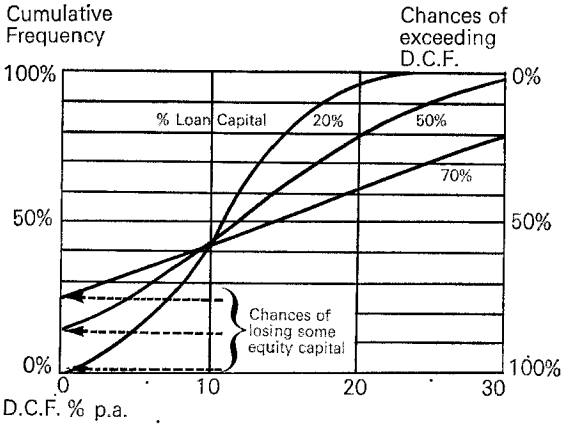


Fig. 3—Gearing ratio

(*b*) *Loan terms*

Loan terms cover a number of pertinent factors such as interest rate, repayment terms, security or guarantees required, prepayment penalties, raising fees, dividend restriction provisions, etc. Where alternative loan proposals are to be compared, it is however possible to use risk analysis techniques to compare the overall effect of the different proposals not only on the likely D.C.F. return, present equity share value, payback period, etc., but also on the associated risks of any specified return, share value or payback period not being achieved. The procedures are the same as before and will enable the vendors to judge whether a loan with a lower interest rate, but carrying conversion rights into shares, is to be preferred to a loan with a higher interest rate and no conversion rights, etc.

The calculations on financing alternatives could for example also indicate what level of share subscription rights the vendors could afford to give off at any stipulated premium to a major provider of loan capital so as to leave them either with the same D.C.F. return or with the same potential capital appreciation on their equity investments. Alternatively, if the vendors are willing to let an outside party in only up to a fixed percentage interest, the number of shares for which subscription rights are to be passed over to the lender could be fixed, and the corresponding share premium calculated which would give the desired result. The lender will, of course, have to be satisfied that his overall return on his loan plus equity investment is likely to be reasonable in relation again to the overall risks involved and the same analyses can also provide the answers to his problem.

As negotiations proceed with potential lenders such analyses are essential, often at short notice, and only a computerised risk analysis programme can provide the service required.

(*c*) *Total capitalisation required*

The form and extent of the capitalisation usually requires to be settled at a stage when the uncertainties associated with the "risk factors" have not been eliminated and this means that the total amount of capital funds, which will in fact be necessary to reach production and cover net outgoings in the first few years until the venture becomes self-financing, is in fact also uncertain. The decision as to what amount of capital funds to raise, even allowing for a possible degree of flexibility from say a bank overdraft up to a specified level, is, therefore, also a "risk" decision with a definite danger of the funds proving to be insufficient.

Because of this factor vendors have frequently been severely embarrassed by having to raise further funds in a hurry and on terms then dictated by the lender(s); they should, therefore, not have to settle the level of capital funds to be raised without a logical estimate of the chances of these funds in fact proving to be insufficient. On the same basis as before 50 or 100 cases can be run on the risk analysis programme each with a selection of "risk factor" values to give a frequency distribution of the total capitalisation required to provide the funds required during the critical period covering the first few years of production (See Fig. 4).

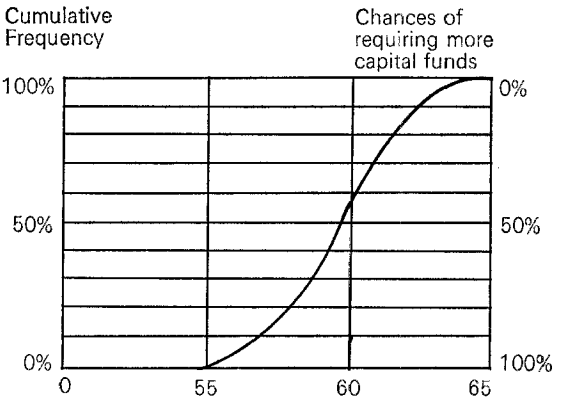


Fig. 4

CONCLUSION

The questions dealt with here usually arise in the above sequence but can often not be finalised strictly in this sequence or even one at a time. With the availability of the risk analysis computer programme as described here, however, management is in a position to arrive, if necessary by a reiterative procedure, at that combination of answers and decisions which, under the circumstances and at that time, is logically the best. Where these decisions are not necessarily final, they can constantly be reviewed as and when any of the relevant factors, or the risks associated with them, change.

As the sales and capitalisation negotiations for the Prieska mine proceeded, the relevant programme gave management a clear and constantly up-dated picture of the risk factor, the relative merits of alternatives and the overall effects of changes in the basic estimates. It assisted materially in the speedy and most effective conclusion of negotiations with various overseas and local mining, smelter and banking interests.

ACKNOWLEDGEMENT

The granting of permission by Anglo-Transvaal Consolidated Investment Company Limited, to publish this resumé of the principles and advantages of the Prieska capital investment and risk analysis programme is appreciated.

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EQUITY PERFORMANCES IN THE SIXTIES AND SEVENTIES

J. A. Rogers, M.A. (Cantab)

INTRODUCTION

During the 1960's South Africa experienced two major upswings in share prices. The second one was unusually frenzied, and the speed with which prices rose was exceeded only by the pace at which they subsequently declined.

By the time prices peaked, in May 1969, non mining equities were, on average, standing at double their levels of two years previously and had quadrupled since the start of the decade.

In the next two and a half years most share indices recorded a drop of some 60% and many individual shares — notably the erstwhile glamour stocks — had fallen by as much as 90%.

One effect of these wild gyrations in price was to cause many investors to question two important aspects of equity investment. The first concerned the degree to which share prices could, in practice, be correlated with the underlying fundamentals of earnings and dividends. The second concerned the long-term merits of equity investment itself.

The major purpose of this study is to examine these points by analysing the statistics of company earnings, dividends and share prices over representative periods of time. Amongst the specific questions it attempts to answer are:

1. What return has the long-term investor enjoyed on his shares in recent years? What dividends has he received and to what extent has his capital grown?
2. If his capital has grown, to what extent has this been accompanied by a growth in the earnings and dividends of the companies themselves? More specifically, have share prices risen faster or slower than their underlying fundamentals?
3. Is it possible, barring cataclysms or unexpected good fortune, to judge the return that the investor in equities can reasonably anticipate over the next few years?
4. Do the relative performances of different shares over a period of time give any strong indication of a statistical basis for selecting those stocks most likely to provide a handsome return in the coming years?

METHODS USED IN THIS STUDY

The approach adopted in attempting to discover the answers to these, and similar, questions has been broadly as follows:

(*a*) Fifty companies were selected for analysis.

(*b*) Figures were extracted, for the ten-year period January 1960 to December 1969, of the earnings, dividend and price records of these companies. Certain figures were also extracted for the twelve and a half years to the end of June, 1972.

(*c*) Allowance was made for the effects of rights and scrip issues.

(*d*) An analysis was made of the income and capital returns that shareholders received over both the decade and the longer period on an investment in each company. The rate of growth in underlying adjusted earnings and dividends per share was calculated for the decade.

(*e*) The results were tabulated and the companies were listed in the order of their "performance ranking" (combined capital growth and income return) over the two periods.

The methods used in analysing and interpreting the results are described in greater detail in the remaining paragraphs of this section.

(*a*) **Selection of companies**

The selection of individual companies was designed to cover a broad range of shares which the institutional investor of 1960 was likely to have included in his portfolio. By restricting the selection to relatively well-established concerns, the abnormal performances of spectacular "newcomers" were eliminated. In addition, an effort was made, as far as possible, to avoid selecting shares merely by reason of their success; in fact, a number of investments which have proved disappointing were included deliberately.

Of the fifty companies, five were gold mining concerns. They have been included mainly for comparative purposes and their results have not been incorporated in the averages.

(*b*) **Extraction of figures**

The decision to extract the figures over a period of at least ten years was taken with a view to eliminating, as far as possible, the impact of short-term market aberrations. The use of an exact decade, from the start of January 1960 to the end of December 1969, was an obvious and convenient choice. To some extent, however, the selection of January 1960 as a base date tends to understate the degree of the subsequent rises in equity prices, since at that date shares were near their pre-Sharpeville peaks. The choice of December 1969, on the other hand, also presents some difficulty in that although prices were already well off their peak levels they were destined to decline considerably further in the subsequent months. To meet this difficulty the subsidiary exercise was performed, up-dating some of the results to the end of June, 1972.

(*c*) **Allowance for capital changes**

Allowance for capitalisation (or "free scrip") issues and share splits has been made on the normal, generally accepted basis. In adjusting for rights issues the assumption has been made that sufficient shares were sold ex-rights to pay for the total cost of exercising the rights accruing on the original holding. In this way the amount invested in each share remains constant and valid comparisons can be made of the returns accruing on each holding.

A similar procedure was followed in cases where shareholders of one company were offered rights to subscribe for shares in a new concern. The assumption was made that sufficient shares in the new concern were sold as soon as it became listed to cover the cost of exercising the rights.

(*d*) **Analysis of yields and growth rates**

It has been assumed that an initial investment of R10 000 was made in each company. Thus, if a share was priced at 500 cents at the beginning of January 1960 an initial holding of 2 000 shares would have been acquired. The rate of dividend paid out by the company from time to time has been applied to this quantity of shares or to any quantity as adjusted for subsequent changes of capital. By comparing the total value of the holding and the earnings and dividends applicable to it at the beginning and the end of the period, the figures for 1969 (or where applicable, for mid-1972) could be readily compared with those for 1960 in the form of ratios. These ratios have been converted into compound rates of annual growth.

(*e*) **Performance ranking**

In comparing the returns on different investments it is necessary to take into account that a high-yielding share with a slow rate of growth may prove to be as rewarding over a period of years as a faster-growing but lower-yielding stock. A method had therefore to be devised for combining the rate of capital growth attained with the income received over a period of years.

One obvious method would have been to add the total amount of dividends received on each holding to the value of the capital fund at the end of the period. The total amounts accruing in each holding could then be compared with one another. This method is, however, biased against the higher yielding stock since it fails to take into account the advantage, in terms of a higher present value, of the early receipt of a high rate of dividends.

A second method would have been to compound each dividend from the date of its receipt. In principle, this would provide a highly accurate result, but there are major objections to it in practice. One is the question of the rate at which the dividend accruals should be compounded; virtually any rate selected can be criticised as arbitrary. Another is that this method is laborious in the extreme and the extra degree of refinement that it introduces is insignificant in relation to the more important factor of the rate of compounding.

The method adopted in this study has been to express the total dividends received over the periods as an annual average dividend yield on cost. This rate of dividend yield has then been added to the compound rate of capital growth achieved. Effectively this method compounds the dividend receipts at approximately the

combined rate of capital growth and dividend return on the stock. It is suprisingly accurate and has the supreme merit of simplicity.
The combined rate of capital growth and dividend return as calculated by this method is regarded as being the "performance" of each share.

ANALYSIS OF GENERAL RESULTS

The results of these calculations are summarised in Table I, in which the various concerns have been listed in the order of their performance ranking to December 1969. The individual gold mines have been listed separately and are excluded from the averages of the general results since they are influenced by factors that are somewhat different from those applicable to the remaining investments.
An analysis of the general results reveals some clear answers to the first two of the four questions posed in the introduction and provides scope for conjecture in answering the third.
The investor who bought R10 000 of each non-gold mining equity at the beginning of 1960, at a total cost of R450 000, would have had a portfolio worth over R1,8 million ten years later. Over the ten years, he would have received dividends totalling just over R450 000. On average, an investment of R10 000 would have grown to R40 080 and would have earned dividends totalling R10 025. These figures represent an average compound growth rate of 14¾% in capital and an average dividend return of 10%. The performance average for the portfolio as a whole would thus have been 24¾% per annum.
The average of the growth rates of the individual shares, as opposed to that of the portfolio as a whole, was 12½% and the average individual performance was 22¼%. The difference between the growth rate of the portfolio as a whole and that of the individual growth rates arises from the fact that a high rate of growth on the part of one concern will affect the total value of the portfolio more significantly than it will the average of the growth rates.*
If these figures are extended to the middle of 1972 they reflect a less dramatic growth rate in the value of the capital but an improvement in the average dividend return on cost. Despite the net drop in share prices over the two-and-a-half years, the average of the performances remained a very respectable 20%.
The salient features of the results for the two periods are summarised in the following table; in both sets of figures gold shares are again excluded, whilst the results for the longer period exclude Moshal Gevisser, Associated Wine and Amcor, all of which were taken over and delisted.

	Average of individual compound growth rates	Portfolio growth rate	Average dividend return	Average of individual performances	Portfolio performance
To 1969	12½%	14¾%	10%	22¼%	24¾%
To mid-1972	8¾%	10½%	11¼%	20%	21¾%

The rise in the capital value of the shares between the beginning of 1960 and the end of 1969 can clearly be attributed in some degree to a change in market conditions, or in other words to a swing in the rating of shares. Over the decade, average earnings yields fell from 12,6% to 6,9%, whilst average dividend yields declined from 6,4% to 3,9%. The ratios of earnings and dividend yields in 1960 to those in 1969 were respectively 1,82:1 and 1,64:1. These ratios average out at 1,73:1. In effect the reduction in acceptable yields means that, quite apart from any increase in underlying earnings and dividends themselves, the enhanced status of equities in the minds of investors led to their being prepared to pay prices 73% higher at the end of the decade than they were at the beginnning.
None the less, of the total growth of 300% in the value of the average share over the decade, the greater proportion was caused by the growth in underlying fundamentals. Even had there been no re-rating of equities, the growth in underlying earnings and dividends would in itself have carried share prices in 1969 to some 233% of their level at the start of the decade.
The importance of underlying growth, as opposed to re-rating growth, was even more significant over the twelve-and-a-half year period than in the decade. Between 1960 and mid-1972 the average dividend yield declined from 6,4% to 5,1% indicating that the rise in share prices attributable to the re-rating factor was 26%. The rise attributable to underlying growth in dividend distributions was therefore 180%; even in the absence of any re-rating, average share prices a quarter of the way through the seventies would have stood at 280% of their level at the start of the sixties.

EQUITY PERFORMANCES IN THE CURRENT DECADE

If one is to attempt to extrapolate the history of equity growth in the sixties and the early seventies through to, say, the end of the present decade — in other words, to examine the third question posed in the introduction — one is faced with two further questions:

1. What is the likelihood that earnings and dividends will grow at the same rate in the seventies as they did in the sixties?
2. What evidence is there to suggest that there could be a further swing of investment sentiment either to or away from equities?

Prospects for earnings and dividend growth

The early years of the seventies have been difficult ones for the Republic's economy, and the progress of company earnings and dividends has suffered accordingly. Metal and commodity prices, on which South Africa remains heavily dependent, have been depressed, the balance of payments has been through a period of crisis and the economy has passed through a recessionary phase. Whilst there is comforting evidence that the end of these temporary difficulties could now be in sight, the economy is still beset with a number of structural weaknesses. Coupled with the impact of increased inflationary pressures, in the aftermath of two devaluations of the rand, these weaknesses can be expected to inhibit the growth rate of company earnings and dividends over the next few years.
At the same time it can hardly be argued that the outlook for equities was uninterruptedly serene during the sixties. The investor of 1960 was, over the next decade, to be confronted with such hazards as the tailing off of capital expenditure by the gold mines, the aftermath of the "wind of change" speech, Sharpeville, the declaration of a Republic, the panic withdrawal of funds from "African" territories after the Congolese eruptions, and a mounting of pressure for the boycott of South African goods.
The performance of the economy during the sixties was far better than might have been expected against such a background. Manufacturing output rose by an average of 8¼% per annum; much of this represented the upsurge between 1963—1965, and the rate in the late sixties was of the order of 6½%. Over the decade, the average rate of increase in consumer prices was 2½% per annum, rising from under 2% in the first part of the period to over 3% in the latter years.
Had the taxed profits of the companies included in this survey risen at the same rate as the increase in the money value of manufacturing output, then earnings per share of the average company would have grown by 10¾% per annum, compared with the 5¾% actually recorded.
About 1½% of the differential of 5% can be attributed to the rise in the rate of company tax from 30% to 40%, but the reasons for the remaining differential of 3½% are a matter for conjecture.
In the first two years of this decade, manufacturing output rose at less than 4% per annum, whilst consumer prices have risen at over 5% per annum and their rate of increase has recently accelerated.
These recent figures are, however, of limited validity in making longer term projections. The rate of growth of manufacturing output has clearly been reduced by a confluence of adverse factors, and in particular by the recession of 1971, whilst the rate of price escalation has received an exceptional stimulus from the two devaluations.
At a broad guess, both manufacturing output in real terms and the rate of inflation might average increases of 5% per annum during the present decade.

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*This is demonstrated in the following simplified example:

	Value of R10 000 after 10 years	Growth rate p.a.
Company A	16 289 ——→	5%
Company B	25 937 ——→	10%
Average of individual growth rates	20 610 ←——	7½%
Average of portfolio	21 113 ——→	7¾%

If, as some observers believe, the initial impact of inflation is to erode corporate profits, earnings could grow at a slower rate during the seventies than they did in the sixties.
Against the differential of 3½% (excluding the factor of tax escalation) that existed between the rate of increase in company earnings and the money value of manufacturing output during the sixties, the margin might well rise to around 6% during the seventies. Thus, company earnings could perhaps be expected to rise at 4% per annum during the seventies, as compared with the 5¾% achieved in the sixties. Ten years of growth at 4% per annum would imply an increase of 48% in earnings and, in the absence of any swings in market sentiment, would lead to a commensurate appreciation in share prices.

Swings in investment sentiment

Temporary swings in investment sentiment, which are the manifestation of the bull and bear phases of share markets the world over, are not the concern of this survey. It is, none the less, pertinent to enquire whether there is a norm for acceptable market ratings as applicable to South African equities and whether the norm can be expected to alter during the course of the next few years.
Over the past five years South African dividend yields have fluctuated between extremes of about 3% and 6½%, with an average of around 4½%. As a rule, dividends have been twice covered by earnings.
As a comparison, earnings and dividend yields in New York (as measured by Standard and Poor's index of 425 Industrials) are currently 5¼% and 2½% respectively, whilst the Financial Times index of industrial ordinaries reflects returns of 4¾% and 3%.
In all three countries dividend yields are well below the returns on fixed interest investments and have been so for some years. Long term U.S. Government Bonds currently yield 5½%, the yield on British Consols is 9½% and the yield to redemption of long dated R.S.A. stock is 8¼%.
How attractive is the real rate of return on a fixed interest investment yielding, say, 8½% in a period when inflation persists at a steady 5% per annum? For an investor with a marginal tax rate of 40% the arithmetic would run roughly as follows in the first year:

Gross return	8,50%
less taxation at 40%	3,40%
Cash received	5,10%
Real value of cash (5% inflation)	4,85%
less loss in real value of capital	5,00%
Net "performance" in real terms	—0,15%

Poor though this return may be, it will decline progressively in subsequent years owing to the fact that the erosion in the value of money continues at a compounding rate.
Relatively few investors are consciously aware of the paucity of the real return on a fixed interest investment; but it is inevitable that an era of persistent inflation at a higher rate than hitherto experienced will persuade increasing numbers of them to hedge into equities. If the norm of dividend yields were to settle at, say, 3½%, then the real return to an investor on the premises outlined above would be as follows:

Year	**1**	**2**	**3**
Real value of capital at start of year	100,00	98,80	97,61
Gross dividends (@ 4% p.a. growth)	3,50	3,64	3,79
less tax @ 2/3 of 40%	0,93	0,97	1,01
Cash received	2,57	2,67	2,78
Real value of cash (5% inflation)	2,44	2,41	2,38
Cash value of capital at end of year (4% growth)	104,00	108,16	112,49
Real value of capital at year end	98,80	97,61	96,45
Decline in real value over the year	—1,20	—1,19	—1,16
Net "performance" in real terms	1,24	1,22	1,22

It is notable that even at the relatively low yield (by historic standards) of 3½%, the real performance of equities is superior by 1,39% to that of the fixed interest investment. In money terms the differential in favour of the equity is slightly greater, at 1,47% in the first year.
Thus, even though lower real growth in manufacturing output and a higher rate of inflation can both be expected to inhibit the growth of corporate earnings in the seventies, scope still exists for a re-rating of equities to a lower yield basis.

Potential returns

The following table compares the prospective combined returns (in money terms) on the alternative assumptions of unchanged equity ratings and a re-rating to a 3½% dividend yield for investors entering the market in December 1969 and in June 1972:

	end-1969 investor	mid-1972 investor
Dividend yields on cost		
Yield at start of period	3,9%	5,1%
Average yield over period at 4% p.a. growth	4,9%	6,1%
Yield as at December 1979	5,8%	6,8%
Returns if no swing to equities as from purchase date		
Annual appreciation in share price	4,0%	4,0%
Combined return p.a.	8,9%	10,1%
Returns if equities move to 3½% yield		
Total appreciation in share price	145,0%	161,0%
Capital growth per annum	9,5%	13,5%
Combined return per annum	14,5%	19,5%

INDIVIDUAL PERFORMANCES

As table I shows, there have been wide variations in the progress made by individual shareholdings over the two time periods.
The performances of the non-gold equities have ranged from Murray & Roberts' spectacular 57¾% per annum in the ten year period (or 45½% per annum in the 12½ year period) down to Amalgamated Collieries' modest ¼% per annum to 1969 or Clydesdale's 2¼% per annum to mid-1972.
The performances of the gold mines have been scattered over a narrower spectrum, partly because only a few of them were included in the study. In the period up to December 1969 the best performance was President Brands' 11¼% per annum; only 6 of the 45 non-gold equities produced worse performances. In the period to June 1972 the best performance amongst the gold shares was West Driefontein's 13¾%; only 11 of the 42 non-gold equities produced worse performances.
Up to the end of 1969 only two of the non-gold equities performed worse than the average of the gold shares, whilst for the longer period only five of them did so.
In table II, an attempt has been made to answer the fourth question posed in the introduction to this study: is there any evidence that a statistical basis exists for selecting those stocks most likely to provide a handsome return in the coming years? In the table, the six highest and lowest earnings and dividends yields and the highest and lowest rates of earnings and dividend growth have been compared with performance rankings for the ten years to December 1969. The table points to two intriguing and surprising conclusions, which are of special significance in formulating future investment decisions.
The first conclusion is that the investor who accepts a low initial earnings or dividend yield in the expectation of being rewarded by an above-average rate of capital and income growth will probably be disappointed. Of the seven stocks offering dividend yields of 4,2% or less in 1960 (against the average of 6,4%) only one, J.C.I., produced outstanding growth in its earnings or dividends. For the six stocks offering earnings yields of 7,7% or less (against the average of 12,6%) the same position applied. All the other shares offering low earnings or dividend yields at the start of the period achieved below-average performance rankings. The shares offering a low dividend yield, for example, produced an average performance of 14¾% per annum, against the overall average of 22¼%.
The second conclusion is that the decision to buy a share offering an unusually high initial dividend yield does not, as is commonly supposed, entail a sacrifice in long-term investment potential. Table II shows that the six shares with the highest dividend yields in 1960 all ranked amongst the best nine performers in the subsequent decade. The least impressive performance of these shares was a handsome 34% per annum by Ropes and Mattings; the best performance was Barlows' 43% per annum.

TABLE I: Earnings, dividend and price performances from 1st January, 1960, to 31st December, 1969, and price and dividend performances to June 1972

Name of Company	Performance Ranking to Dec. 1969 1 (a)	Performance Ranking to June 1972 1 (b)	Value of original R10 000 in 1969 2 (a)	Value of original R10 000 in 1972 2 (b)	Total Dividends received 1960/9 3 (a)	Total Dividends received 1960/72 3 (b)	Compound rate of capital growth to Dec. 1969 4 (a)	Compound rate of capital growth to June 1972 4 (b)	Average dividend return on cost 1960/9 5 (a)	Average dividend return on cost 1960/72 5 (b)	Combined capital growth rate & dividend return to mid 1969 6 (a)	Combined capital growth rate & dividend return to mid 1972 6 (b)	Dividend Yield in 1960 7 (a)	Dividend Yield in 1969 7 (b)	Dividend Yield in 1972 7 (c)	Earnings Yield in 1960 8 (a)	Earnings Yield in 1969 8 (b)	Compound rate of growth to 1969 of Earnings 9 (a)	Compound rate of growth to 1969 of Divis. 9 (b)
Murray & Roberts	1	1	148 373	71 606	26 769	35 542	31%	17%	26⅜%	28⅛%	57⅜%	45½%	8,1%	3,7%	3,8%	16,8%	7,9%	21½%	21%
Barlows	2	2	100 650	147 149	17 072	25 610	26%	24%	17%	20½%	43%	44½%	9,0%	2,6%	2,6%	19,1%	5,6%	11½%	11¼%
Greatermans	3	7	118 240	49 983	13 560	19 677	28%	13⅜%	13½%	15⅜%	41½%	29½%	9,0%	2,0%	5,2%	11,3%	4,9%	17⅜%	10½%
Reunert & Lenz	4	5	87 734	56 769	17 224	24 716	24⅜%	15%	17½%	19⅜%	41½%	34⅜%	9,7%	3,1%	5,5%	14,8%	7,6%	16¼%	10⅜%
Tiger Oats	5	4	75 427	92 189	15 812	22 587	22½%	19½%	15⅜%	18%	38½%	37½%	7,5%	3,3%	3,1%	11,0%	5,9%	15%	12½%
Hubert Davies	6	11	69 228	28 845	13 428	18 159	21⅛%	10½%	13½%	14½%	34⅜%	25%	9,0%	2,9%	5,6%	12,8%	5,3%	10¾%	8½%
Huletts	7	3	52 960	83 412	16 086	24 625	18½%	18½%	16%	19⅜%	34½%	38¼%	6,6%	3,1%	5,4%	12,2%	2,7%	2%	9½%
Edblo/Bromain	8	22	56 664	15 499	15 003	18 336	19%	3½%	15%	14⅜%	34%	18½%	10,4%	2,9%	8,6%	21,7%	4,0%	½%	4⅜%
Ropes & Mattings	9	18	36 970	11 026	20 052	23 359	14%	¾%	20%	18¾%	34%	19½%	9,2%	3,2%	8,4%	28,1%	7,8%	Nil	7⅜%
Truworths	10	6	65 382	65 382	12 737	17 159	20½%	16½%	12⅜%	13⅜%	33½%	30%	6,3%	3,1%	3,5%	17,3%	5,7%	8%	12½%
S.A. Breweries	11	9	58 230	46 907	10 454	15 595	19½%	13½%	10½%	12½%	29⅜%	25⅜%	5,9%	2,4%	4,5%	9,5%	3,7%	8%	8½%
De Beers	12	8	58 016	61 538	9 971	13 907	19½%	15½%	10%	11¼%	29½%	26⅜%	6,5%	2,5%	2,5%	12,5%	5,8%	10½%	8%
Nampack	13	10	56 294	49 135	10 385	14 951	19%	13½%	10¼%	12%	29½%	25½%	6,3%	3,5%	6,6%	19,0%	6,3%	10⅜%	10%
Moshal Gevisser	14	—	44 577	—	10 639	—	16%	—	10½%	—	26½%	—	7,7%	3,5%	—	12,3%	8,3%	11⅜%	7½%
JCI	15	19	56 250	42 500	6 825	8 888	19%	12½%	6⅜%	7%	25⅜%	19½%	3,9%	3,4%	2,5%	6,3%	4,6%	15½%	9¼%
Grosvenor	16	15	28 750	26 875	14 378	18 628	11%	8¼%	14½%	15%	25½%	23⅜%	9,4%	6,0%	6,5%	13,8%	8,7%	6%	6%
O.K. Bazaars	17	23	49 392	31 752	7 779	10 143	17½%	9⅜%	7⅜%	8%	25¼%	17½%	5,0%	2,4%	3,8%	10,8%	4,4%	7¼%	9%
Jaggers/Rennies	18	14	35 775	38 985	12 276	14 569	13%	11½%	12¼%	11⅜%	25¼%	23⅜%	6,3%	3,1%	3,2%	9,4%	3,6%	6½%	9½%
Sappi	19	35	35 400	12 362	10 412	13 446	13½%	1⅜%	10½%	10⅜%	24%	12½%	6,0%	3,6%	3,6%	14,5%	5,4%	2⅜%	7⅜%
Anglovaal Cons.	20	20	44 400	34 416	7 654	10 754	16%	10½%	7⅜%	8½%	23⅜%	19%	6,0%	2,3%	3,3%	11,0%	4,5%	6¼%	5½%
Cons. Glass	21	12	28 629	34 245	12 500	17 842	11%	10¼%	12½%	14¼%	23½%	24½%	8,6%	3,9%	5,6%	13,7%	7,2%	7¼%	6%
United Tobacco	22	13	31 109	40 738	10 628	15 072	12%	12%	10⅜%	12%	22⅜%	24%	7,4%	5,0%	4,9%	16,3%	7,8%	4¼%	7⅜%
Dorman Long	23	17	30 888	26 910	9 941	14 341	12%	8¼%	10%	11½%	22%	19⅜%	8,0%	4,2%	5,2%	12,3%	7,6%	6½%	5%
Fed. Stores	24	36	44 000	24 063	4 937	6 312	16%	7¼%	5%	5%	21%	12½%	3,9%	1,5%	3,0%	10,6%	6,3%	9⅜%	5¼%
P.P. Cement	25	28	30 659	23 594	8 091	11 071	11⅜%	7%	8%	8⅜%	19⅜%	15⅜%	6,0%	3,2%	5,1%	17,1%	9,1%	5%	5%
NCP/Sentrachem	26	26	28 646	22 678	8 056	12 084	11%	6⅜%	8%	9⅜%	19%	16½%	3,7%	5,2%	7,2%	8,6%	8,0%	10¼%	14⅜%
Nat. Nav./Trans-Natal	27	24	17 987	18 864	11 234	15 072	6%	5¼%	11¼%	12%	17¼%	17¼%	6,3%	8,2%	8,1%	9,8%	11,4%	7⅜%	8¼%
Lion Match	28	34	23 690	18 025	7 759	10 128	9%	4⅜%	7⅜%	8%	16⅜%	12⅜%	5,7%	3,9%	5,1%	7,7%	7,5%	8%	5%
Becketts	29	16	22 780	34 410	7 616	12 383	8⅜%	10¼%	7½%	10%	16¼%	20½%	6,4%	1,3%	5,1%	22,8%	1,6%	—21½%	—8¼%
Bakers	30	27	21 860	26 976	8 000	9 953	8¼%	8¼%	8%	8%	16¼%	16¼%	7,0%	3,8%	3,8%	13,0%	7,2%	1¼%	1¼%
Anglos	31	25	26 611	35 766	5 605	7 676	10¼%	10⅜%	5½%	6¼%	15⅜%	17%	4,2%	2,8%	2,2%	6,4%	4,9%	7½%	6%
CNA	32	33	26 183	21 820	5 309	8 005	10%	6½%	5¼%	6½%	15¼%	13%	4,5%	2,5%	4,7%	10,0%	8,7%	8½%	3½%
Ass. Wine	33	—	16 333	—	9 176	—	5%	—	9¼%	—	14¼%	—	8,5%	6,0%	—	11,4%	11,6%	5¼%	1½%
Schweppes	34	32	13 634	14 997	10 608	12 380	3%	3¼%	10½%	10%	13½%	13¼%	6,8%	8,0%	4,5%	9,1%	9,8%	4%	4⅜%
Reynolds	35	21	17 786	31 620	7 292	11 838	6%	9½%	7¼%	9½%	13¼%	19%	6,6%	2,7%	5,0%	14,3%	3,8%	—8¼%	—11¼%
Union Corp.	36	29	22 302	28 934	4 684	6 417	8½%	9%	4⅜%	5¼%	13%	14¼%	3,0%	2,6%	5,6%	8,8%	5,5%	3½%	7½%
Nat. Canvas	37	39	21 246	12 866	4 313	5 413	7⅜%	2%	4¼%	4½%	12%	6½%	4,2%	2,4%	5,1%	16,7%	6,4%	—2¼%	1⅜%
Ver. Refracs.	38	31	15 508	20 405	7 201	9 629	4½%	6%	7½%	7⅜%	11⅜%	13⅜%	6,1%	5,5%	4,8%	10,2%	10,2%	4⅜%	3½%
De Beers Ind.	39	37	16 400	16 000	6 500	8 000	5%	3⅜%	6½%	6½%	11½%	10¼%	4,5%	4,6%	5,0%	5,4%	5,6%	5½%	5½%
Amcor	40	—	16 847	—	4 814	—	5½%	—	4⅜%	—	10¼%	—	5,0%	2,3%	—	15,1%	4,4%	—7½%	—2⅜%
Plascon-Evans	41	30	11 927	13 333	7 018	14 577	1⅜%	2¼%	7%	11⅜%	8⅜%	14%	6,1%	5,9%	6,0%	11,6%	7,6%	—2½%	1¼%
Edworks	42	38	15 810	16 856	3 581	4 930	4⅜%	4¼%	3½%	4%	8¼%	8¼%	2,3%	3,7%	3,6%	6,5%	11,0%	10¼%	9½%
Usco	43	40	11 080	9 171	5 684	7 642	1%	—⅜%	5⅜%	6%	6⅜%	5¼%	4,8%	5,6%	6,8%	14,3%	11,6%	—1¼%	2⅜%
Clydesdale	44	42	7 731	6 627	5 139	6 732	—2½%	—3¼%	5¼%	5½%	2⅜%	2¼%	4,3%	8,2%	9,6%	4,3%	10,4%	6½%	4½%
Amal. Colls.	45	41	5 239	7 415	6 930	8 381	—6¾%	—2½%	7%	6⅜%	½%	4¼%	7,3%	10,8%	8,8%	9,2%	14,5%	—2%	—2½%
AVERAGE (excluding gold)			40 080	35 063	10 025	13 965	12½%	8¾%	10%	11¼%	22¼%	20%	6,4%	3,9%	5,1%	12,6%	6,9%	5⅜%	6%
Pres. Brand	1	2	12 650	11 385	9 457	12 715	2½%	¾%	9½%	10¼%	11⅜%	11%	7,0%	11,5%	11,1%				7⅜%
West. Drie.	2	1	11 088	20 160	7 121	10 030	1%	5¾%	7%	8%	8%	13⅜%	5,3%	6,5%	6,7%				3%
Blyvoors.	3	3	7 418	10 642	8 393	10 393	—3%	½%	8½%	8¼%	5½%	8¾%	7,8%	10,4%	7,9%	— Not applicable —			Nil
Western Holdings	4	4	7 880	10 506	7 780	10 121	—2⅜%	½%	7⅜%	8%	5¼%	8½%	5,4%	11,6%	10,1%				5¼%
Marievale	5	5	4 914	5 863	10 133	12 420	—7¼%	—4½%	10¼%	10%	3%	5½%	11,5%	20,0%	11,8%				—1½%
AVERAGE (Gold)			8 790	11 711	8 577	11 136	—2%	½%	8½%	9%	6¾%	9½%	7,4%	12,0%	9,5%				3%

There are two aspects to the outstanding performance of the high-yielding shares. The first is that if subsequent growth had been distributed randomly as between high-yielding and low-yielding shares, then the high yielders could have been expected to produce above-average returns. This is because the high yielders had already arrived, at the start of the period, at a level of return on the amount invested that could be expected to be achieved by lower yielding shares only after they had succeeded in producing good growth for several years. The second aspect is that subsequent growth was not, in fact, randomly distributed. It tended to be concentrated in those stocks which, though not without promise, were for one reason or another regarded as being dubious and which the market rated so poorly as to place them on a high dividend yield basis. Of the six stocks offering dividend yields of 9% or more in 1960, two achieved exceptional growth rates in dividend payouts and three achieved exceptional growth rates in their earnings per share.

Similar results applied for the six shares offering the highest earnings yields in 1960, though the tendency was not so marked as with the high dividend yields. Of the six shares offering earnings yields of 17,3% or more, two achieved exceptional rates of dividend growth and one achieved an exceptional rate of earnings growth. Four of them ranked amongst the best ten performers. Of particular interest was the performance of Becketts, which started at the high earnings yield of 22,8%. Despite the company's disappointing subsequent record (with declines of 8¼% per annum in dividends and 21½% per annum in earnings), the shares produced a performance of 16¼% per annum and were ranked twenty-ninth.

These results indicate strongly that the investor who follows current market fancies is destined for disappointment in the long run. If a share is bought expensively in relation to its current earnings and dividends then, even if subsequent growth is exceptional, the performance of the investment is likely to be no

better than average. If subsequent growth is no better than average the performance of the shares is likely to be poor. Conversely, if a share is bought cheaply in relation to its fundamentals, then even a modest rate of subsequent growth will be sufficient to ensure a good investment performance. If subsequent growth is above average, which may well be the case, then the performance of the investment will be exceptionally good.

This conclusion is, of course, subject to the caveat that it is based on the records of established companies. The correlation between a high initial dividend yield and a high subsequent performance would not necessarily apply to untried and undercapitalised companies with inadequate management.

Table II Best and Worst Performances from January 1960 to December 1969

Compared with: (a) Highest and lowest initial dividend and earnings yields. (b) Highest and lowest growth rates of dividends and earnings.

			Dividend Yields in 1960		Earnings Yields in 1960		Dividend Growth Rates		Earnings Growth Rates	
Name of Company	Performance ranking	Combined return p.a.	Six highest	Six lowest	Six highest	Six lowest	Six fastest	Six slowest	Six fastest	Six slowest
Murray and Roberts	1	57¾%					21 %		21½%	
Barlows	2	43 %	9,0%		19,1%		11¼%		11½%	
Greatermans	3	41½%	9,0%						17¾%	
Reunert and Lenz	4	41¼%	9,7%				10¾%		16¼%	
Tiger Oats	5	38¼%					12½%		15 %	
Hubert Davies	6	34¾%	9,0%							
Edblo/Bromain	8	34 %	10,4%		21,7%					
Ropes and Mattings	9	34 %	9,2%		28,7%					
Truworths	10	33¼%			17,3%		12½%			
API/Nampack	13	29¼%			19,0%					
J.C.I.	15	25¾%		3,9%		6,3%			15¼%	
Federated Stores	24	21 %		3,9%						
N.C.P./Sentrachem	26	19 %		3,7%						
Lion Match	28	16¾%				7,7%	14¾%			
Becketts	29	16¼%			22,8%			−8¼%		−21½%
Bakers	30	16¼%						1¼%		
Anglos	31	15¾%		4,2%		6,4%				
Reynolds	35	13¼%						−11¼%		−8¼%
Union Corporation	36	13 %		3,0%						
Natal Canvas	37	12 %		4,2%						−2¼%
De Beers Industrial	39	11½%				5,4%				
Amcor	40	10¼%						−2¾%		−7½%
Herbert Evans	41	8¾%						1¼%		−2½%
Edworks	42	8¼%		2,3%		6,5%				
Usco	43	6¾%								
Clydesdale	44	2¾%				4,3%				
Amalgamated Collieries	45	¼%						−2½%		−2 %

SUMMARY AND CONCLUSION

In this study a detailed examination has been made of the earnings, dividend and share price performances of 50 companies over the ten years from the beginning of January 1960 to the end of December 1969 and a supplementary exercise has been performed covering the 12½ years to the end of June 1972.

Over the ten-year period the 45 non-gold mining equities included in the study yielded the investor an average dividend of just over 10% on cost. The average share appreciated in value at a compound rate of just under 12½% per annum, giving the investor a "performance" (income plus capital) of 22¼% per annum. Because of the effect of some highly successful individual shares, the performance of the portfolio as a whole was even higher than this figure, being 24¾% per annum.

The net decline in share prices up to the end of June 1972 reduced the average company's performance to 20% per annum for the 12½ year period.

Among the individual shares, the best performers as a group were those offering the highest initial dividend yields. Shares offering high initial earnings yields also performed exceptionally well. The superior performance of these groups appears to have resulted from a compounding of two factors: firstly, they were already standing at dividend and earnings yields that would be attained by lower yielding shares only after a few years' growth; secondly, despite their poor market ratings, they tended to achieve a considerably higher rate of earnings and dividend growth than average. It follows that although virtually all investors in equities did well, those who did best were the ones who concentrated on sound companies backed by levels of earnings and dividends that had already been visibly achieved. Those who did worse were the ones who bought the glamour stocks of the moment on the assumption — which was unwarranted — that their high rates of growth in future years would at least compensate for their low current yields.

The indications are that the first few years of the seventies will see a lower rate of real growth and a higher rate of inflation than prevailed in the sixties. On the assumptions of a growth rate of 4% per annum in underlying dividends and of no swing of investment sentiment to or from equities compared with the position as at date of his purchase, the investor who bought at the end of 1969 can look to a ten-year performance of just under 9% per annum, consisting of 4% per annum capital growth and 5% per annum dividend yield on cost. The investor entering the market at the end of June 1972 can look to a combined return of just over 10% per annum, consisting of 4% capital growth and an average dividend return of 6% on cost.

These performances are considerably lower than the averages recorded during the sixties and during the 12½ years to the end of June 1972. None the less they compare favourably with the prospective performance of a fixed income investment, such as a mortgage bond, offering an interest rate of 8½%.

If the need to hedge against a persistently higher rate of inflation persuades more investors to move into equities, the investment status of ordinary shares could be further up-graded. If their normal dividend rating were to move to 3½%, then the investors of December 1969 and June 1972 could enjoy performances of 14½% and 19½% per annum respectively in the period up to the end of 1979.

Conjectural though these projections may be, they do provide a measure of what the rest of the decade may have to offer the investor in equities. Unhappy though their experiences may have been at the end of the sixties, most holders of equities, given reasonably normal progress in the economy and the share market, should have little reason to regret their choice of investment medium in the coming years.

INTEREST RATES—ANOTHER ASPECT

MERTON DAGUT, M.A. (Witwatersrand)

Interest rates fascinate me. Why are they what they are, what are they going to be next week and next year? This note is not an attempt to cover the vast and complicated topic comprehensively — I would not be able to — but only to put another and sometimes neglected idea back into the melting pot: if we look for the 'real rate of interest' we may not find it, but we should find the way to a possibly very useful line of enquiry — at any rate some interesting questions arise — thus an interim report on work in progress.

THE FIRST LAW OF MARKETS

The first law of the economics of markets (or for the technically minded, 'neo-classical' and 'neo-neo-classical' analysis) is "to he who hath shall be given". This law explains also the existence of 'interest' on money. It is the price charged in terms of money itself directly rather than in terms of goods, by those who have money or anything that can do the work of money (the granting of generalised command over goods and services, both present and future), to lend it to others to whom by so doing they give up this command 'now' in return for a bigger chunk of command 'later'. It is paid by those who require a good or service 'now' but do not already "hath" and so must either steal or borrow the generalised purchasing power of those who "hath". If they borrow they usually bind themselves to give up more 'later'.

There may be some pain in having to forego present unspecific command over real goods or services, but in the main it is because people value the delights of the present more highly than those of the future and because most societies contain more would-be-spenders who seek to invest in real assets which will generate future income streams than would-be-savers, that interest rates are positive rather than negative. (Again for those who would like to relate this view to text-book terminology, the contention is that the elements of true economic rent and time preference in interest could be larger than some have recognised and also that real investment demands are more important than directly consumption-orientated demands in the aggregate of borrowing.)

A FALSE CONUNDRUM

The operation of the second law of the economics of markets — that of price equating supply and demand — in periods of inflation complicates the argument that interest rates are usually positive. The law dictates that goods, services or assets in over-supply must tend to become cheaper; if only relatively to other goods, etc.

Now inflation is thought by many to be 'caused' by too much money. However, while one need not necessarily accept that causality, there can be little doubt that an overabundant supply of money or of that which does its work is a necessary precondition for inflation. Nor, however it is caused, can it be doubted that inflation is a process which makes each unit of money less valuable in terms of goods and services. But during periods of inflation the present money price of this asset which is in over-supply and depreciating in value tends upwards not downwards— in both relative and absolute terms. This remarkable seeming claim is borne out by the figures of the recent past. From the graph it can be seen that the price of money measured by the private long-term market rate of interest increased between 1963 and the end of 1971 by 4,25 percentage points on a base of 6 per cent, i.e. by more than 66 per cent. The consumer price index rose by 33 per cent over the same period, i.e. by half that amount.

It was to grapple with this conundrum that this note came to be written. But the problem is a false one for the conundrum vanishes when it is realised that money itself is not a good, only an asset the value of which is its generalised command over goods, services and other assets which can bridge time or yield income streams. Looked at in this way its price can be seen not to behave atypically.

OTHER MAJOR INTEREST RATE DETERMINANTS

Before turning to the concepts and calculations behind the graph, however, another major set of determinants of the price of money must be recalled. In the short-term as well as being a function of what they were and what it is believed they are going to be, interest rates are determined by the institutional constraints in the market. They are set by the rules, the behaviour patterns and the skill of the players of the financial game. Any thorough-going analysis of interest rate changes should start with an examination of the structure of the market and the weights and track records of the consistent borrowers, the large lenders, the various financial intermediaries and the policy of the referee and his assistants. The reactions of the players to various stimuli, not least importantly their sensitivity to changes in rates of change and alterations in expectations, should be probed and understood.

In the longer run though, because institutional arrangements change by evolution (or learning) only slowly and by the passing of new laws only at discrete intervals, the pace of the economy, its underlying liquidity flows (themselves influenced by institutional constraints) and borrowing demands, affected in turn by the type and tack of official policy make themselves felt.

Thus underneath it all, unless the extra-market interference is so great as to distort the allocative mechanism, interest rates are the prices which equate the demand for and the supply of the various types of loanable funds. Therefore in turn they are determined by and help to determine the flow of funds between sectors, regions and through time the allocation of the real goods and services over which the funds enable their holders to exercise generalised demand.

WHAT INFLATION MEANS

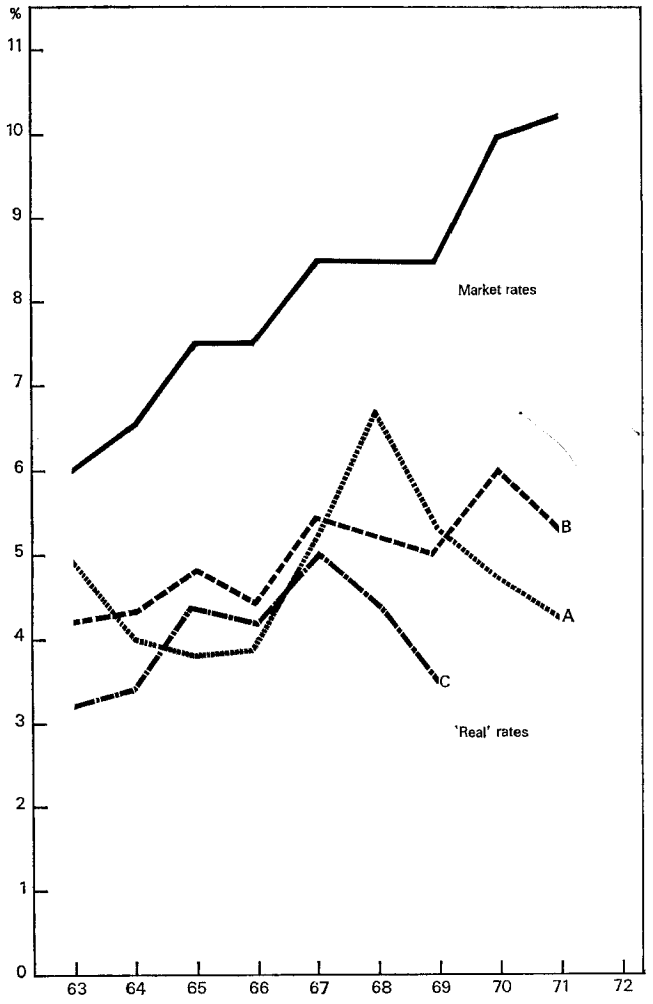
Now to inflation: because money or credit is akin enough to a real good to be thought of in terms of units of real goods, changes in the rate of price inflation or expectations of such changes have an immediate effect on both the demand for and supply of loanable funds and hence over capital market interest rates.

Consider first the demand for loanable funds: accelerating price increases lead to demands for larger and larger sums to finance the same amount of real purchases of capital goods. Except in the happy event of technological productivity gains being equal to the price increases of investment goods or in a less happy switch in real income distribution in favour of 'profit' and against 'wages', price inflation means that entrepreneurs who wish to create future real income streams equal to those in the past can do so only at a higher unit cost per capital input. In short inflation means that they must borrow more 'now' to produce as much 'later' as they did 'earlier'. The price increases may lead also to bigger anticipated money profits from funds appropriately employed in real productive sets. To seek this enhanced profit borrowers would want to borrow more and indeed may be prepared to pay more for their borrowings. (In Keynsian language, inflation of this type shifts a money-measured marginal efficiency of capital schedule upwards and to the right.) This latter may be offset, however, if the inflation is in a cost-push phase and is accompanied by sufficient consumer resistance to cause the anticipated profits to be eroded by the increases in wage and other costs inherent in the inflation view.

Turning to the supply side: a preference for 'growth assets' (i.e. ones which it is hoped will inflate as well) such as equities or land may dry up the steam of funds available for fixed-interest lending, unless relative price movements cause doubt to be cast, too, on the validity of the 'growth thesis'. In the longer run inflation, which comes about in the first instance because in aggregate present consumption is preferred to future consumption, may result in so great a general preference for consumption rather than saving that the already relatively short supply of domestic institutional funds available for investment dries up all but completely. Money rates of interest will then tend to an infinitely high level while the economy hurtles itself to a dead still.

ADJUSTING FOR PAST AND PRESENT INFLATION

On the graph, the market rate of interest plotted is the average yield on private sector debentures and stocks. This rose continually with brief periods of stability in 1966 and 1968-69. The remaining three lines represent attempts, by various methods, to remove the effects of price inflation from the market rates.



The simplest is A, where the average increase in the consumer price index has been deducted from the market rate of interest. Implicit in its construction is the assumption that lenders and borrowers are heavily influenced by the experience of present price inflation and adjust their anticipated income streams to it.

This line suggests that inflation was the main cause of rising rates over the years 1964-66 and again from 1969 to 1971, while 'real' causes were dominantly operative only during the 1967-68 period. The 'real rate of interest' in 1971, according to this method of measurement, was lower than that of 1963. The trend displayed by line A does raise interesting questions about the possible change in time preference during the post Sharpeville recovery and focused attention on the effect of institutional changes as the authorities took an increasingly anti-inflationary monetary stance in 1966 and 1968 before the economy was set awash by the capital inflow. But it tells also that the consumer price index used in this form is not a suitable 'deflator' for interest rates.

Line B offers a more hopeful means of diagnosis. The market rate of interest for each year is here reduced by the gap deflator averaged for that year and the two immediately preceding it.

The importance of real investment as a source of borrowing demand is given its rightful place because investment goods enter into the gdp deflator but not the consumer price index.

It also implicitly assumes, and with justification, that people base their expectations on recent past experience as well as on the events of the ephemeral present.

A far more stable trend is indicated. With the exception of 1971 each increase in the market rate is accompanied by a rise in the real rate, and a levelling-out of the former, as money supply caught up with demand, or the effects on profits of future inflation curbed borrowers' enthusiasm, by a decline in the latter. Thus between 1963 and 1970 the pattern of interest rates can be seen to have been determined basically by 'real' forces in the economy, although inflation probably reinforced the factors pushing it upwards, and prevented it from falling when 'real' causes were exerting downward pressure. In 1966, for example, the overall balance of payments swung from deficit into surplus and domestic saving sufficed to finance total investment. 'Real-real' forces were at work, the rate of increase of total fixed investment fell from more than 22 per cent in 1965 to below 6 per cent in 1966. Not surprisingly with slackened borrowing demand, yieds fell in 'real' terms, but market rates remained unchanged. During 1968 and the first half of 1969 massive capital inflows resulting from international currency uncertainty pushed 'real' rates down, but inflationary expectations attracted funds into equities and again fixed interest market rates did not fall.

In 1971 the 'real' and market rates moved in opposite directions. The supply of loanable funds was relatively short, mainly because of a large balance of payments deficit. Demand in money terms was buoyant — gross domestic investment rose by 15 per cent.

But in 'real-real' terms, the demand for funds probably slackened appreciably. Gross investment corrected back to constant prices, in fact, increased by only 7 per cent. With productivity in industry and the volume of exports in a decline, borrowers were attracted to the market more on account of opportunities to profit by sharply rising prices than by hopes of increasing sales volumes — the allocative mechanism of inflation was at work and it appears that the upward movement in rates during 1971 was almost exclusively an inflationary phenomenon.

ADJUSTING FOR FUTURE PRICE INCREASES

The line C is an attempt to correct interest rates not merely for current and past inflation rates, but for anticipated price rises as well as the present inflation. This has been done by deducting from each year's market rates the average gdp deflator for that year and the two succeeding years — that is why the line stops in 1969. It is implicitly assumed that investors' expectations with regard to inflation are borne out by events. The sharp decline in 1968-69 to a level much lower than that of line B, indicates that, if such expectations were operative in the market, the real rate in the conditions of 1969 was only about 3½ per cent. This suggests even more strongly that inflationary expectations were the reason for the failure of market rates to decline despite the weight of funds even after the equity market lost its magnetic attraction.

CONCLUSION

Each of the three lines helps me understand some aspect of the interrelated forces which influence interest rates. But none, I believe, is in itself other than a useful, if rough estimate of the 'real' rate of interest in South Africa. Nor to my knowledge has enough theoretical work been done to make it possible to plot the 'real-real' rate. Intuitively, though, I think that the line, when it is drawn, will trace a pattern somewhere between that of 'B' and 'C' in the graph. One hopes that the research will be done because the questions raised in this note have suggested that interest rate changes, when carefully enough read, are a useful and up to date analytical input for diagnosing the present state of the economy — and for those whose nerves are strong enough for preparing predictions of what is to come.

THE USE OF COMPUTERS IN INVESTMENT RESEARCH

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In the context of the discussion held recently at a combined symposium[1] of The Investment Analysts Society of Southern Africa and the Actuarial Society of South Africa on the use of computers in investment research, it is worthwhile taking a closer look at certain aspects of the subject, illustrating with practical examples.

1. FORECASTING FUTURE EARNINGS

The first matter requiring consideration is the use of the computer in forecasting future values for earnings and dividends of a company and the discounting of these at a desired rate to arrive at a present value. For any particular company projection it is necessary, firstly, to assess which are the key variables which affect the company's profits and then to make certain assumptions as to the future trend of these variables. Such variables usually include sales, profitability, rates of depreciation, interest paid, taxation, dividend payout, ratios of stocks, debtors and creditors to sales, expenditure on fixed assets, etc.

The important end-result which the analyst usually aims at estimating is the terminal earnings and dividend per share. With the future growth rates or values of the key variables as inputs, a computer programme can be prepared to undertake the projection and forecast the terminal earnings and dividend per share, accompanied by the corresponding balance sheet, profit and loss account and source and disposition of funds statements and relevant ratio analysis. This is usually done in a deterministic manner by the individual analyst.

(*a*) The Deterministic Method

The deterministic method of earnings projection concerns assigning a set of fixed values to the key input variables and obtaining as output a set of fixed values for projected earnings.

The deterministic method is such a tedious process, however, that it is usual for an analyst to carry out a single point estimate projection using one pre-determined value for each input variable. Possible variations in the values of these variables, some of them very large, are ignored because it is too tedious a job to alter the value of these variables and carry out the projection all over again. With the aid of the appropriate computer programme, however, projections can be made, in a short space of time and with little difficulty, on all the permutations of different values of the input variables which the analyst deems necessary to test. All that the analyst needs to do is to adjust the values of input variables in accordance with the permutation desired and then to run off the programme which derives the resultant projection. A consequent and most useful application of the above idea is the immediate updating of a projection and valuation of a share on the appearance of the latest results or annual report, or when a new factor manifests itself which can influence the value of an input variable.

A major drawback in the deterministic approach to fundamental analysis is that a single point estimate cannot assemble in one movement all possible value variations to give an idea of the likely movement about the projected earnings and dividends that can be expected from a share. In other words, the risk factor of an investment in a share cannot be quantified in any form whatever and, as a result, investment analysts tend to ignore this very important factor. Projections by means of probabilistic models, however, can materially assist in the solution of these problems but because they involve such a large number of calculations cannot be made without the aid of a computer.

(*b*) The Probabilistic Method

(i) One way of effecting the probabilistic approach is to attach fixed values to possible outcomes (usually in the form 'probability of a high value', 'medium value' or 'low value', such that the sum of these probabilities is unity). A so-called 'probability tree' can thus be built up, the extent of which will depend on the number of variables to which probabilistic elements have been attached. The computer's task is to perform in a few minutes, or even seconds, the thousands of multiplications involved in combining all probability values and to determine the final value range with which the analyst is concerned. Only with a computer are such calculations possible.

(ii) A second way of effecting the probabilistic approach is to attach to each variable an actual probability distribution specifying the parameter values of the distribution as input. The computer can then be programmed to carry out a Monte Carlo simulation on all the probability distributions to yield the required histogram (or probability graph) for the output required, usually earnings or dividend per share at some future date. (Monte Carlo simulation refers to the random sampling of a variable from a distribution of that variable.) It can be clearly seen that this is an impossible task to perform manually.

The aptness of the second approach is that the analyst can translate into a probability distribution his subjective judgement concerning the value of a variable with regard to its possible variance, skewness, etc. and combine his subjective judgements on all variables to yield a single all-embracing picture of the output in which he is interested, viz. the probability distribution of the projected earnings or dividend. Needless to say, the accuracy of the final result is dependent on the reliability of the analyst's subjective judgement and on the number of Monte Carlo trials which the computer is ordered to carry out.

In order to demonstrate the efficacy of computerisation employing the Monte Carlo probability technique described above, it is worthwhile considering a practical example of share evaluation,

Table I

	Type of distribution	Mean	Standard deviation
Sales (% annual growth rate in monetary terms)			
Wheat	Normal	11	1,5
Maize	„	13	1,75
Feeds	„	14	11,0
Oils	„	15	2,5
Distribution	Rectangular	−25 to + 25	
Other Income	Skew Normal	15 range from 0 to 35	
Profitability (profit before interest & tax but after depreciation as a % of total assets)			
Wheat	1972 Normal	0,115	0,0025
	1973/75 „	0,12	0,0025
Maize	1972 „	0,125	0,0075
	1973/75 „	0,1275	0,0075
Feeds	1972/75 „	0,125	0,175
Oils	1972/75 „	0,15	0,0075
Distribution	1972 Normal	0,20	0,05
	1973/75 „	0,08	0,03
Short-term interest rate (%)	1972 Normal	5,5	0,25
	1973/75 „	5,25	0,5
Tax rate (%)	1972 Normal	40	1
	1973 „	40	1,5
	1974/75 „	40	2
Dividend as a % of earnings	1972 Normal	47	2
	1973 „	45	3
	1974 „	42	3
	1975 „	40	3

[1] *Held on the 6th June, 1972, in Kelvin Hall, Hollard Street, Johannesburg, to conduct a general discussion on a paper entitled "The Computer for Investment Research" by J. Plymen and R. M. Prevett, Faculty of Actuaries, Edinburgh, March, 1972.*

the case chosen being that of the food group, Tiger Oats and National Milling Company Limited. Tiger Oats is engaged in five principal activities: wheat milling and baking, maize milling, the production of oils and fats, the production of balanced feeds, and general trade and distribution. In addition, the group earns income from certain trade and other investments which it does not consolidate into its accounts.

From analysis of historical accounts and reports, general industry statistics and other usual sources of information available, the probability distributions have been used as input data for the programme for purposes of projecting to 1975, (Table II).

By utilising the above input data (Table I) it has been possible to combine in one movement all the following factors :- the steadiness of sales in the wheat, maize and oils industries which are chiefly dependent on the stable element of population growth; the large variability of feeds sales which are greatly influenced by changes in climatic conditions; the complete absence of any definite sales trend on the distribution side; the historically skewed distribution which has been evident in 'other income'; the control of profitability at 12% for their respective industries by the Wheat Board and, to a lesser extent, by the Maize Board; the increase in Tiger Oats' wheat and maize milling capacity over the past year, which capacity will be utilized in future years, thereby increasing profitability slightly; the slight uncertainty as to the exact level of profitability in the oils industry; the variable profitability of the feeds industry; the high but uncertain levels of profitability of the distribution activities in 1972, resulting mainly from the devaluation of the rand; the low and highly erratic profitability of the distribution side during more normal years; an expected decline in short-term interest rates subsequent to 1972; increasing uncertainty with respect to the company's tax rate the further forward one projects, reflecting possible changes in the rate of company taxation, investment allowances, etc.; a dividend cover which increases slightly over the years in order to help finance an increase in assets; and a highly variable inflation rate of about 5%.

Table II
SUMMARY OF RESULTS AFTER 100 TRIALS

		Mean	Standard Deviation	High Value	Low Value
1972					
Total sales	(Rm)	119,1	2,5	125,2	114,0
Total assets	(Rm)	70,7	2,1	76,4	66,8
Pre-tax profit	(R'000)	8119	412	9325	7381
Profit after tax	(R'000)	4862	260	5594	4366
Dividend per share	(c)	20,74	1,36	25,00	18,00
Earnings per share	(c)	44,08	2,39	50,78	39,55
Operating ratio	(%)	5,50	0,31	6,28	4,86
Current ratio		1,18	0,08	1,37	0,96
Shareholders' interest	(%)	60,69	1,67	64,30	56,40
Pre-tax profit ratio	(%)	18,95	0,90	21,47	17,32
Earnings equity ratio	(%)	11,40	0,58	12,99	10,35
1973					
Total sales	(Rm)	113,7	3,8	143,3	124,8
Total assets	(Rm)	81,1	4,2	9,1	7,1
Pre-tax profit	(R'000)	8672	617	10414	7166
Profit after tax	(R'000)	5185	378	6024	4280
Dividend per share	(c)	21,09	2,08	28,00	15,50
Earnings per share	(c)	47,08	3,46	54,78	38,82
Operating ratio	(%)	5,08	0,49	6,06	3,89
Current ratio		1,04	0,11	1,29	0,75
Shareholders' interest	(%)	56,49	2,88	64,44	50,50
Pre-tax profit ratio	(%)	18,98	1,24	22,57	15,79
Earnings equity ratio	(%)	11,41	0,77	13,04	9,47
1974					
Total sales	(Rm)	150,7	7,0	170,1	133,2
Total assets	(Rm)	93,9	9,0	118,3	74,2
Pre-tax profit	(R'000)	9685	766	11804	8201
Profit after tax	(R'000)	5786	507	7174	4837
Dividend per share	(c)	21,85	2,20	29,00	17,00
Earnings per share	(c)	52,62	4,66	65,36	43,90
Operating ratio	(%)	4,88	0,65	6,05	2,81
Current ratio		0,94	0,16	1,36	0,52
Shareholders' interest	(%)	52,62	4,90	65,46	40,93
Pre-tax profit ratio	(%)	19,75	1,35	23,45	16,96
Earnings equity ratio	(%)	11,86	0,91	14,43	10,14
1975					
Total sales	(Rm)	17,04	1,1	205,3	143,9
Total assets	(Rm)	110,1	1,6	162,4	78,6
Pre-tax profit	(R'000)	10934	931	14334	92,05
Profit after tax	(R'000)	6568	612	8641	5094
Dividend per share	(c)	23,62	2,70	30,00	17,00
Earnings per share	(c)	59,81	5,63	78,87	46,27
Operating Ratio	(%)	4,70	0,83	5,95	2,24
Current ratio		0,86	0,21	1,40	0,36
Shareholders' Interest	(%)	49,08	6,83	65,76	32,29
Pre-tax profit ratio	(%)	20,63	1,43	25,66	17,76
Earnings equity ratio	(%)	12,46	0,99	15,58	9,94

Notice the flexibility which has been engendered into the whole model. On any new set of results that might become known or on the appearance of any new factor which might affect the above variables, the input data can be altered accordingly, and the programme can be re-run to produce a new up-dated projection. A consequent advantage resulting from the use of the computer in the manner described here, concerns the ease with which the analyst is able to convey to the portfolio manager or client changes that have been made in quantitative assumptions.

A Monte Carlo simulation of 100 trials was carried out on the above model, the results of which appear in Table II above.

It can be concluded that Tiger Oats' dividend per share should be between 18,2c and 29,0c in 1975 with 95% confidence (approximately twice the standard deviation on either side of the mean 23,6c) and earnings per share should be between 48,6c and 71,0c with 95% confidence, about a mean of 59,8c.

It can also be immediately observed that the current assets ratio over the years to 1975 will decline to dangerously low levels as liquidity becomes increasingly tight. To a lesser extent this applies to the shareholders' interest as well.

Knowing the past history of Tiger Oats, it could be consequently suggested that the group might come to the market at some time in the future with a rights issue to alleviate the liquidity strain. If deemed necessary, the programme could be altered slightly to make the issued share capital of the group a variable input in order to accommodate such a rights issue. The new programme could then immediately be run to generate a new projection which would assume that the group has a rights issue. It would then become possible, at short notice, to analyse, with the aid of new appropriate statistics, the effects of a rights issue on the group's profits and balance sheet.

If the 95% confidence bands are considered too wide, the confidence level can be reduced to say, 75%, with a narrower range of variation for the values. This confidence limit approach must surely be more meaningful than an actual point estimation, for it reflects the risk involved in investing in the share. But, as indicated previously, such an approach is only made possible by the use of a computer.

Histogram and probability distribution of Tiger Oats' projected 1975 earnings per share

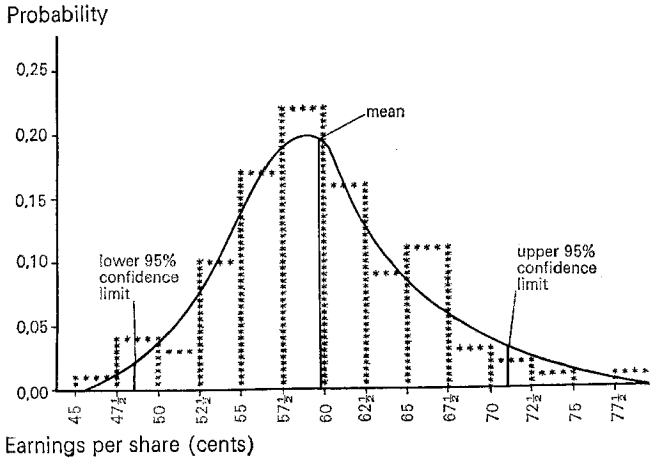


Fig. I

A present value table can now be drawn up on each of the lower confidence limits, the mean and the upper confidence limit values of dividend per share, for example, reflecting the minimum, actual expected and maximum fundamentals of the share. If, for example, the share reflects good value on both minimum and maximum projections, then it would appear to be a buy fundamentally and vice-versa.

The computer can go even further than to state the mean value of the required output variables and their standard deviations. It can even draw for the analyst, according to his needs, the histograms (or probability graphs) of the relative frequency of the output variables. In other words, the expected outcome can actually be depicted on a graph by the computer. The probability distributions and 95% confidence limits of Tiger Oats's projected 1975 earnings and dividend per share appear in Fig. I and Fig. II.

Computer programmes such as the one illustrated can be categorized for different sectors of the market. The most common method of analysis of industrial shares is naturally to have variable total sales and operating ratio, as well as debtors, stocks and creditors as a % of sales. The above example was presented in a slightly more complicated model, merely to illustrate the flexibility of the approach used. The approach, for example, can easily be adapted to the analysis of mining shares. In their case, the chief probabilistic variable is the price of the metal or mineral involved and a separate programme would have to be devised to accommodate this feature.

Histogram and probability distribution of Tiger Oats' projected 1975 dividend per share

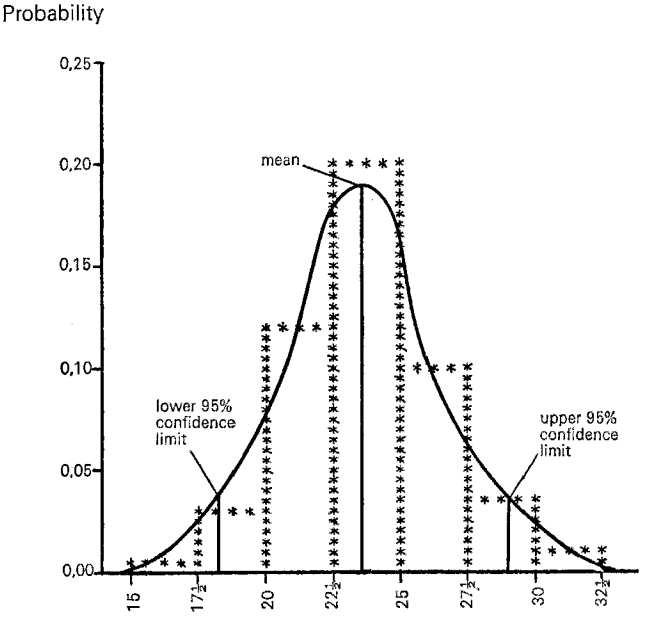


Fig. II

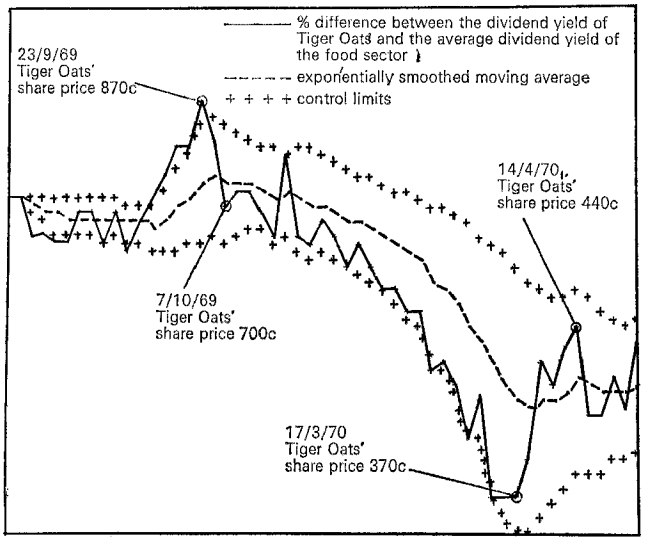
The computer, however, enables us to extend the use of the above ideas even further. Once each share in the market has been analysed in the above way reflecting its terminal dividend or earnings per share accompanied by its terminal variance, we can apply in a practical way the ideas expounded by Sir John Hicks on the pure theory of portfolio selection in Chapters 2 and 6 of his "Critical Essays on Monetary Theory", Oxford Univ. Press, 1967. According to Hicks, the potential gain of an investment is the mean expected rate of return on the investment at the prevailing share price. This may be illustrated in the example set out by the present value table of the mean projected terminal earnings or dividend per share. The risk attached to an investment is the possible variance of that expected mean rate of return. In terms of our example this would be depicted by the variance (or standard deviation) of the projected terminal earnings, or dividend per share. Given the amount of capital available for investment and a specified level of risk aversion, the potential gain (mean) and risk (standard deviation) on all investment possibilities can be combined by a computer programme to generate the ideal portfolio, which will yield the maximum gain for a given amount of risk. As new fundamental research becomes available, input data can be immediately altered and the computer programme re-run to generate advice on what changes should be brought about in the portfolio.

By making probabilistic projections of earnings or dividends with the aid of a computer, therefore, it is possible to effectively apply investment research in practice in what has hitherto seemed to be a purely theoretical concept of portfolio selection.

2. RELATIVE VALUE ANALYSIS

Another area in which computers can help in investment research concerns the relative analysis of investment trust net asset value discounts discussed by J. Plymen and R. M. Prevett in the

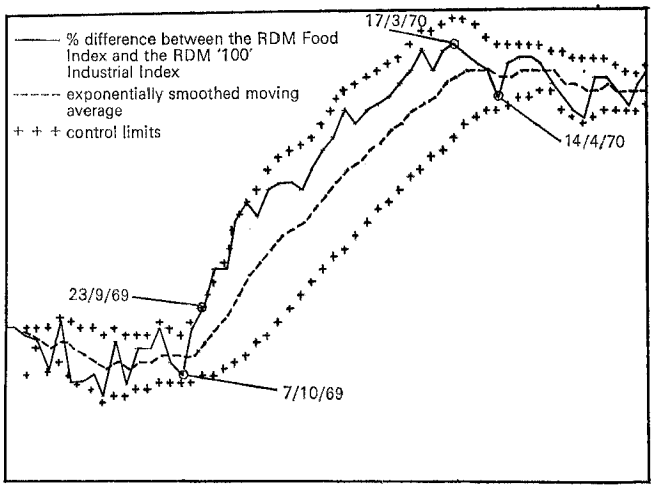
paper entitled "The Computer for Investment Research"" (see footnote on Page 14).
The following is a summary of the method used by Plymen and Prevett:
Examination by Plymen and Prevett of the time series represented by the data on investment trust net asset value discounts showed that the time series were characterized by random variations of the discount about its average value.
A control chart technique suggested itself as a means of identifying major turning points in the discount. Application of this principle involved calculation of the standard deviation of fluctuations of the discount about its average value and then the setting of control limits at a suitable multiple of standard deviations away from the average discount. In order to obey scientific principles on control charts, control limits were set so that they were exceeded only when a major turning point occurred in the discount. Penetration of the control limits thus gave a buy/sell signal. The proximity of discount data to control limits could help to give an indication as to how cheap or expensive investment trust shares became.
In order to have an objective mathematical means of calculating the moving averages of the discounts, exponentially smoothed moving averages were used. These were calculated by applying to the discount data weights (determined by a smoothing factor) which decreased in an exponential manner the further back one went in time. It was shown that the exponentially smoothed moving average is given by the equation:
New average = b(current data) + (1—b) (previous average)
where empirical evidence suggested that the value of 'b', the exponential smoothing factor, should be between 0,10 and 0,25.
In order to set the control limits, instead of calculating the standard deviation of the discount about its exponentially smoothed moving average, it was found to be more appropriate in practice to use the mean absolute deviation, its equation being given by:
New MAD = b(absolute value of current deviation) + (1—b) (previous MAD).
Empirical evidence suggested that the control limits should be set at about 1,6 MAD.



Relative Value Analysis of the dividend yield of Tiger Oats against the average dividend yield of the food sector.

Fig. III

The method illustrated was used to calculate turning points in investment trust net asset value discounts. It seemed plausible to the author, however, that the method lent itself for use in the evaluation of the relative value of a share to other shares or the relative value of a sector to the industrial market as a whole at any point in time. Taking the case of Tiger Oats again will help to illustrate the point.
Instead of representing a time series by the discount of an investment trust on its net asset value, a time series was represented by the weekly percentage difference between the dividend yield of Tiger Oats and that of the average for the food sector as a whole and similarly for the respective price/earnings ratios. In addition, a time series was represented by the percentage difference between the RDM food index and the RDM "100" industrial index. Values for the exponential smoothing factor 'b' of 0,15 or 0,20 were used and the mean average deviation multiplier was kept at 1,6 for all three time series analyses.
Although the resultant graphs produced by the computer do not tell when to actually buy or sell Tiger Oats or food shares in general, they help to give a week-by-week idea of the value of Tiger Oats relative to other food shares and of the value of food shares relative to the industrial market as a whole. This relative picture must, however, be seen within the context of the trend of the share market as a whole.
Some examples of the observations which can be made from inspection of the relative value graphs in Fig. III and Fig. IV are as follows:
On the 23rd September, 1969, Tiger Oats was extremely overvalued relative to the food sector as a whole and the food sector was overvalued relative to the industrial market. Yet within the space of two weeks, the share price plummetted from 870c to 700c, reflecting a fall far greater than that of the industrial market as a whole.
On the 17th March, 1970, Tiger Oats at 370c was undervalued relative to the food sector and the food sector was undervalued relative to the industrial market. Four weeks later, however, Tiger Oats was 440c, showing an appreciation of 19% over a period during which the RDM "100" index rallied from 227 to 229, viz. by 1%.
The data which are used to draw the above relative value graphs can be stored by the computer. Once this has been done, it is a simple task to up-date the data each week and to get the computer to calculate and draw the up-dated graphs. It is a task which can easily be handled each week on many shares.



Relative Value Analysis of the RDM Food Index against the RDM '100' Industrial Index

Fig. IV

The above idea on relative value analysis can provide an important link between fundamental analysis and technical analysis in the timing of share transactions.

3. CONCLUSION

It would appear superficially that the computer's value in investment research is most evident in technical analysis. This is because the computer can calculate with great speed, for many shares and as often as desired, such useful technical instruments as moving averages, over-bought and over-sold situations, buy/sell lines, relative volumes, etc., instruments which naturally help greatly in performance on the Stock Exchange.
The assertion, however, that the computer has the greatest potential in the field of technical analysis is questionable.
Much scope clearly exists for its use in fundamental research also and the complexity of such research suggests that its use will increase greatly. The computer has undoubtedly made feasible the execution of complicated methods of fundamental analysis. With the aid of technical analysis, these can be neatly integrated into more efficient portfolio management techniques which should ensure greater success in performance on the share market than the system of objective analysis presently in vogue.

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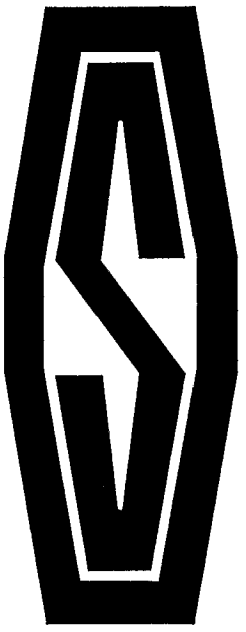

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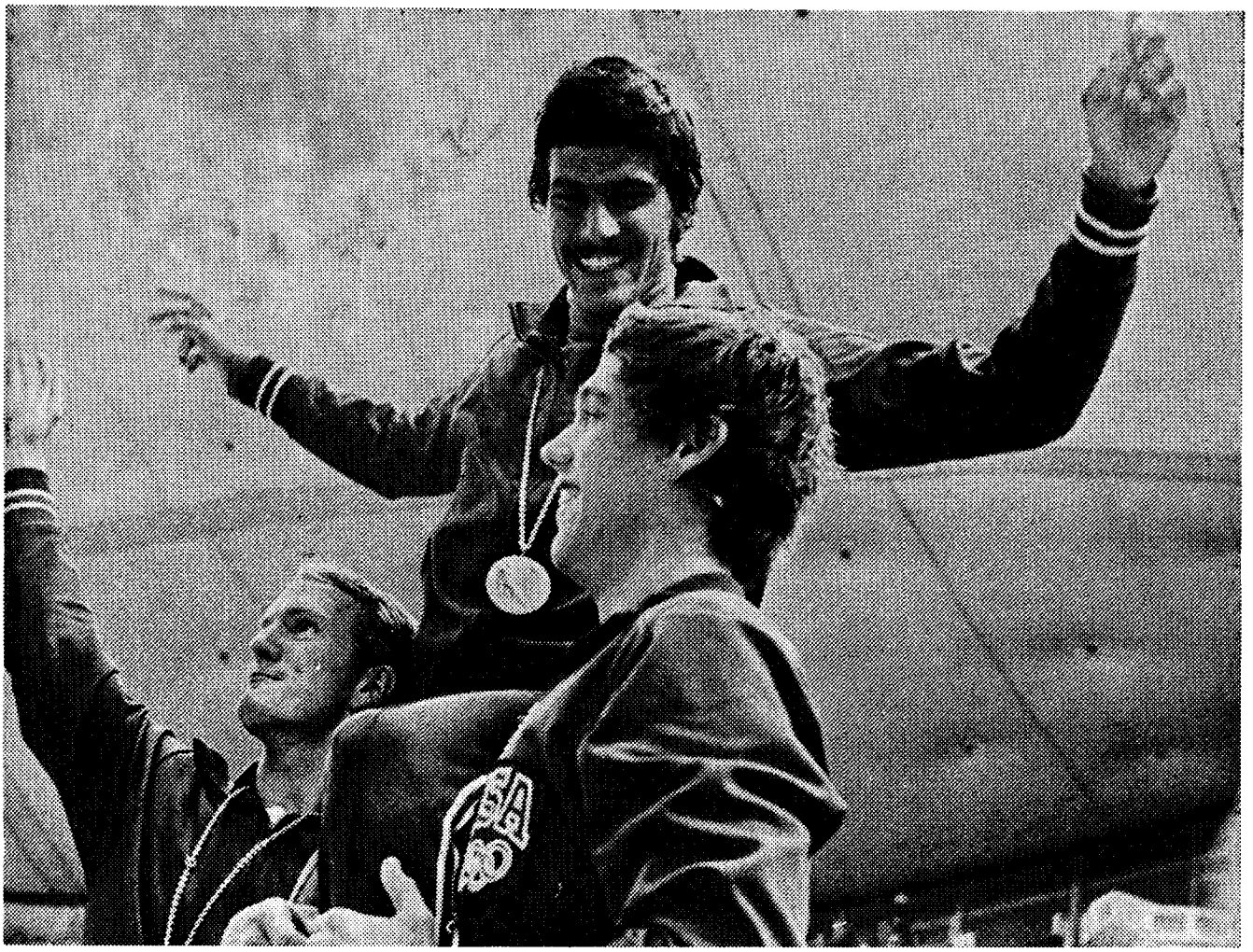

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