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Inhoud

This issue in brief

Responsibility and economic forecasting

Pronouncements about the economic future are not always responsibly made. Very often they emanate from people who profess to have insights into the workings of society denied academic economists and, very often, economists themselves fail to disclose what the assumptions are that underly their prognostications so that no objective evaluation of their opinions can be made. According to Professor De Wet, such people are little better than false prophets, oracles and throwers of bones, and their main contribution to the community consists in starting rumours and causing confusion. However, if Professor De Wet has harsh things to say about economic pronouncements that have no roots in systematic reasoning, he also has harsh things to say about the builders of econometric models whose economic projections are so objective in character as to be equally meaningless. He therefore advocates an approach to economic forecasting that has subjective as well as objective elements, that has a verifiable frame of reference but, which at the same time, is flexible and realistic.

The Johannesburg Stock Exchange as an efficient market

Are stock markets efficient markets? And what are the implications of stock market efficiency for fundamental and technical analysis and for portfolio management? In recent years much attention has been focused in overseas investment circles on these two questions but, to date, no generally accepted answers to either of them have been found. In this article, B. P. Gilbertson and F. J. P. Roux consider the results of a number of statistical tests and trading rule simulations on share price sequences in South Africa and also examine the performance of South African mutual fund portfolios. They conclude that the evidence supports the assumption that the JSE is an efficient market and, therefore, imply that technical analysis can have no more value to the prediction of future share prices in this country than it has to the prediction of future share prices on efficient capital markets elsewhere, and that fundamental analysis, here as abroad, is an activity that generally does not justify its cost. This is a controversial view and one local investment analysts cannot afford casually to dismiss.

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Simplified method of assessing the value of a South African gold mine

The recent increase in the price of gold has focused attention once again on the South African gold mining industry. Despite the importance of gold mining investment and despite the fact that gold mining companies publish a wealth of information about their activities, many private investors and a good number of institutional portfolio managers remain ignorant of basic mining evaluation procedures. It is to their need that J. E. Whillier's article is directed. Mr. Whillier is not only a mining engineer himself, having worked in the mining industry in South Africa, but is also a financial analyst of many years' experience. He therefore brings to his discussion a knowledge both of the theory and of the practice of gold mining and of an awareness of the financial implications of changes in mining variables. He however leaves his readers in no doubt, despite the title of his article, that there are no short-cuts to success in this complicated field.

An analysis of the possible effects of a rights issue on the issuing company's share price

Investment analysis, particularly as it relates to listed securities, is concerned with two primary objectives: first, with an uncovering and an assessment of the facts on which subsequent security evaluation ought to be based, and second with predicting the behaviour of the factors that form part of the investment equation. Because rights issues result in basic changes in balance sheet structures and often profoundly affect the companies to which they relate, they disturb the continuity of investment data and make it necessary for the data to be adjusted before it can be used for share evaluation purposes. Though this is appreciated by most professional analysts, many remain unaware of the general complexity of the problem either as it concerns the continuity of company accounts or share prices themselves. This article by Professor Woods deals mainly with the price-influencing factors in rights issues.

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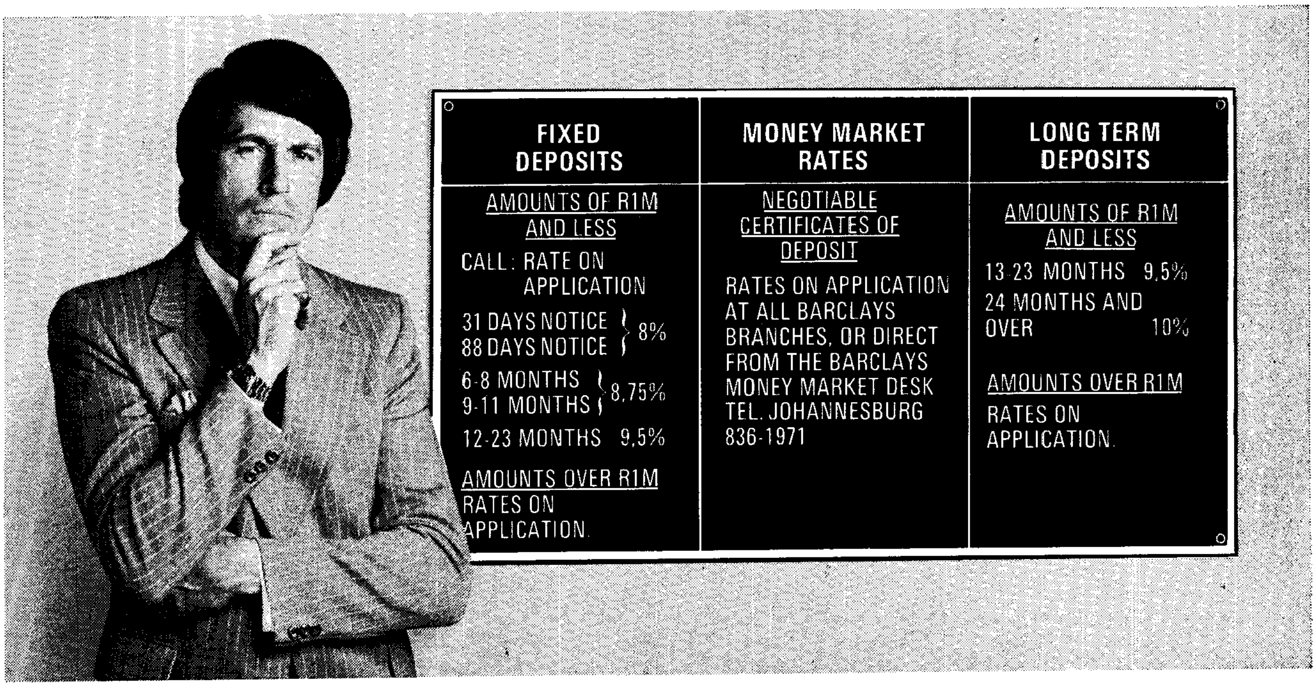

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The Investment Analysts Journal

Ninth issue
March 1977

Although the transition in economics from "political economy" to "social science" was really completed more than a hundred years ago, the question, "Is economics a science or an art?", continues to be asked by both economists and laymen, and controversy still rages over what the correct answer is. If by science is meant exact science, and if by art is meant purely intuitive or imaginative manipulation to a given end, economics, strictly, is neither. It is, instead, some strange mixture of both enjoying, because of the ambiguity, repeated misidentification.

The reason for the continuing debate over the nature of economics eighty-six years after the publication of Marshall's famous "Principles" and forty-four years after the publication of Robbins' essay on the subject, has to do with economics' two-fold preoccupation. Economics is concerned with explaining a particular aspect of human behaviour and in doing so employs scientific method; but it is also concerned, or at least economists are concerned, with predicting what such behaviour will be, either in the general or in the particular, in specified future circumstances and it is here that we run into trouble. Whereas in the physical sciences it is possible to test theories with a reasonable degree of thoroughness and, thus, to reject those that are wrong and to accept those that are right, this is far more difficult in the social sciences, and for obvious reason. In the social sciences the subject-matter is people, as individuals and as groups, and people are not only self-willed but are the possessors of political rights which preclude resort to controlled testing of the kind physical scientists are able to initiate in the seclusion of their laboratories.

Because of this inability to test social theories in a controlled fashion and because of the complexity of economic relationships and the intrusion of random developments into regular social processes, economics, for a long time, defied the sort of quantification that came to characterise physics, engineering and other exact disciplines. Thus, though it made use of mathematics and statistical method, these played only a limited role in its development. Deductive rather than inductive analysis was its dominant characteristic.

All this, however, has begun to change. Since the Second World War, but more particularly since the end of the 1950's, there has been a veritable revolution in quantitative analysis and nowhere has this been more important than in the field of finance. Empirical studies, of the kind that have given rise to the efficient market hypothesis, made possible because of computers, have been undertaken on a vast scale, and have begun to effect a radical transformation of the subject.

The studies, however, rather than reducing uncertainty about the future through an improvement of the techniques of forecasting, have tended to emphasise just how difficult it is to make accurate economic and investment prognostications, and in some cases (for example, stock markets, commodity markets and foreign exchange markets) have even suggested that the taking of consistently effective anticipatory action is totally impossible.

That conclusions of this kind should meet with resistance is understandable for two reasons. Firstly, the

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Negende uitgawe
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Hoewel die oorgang in die ekonomie van „politieke ekonomie" na „sosiale wetenskap" eintlik al meer as honderd jaar voltrek is, word die vraag „Is ekonomie 'n wetenskap of 'n kuns?" steeds deur ekonome sowel as leke gevra, en teenstrydigheid heers nog altyd oor wat die juiste antwoord is. As ons aan „wetenskap" die betekenis van eksakte wetenskap toesê, en aan „kuns" die betekenis van bloot suiwer intuïtiewe of verbeeldingsmanipulasie met 'n gegewe doel voor oë, dan is ekonomie streng gesproke nie een van die twee nie. Dit is eerder 'n eienaardige mengsel van die twee, en word, as gevolg van dié tweeledigheid, herhaaldelik verkeerd geïdentifiseer.

Die rede vir die voortgesette debattering oor die aard van ekonomie ses-en-tagtig jaar na die verskyning van Marshall se beroemde „Beginsels" en vier-en-veertig jaar na die verskyning van Robbins se verhandeling oor die onderwerp, hou verband met ekonomie se tweeledige betrokkenheid. Ekonomie is gemoeid met die verklaring van 'n besondere aspek van menslike optrede en gebruik wetenskaplike metodes daarvoor; maar dit is ook gemoeid met (of, ten minste, ekonome is gemoeid met) die voorspelling van wat sodanige optrede, òf oor die algemeen òf in die besonder, in gegewe toekomstige omstandighede sal wees, en dit is hier waar die probleme ontstaan. Waar dit in die geval van die natuurwetenskappe moontlik is om teorieë met 'n redelike mate van deeglikheid te toets, en aldus dié wat foutief is te verwerp en dié wat korrek is te aanvaar, is dit om voor-die-hand-liggende redes moeilik in die geval van die sosiale wetenskappe. Die onderwerp van die sosiale wetenskappe is mense as individue en as groepe, en mense het nie slegs 'n eie wil nie, maar beskik oor politieke regte wat toevlug tot die soort gekontroleerde toetsing wat natuurwetenskaplikes in die afsondering van hulle laboratoriums kan uitvoer, uitsluit.

As gevolg van die feit dat sosiale teorieë nie op 'n gekontroleerde wyse getoets kan word nie en as gevolg van die kompleksiteit van ekonomiese verhoudings en die indringing van onreëlmatige ontwikkelings in reëlmatige sosiale prosesse, het ekonomie lank die soort hoeveelheidsbepaling wat so kenmerkend van fisika, ingenieurswese en ander eksakte dissiplines is, te bowe gegaan. Derhalwe, hoewel dit gebruik gemaak het van wiskundige en statistiese metodes, het hulle slegs 'n beperkte rol in die ontwikkeling daarvan gespeel. Deduktiewe, eerder as induktiewe ontleding was die oorheersende kenmerk daarvan.

Al dié dinge het egter begin verander. Sedert die Tweede Wêreldoorlog, maar meer in die besonder sedert die einde van die vyftigerjare, was daar 'n werklike omwenteling van kwantitatiewe ontleding en nêrens anders was dit van groter belang as op die gebied van finansies nie. Empiriese studies, soos dié wat aanleiding gegee het tot die doeltreffende markhipotese, wat deur rekenaars moontlik gemaak is, is op groot skaal onderneem, en het begin om 'n radikale transformasie van die onderwerp teweeg te bring.

Die studies was egter, eerder as om onsekerheid omtrent die toekoms te laat afneem deur 'n verbetering van die voorspellingstegnieke, geneig om te beklemtoon presies hoe moeilik dit is om akkurate ekonomiese en belegconclusions pose a threat to vested interests and it is natural and inevitable that these should be defended. Secondly, the studies from which the conclusions derive provide, in most cases, only evidence that support a particular contention, not irrefutable proof that the principles to which the contention is opposed, are wrong. However, the fact that the conclusions give rise to dispute is to be welcomed, not regretted, for it is really only through dispute that the way to intellectual truth is to be found and it is, thus, only through dispute that the advancement of the study of both economics and finance will be achieved.

THE EDITOR

gingsvoorspellings te doen, en in sommige gevalle (byvoorbeeld effektemarkte, produktemarkte en buitelandsevalutamarkte) het dit selfs daarop gedui dat vooruitlopende optrede wat deurgaans doeltreffend is, geheel en al onmoontlik is.

Dat gevolgtrekkings van dié aard teenstand sou ondervind, is om twee redes verstaanbaar. In die eerste plek verteenwoordig die gevolgtrekkings 'n bedreiging van gevestigde belange en is dit natuurlik en onvermydelik dat hulle beskerm moet word. In die tweede plek bied die studies waaruit die gevolgtrekkings afgelei word in die meeste gevalle slegs bewyse wat 'n spesifieke bewering staaf, en nie onweerlegbare bewyse dat die beginsels wat die bewering weerspreek verkeerd is nie. Die feit dat die gevolgtrekkings aanleiding gee tot verskille, moet egter verwelkom en nie betreur word nie, want dit is inderdaad slegs deur middel van verskille dat die weg na intellektuele waarheid gevind kan word, en dus is dit ook slegs deur middel van verskille dat die bevordering van die studie van ekonomie sowel as finansies bereik sal word.

DIE REDAKTEUR

Letter to the editor

Dear Sir,

Re: Article by M. E. Rivalland in Investment Analysts Journal

In his article in the Investment Analysts Journal Number 8 August 1976, Mr M. E. Rivalland made certain statements concerning in effect the vindication of shares. It is felt that any statement made in connection with the vindication of shares must of necessity take into account the decision of the Appellate Division in Oakland Nominees Ltd. v. Gelria Mining and Investment Company (Pty) Ltd. In that case it was authoritatively held that an owner of shares which have been stolen can only be prevented or estopped from claiming those shares from an innocent purchaser where such purchaser, as a result of the *culpa* of the owner, was misled into the belief that the person from whom the purchaser acquired the shares was the owner of the shares or was entitled to dispose of them. The judgment in the case set out precise details of what must be proved in effect to ensure that the owners claim against the innocent purchaser can be frustrated by estoppel.

It is believed that this case casts grave doubts on previous Court decisions relating to the vindication of shares by owners against innocent purchasers. It seems perfectly clear that no distinction whatsoever is now to be made by the Courts between corporeals (for example, motor cars and refrigerators) and incorporeals such as shares in a company. It also seems clear that the beneficial as opposed to the registered owner of shares is to be regarded as having full vindicatory rights and any suggestion that a person buying shares and having those shares registered in the name of his brokers' nominee company has only a personal right against the nominee company to compel the nominee company to deal with the shares according to that person's instructions (an action lying at that person's instance against the nominee for any failure to follow instructions) must be discarded. It would appear that an owner of shares is (subject to estoppel) entitled to vindicate those shares against 'all the world' despite the fact that a share may be an incorporeal which may normally give rise only to personal rights.

R. G. Clarke
General Manager
The Johannesburg Stock Exchange

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By Professor G. L. de Wet, Institute for Econometrics, Pretoria University

Responsibility and economic forecasting

A paper delivered before The Human Sciences Research Council's meeting of economists and industrial economists, Johannesburg, November 24, 1976.

1 INTRODUCTION

The purpose of this paper is to show that pronouncements on the economic future of South Africa are not always made with the necessary sense of responsibility.

To this end, such pronouncements are classified, firstly, in accordance with their *modus operandi;* then the requirements for responsible forecasts are set out and, lastly, the situation in South Africa is reviewed.

2 CLASSIFICATION OF FORECASTS

Pronouncements on the (economic) future can be classified in various ways: on the basis of the period of time covered by the forecast, we can refer to short, medium and long-term views; based on the objective framework within which the forecast is made, we can discern forecasts with and without mathematical models; as time passes and the future systematically becomes the past, we obtain realised values for variables about which we could previously only conjecture, and we would even be able to make a classification on the basis of the accuracy, or otherwise, of the forecasts. However, when responsibility in pronouncements on the future is at stake, classification according to the logical *modus operandi* of the forecasting procedure would be the most useful. On this basis, we can differentiate between *prophecies, predictions and forecasts.*

2.1 Prophecies

Generally speaking, it is difficult to give an analysis of prophecies, especially in the field of economic science, except for the fact that they share one common characteristic: the pronouncement on the future is made without the use of an objective frame of reference to which the human mind (with the possible exception of that of the prophet himself) is fully receptive. True prophets, of course, have outer-worldly inspiration not shared by their fellow-economists and they are therefore scarce, but valuable, members of the economic community. There is also, however, a whole host of economists who profess to see and sense trends of which their colleagues are totally unaware. These are the people who get up and proclaim that next year the growth rate, inflation rate or birth-rate will be such and such a percentage. Nothing more! No explanation of how it was arrived at, or how the rate was determined. By the next year, when realised values become available for the variables, he has in all probability forgotten what he had said, and usually there is also no controlling of the accuracy of the prophecy and an adjustment or correction in the frame of reference if the prophesied and realised values do not tally. With these false prophets must also be classed those who make pronouncements about the future that cannot be verified, on the basis of so-called exalted objective frames of reference not accessible to anyone else, and therefore never subjected to critical examination by others. More often than not, these prophecies are also fairly wide of the mark. In actual fact, these people are nothing but false prophets, oracles and throwers of bones. They are of little value to economic science as such, and their share of the role this science has to play in the community consists mostly of starting rumours and causing confusion.

2.2 Predictions

If the prophets take their places at one extreme of the arrangement of speakers on the future, then we find those making predictions at the other end of the scale. Predictions are the outcome of a purely objective process in which some impersonal model or other is used to transform the values of predetermined economic variables into future values of the endogenous economic variables. These models can be of a verbal, graphical or algebraic nature and, in the last mentioned case, with or without the use of statistical techniques. The common characteristic of predictions is that the transformation process from predetermined to predicted values — the model — is fully verifiable and reproducible by others. Given the model and the predetermined values, all users would arrive at precisely the same values for the endogenous variables. The main and only theme, therefore, is objectivity and there is no subjective adjustment at all.

In the case of econometric models, we would have a system of equations representing the economic relationship between predetermined variables (X_i; $i = 1,2, \ldots m$) and endogenous variables (Y_i; $i = 1,2, \ldots n$) : $f_i(Y_{1t}, Y_{2t}, \ldots, Y_{nt}; X_{1t}, X_{2t}, \ldots X_{mt}) = U_{it}$, $i = 1,2, \ldots n$. With the explicit form of these functions known, we can, in any future period of time t, $t = 1,2, \ldots, T$ predict the future values of Y_{it} $i = 1,2, \ldots, n$, by simply inserting the values of X_{it} $i = 1,2, \ldots, m$ in the system of equations, and then solving the n equations for the n endogenous variables. With f_i $i = 1,2, \ldots, n$ and X_{it} $i = 1,2, \ldots, m$; $t = 1,2, \ldots, T$ known, everybody would arrive at the same values for Y_{it} $i = 1,2, \ldots, n$; $t = 1,2, \ldots, T$.

Naturally, the degree of sophistication of these econometric models may vary, and the general assumption is that the more complicated, extensive and detailed such a model, the more accurate these predictions will be. Bearing in mind these considerations, we find a variety of alternative methods of prediction: single-equation regression models, time series analyses and especially the application of spectral analysis, Gompertz Curves and many other more or less complicated types of transformation process.

Predictions suffer, however, from the inflexibility of the projection technique and this probably contributed in no small measure to the criticism voiced against the use of models. No matter how complicated and sophisticated a model may be, it will always remain a simplified version of the real world. In the process of simplification certain information must inevitably be lost and this must of necessity influence the reliability of the prediction.

Experience in model building has made economists thoroughly aware of this fact. Mistakes vary from direct faulty specifications in respect of functional economic relationships, to subtle technical factors such as built-in serial correlation in the error structure of statistically estimated models. Errors that originate when the future values of the predetermined variables are calculated independently of the model, will naturally be transplanted to the endogenous variables by the transformation process.

A major problem is posed by the continually changing economic structure. This sometimes happens gradually, and at other times suddenly and unexpectedly. Any type of model built on the basis of information from the past, acquires an additional dimension of unreliability — whether it be a verbal, graphical, econometric or time series model, or any other kind. All other shortcomings apart, a purely mechanical process of prediction therefore has to be revised on a continuous basis to keep abreast of structural changes.

Because both represent extremes, there is little choice between prophecies on the one hand and predictions on the other. The former has no verifiable frame of reference, while the latter is so objective that it has a built-in inflexibility which inevitably gives rise to unrealistic views. The third method of looking at the future has subjective as well as objective elements. When applied correctly, it is verifiable without the inherent inflexibility. However, it needs to be used with circumspection and remains, when all is said and done, an art.

2.3 Forecasts

Forecasts entail the determination of the most probable course of the future values of endogenous economic variables by supporting and supplementing the mechanical transformation of known information to these values, with sound economic judgment as well as with available information which has not been incorporated in the mechanical transformation process, while all the time maintaining verifiability. The latter is important to guard against once again lapsing into a throwing of bones.

In the forecasting process, use is undoubtedly made of some or other transformation process which can be called a model. As in the case of predictions, the model can be of a verbal, graphical or algebraic nature, and in the latter instance it can take a variety of forms, of which an econometric model is only one. On the other hand, the economist does not sacrifice his autonomy as a thinker over the workings of the system which he is studying.

On the one hand, it is obvious why we are looking for an objective frame of reference within which forecasts can be made. The human intellect simply does not have the ability to follow all the results of a change in certain economic magnitudes right through all the intricate relationships up to the eventual final influence at every possible point in the system. This fact must surely be the prime motivation for the setting up of economic models of whatever form, and also plays a role in other sciences. In addition, objectivity in the process of forecasting means that it can be verified as well as repeated. The more objective the prediction, the less its dependence on the knowledge and insight of the person making it. If sufficiently objective, the forecasting technique can be passed on from person to person and from generation to generation. Given certain initial values and given the external influences on the system, researchers would have far fewer or no differences of opinion regarding the future course of economic variables. Objectivity in the forecasting process therefore brings with it the discipline of a true science.

The reasons why such a purely objective approach is not yet possible and why we are on the other hand obliged to bring subjective judgment to bear on the process of forecasting, are likewise clear and were in fact touched upon in the discussion of predictions. All models are simplifications of the real world and therefore omit certain information which may be of critical importance in a particular case. There may be defects in the structure or character of the model. These defects may not be so serious as to render the model totally useless, but they may be sufficiently serious to make a subjective check of the model's framework necessary. The difference between the problems of simplification and faulty specification in models is clearly only a matter of degree. The underlying economic relationships or interaction of which the model is supposed to be a reproduction, could have undergone a change since the setting up of the model, or could change during the forecasting period. To this is added the fact that, at any time, strong unexpected influences of a passing nature, which therefore do not influence the basic structure, can act upon the economic system. Nevertheless, it can divert the course of the economy drastically from that predicted by the mechanical application of the model. In the world in which we live, new data and therefore new sample information, does not become available at a high enough frequency so that new models of whatever nature, can always be re-assembled in time to compensate for these structural and incidental changes. Of course, it also requires time to revise such a model! Experience has shown, however, that with the application of sound judgment, the usefulness of a given model can be maintained almost entirely even in the face of drastic structural changes. In the case of econometric models, this can be achieved, inter alia, by a subjective adjustment of certain critical parameters.

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The data at our disposal for the building of models is itself naturally subject to inaccuracies and other defects. Even with the model building process perfected in all other respects, this fact leads to defects in the model. These, however, once again need not cause serious problems, provided that the forecasting process goes hand in hand with sound judgment, and the data problems are not too serious. Those types of model that do not consist of the extrapolation of curves (as found in time series analyses), but make use of data input to produce data output, have at least two additional stumbling blocks that must be overcome before more accurate forecasts can be achieved. Firstly, the models must make use of initial values for the endogenous variables, and secondly, they must estimate future values for the exogenous variables. The estimated initial values are usually provisional figures, subject to revision as time passes. All of us are fully conversant with the asterisk-marked columns in the quarterly Bulletin of the SA Reserve Bank! In some cases, due to delays in the sampling process, the latest initial values are not yet available, and then even these have to be estimated. In the case of the national accounts, for instance, quarterly figures are approximately one quarter behind. If purely mechanical use is made of a model, these circumstances would undoubtedly lead to inaccurate forecasting — but with judicious adjustment of model results this problem can be overcome. It can therefore be stated that, when making forecasts, as much use as possible should be made of objective aids to improve the quality and verifiability of the forecasts, so as to rise above the level of the thrower of bones. These impersonal models must, however, be complemented with subjective judgment to bridge the imperfections that still exist in the art of using models.

3 THE REQUIREMENTS FOR GOOD, USEFUL AND RESPONSIBLE FORECASTS

Naturally, a mere mixing of subjective and objective methods will still not necessarily produce good, useful and responsible forecasts. To that end, we require a sound model on a solid foundation or infrastructure, expert use thereof and specialised presentation of the results. The foundation of a model refers mainly to economic theory and empirical data — especially data used in the model's construction. It goes without saying that the quality of these data may not be suspect. Similarly, each model, no matter which variation is used, must be soundly constructed and used correctly. This aspect is, however, the main substance of many university courses. It is also the subject of continuing debate in specialised literature, and it would therefore not be fitting for problems in this connection to be dealt with in the present paper. It would, in any case, be a task of immense scope.

To be useful and responsible, the *presentation* of forecasts should conform to certain requirements, failing which they would be classed in the same category as the pronouncements of the false prophets and the throwers of bones.

The presentation of forecasts

In the first instance, any forecaster should be prepared to subject the general framework within which he views the future — in other words, his model — to the scrutiny and criticism of those at whom his forecasts are aimed. Otherwise his credibility will be suspect, and he runs the risk of being accused of wanting to support a possibly contentious prediction through the use of some mystic instrument which is called upon to guarantee the reliability of his pronouncements. Would this man be any different from the thrower of bones? With an understanding of the forecaster's model, we are not only in a better position to test his credibility, but can also gain an insight into his reasoning and thus be able to judge whether or not any importance should be attached to what he says. In addition, a model supplies a fixed point from which to reason in the settling of differences.

Next, a forecaster should make clear the nature of his data and how he goes about measuring his magnitudes. What, for instance, is the meaning of a pronouncement that, according to somebody's calculations, the rate of inflation in the coming year will be X per cent? The researcher must indicate *how* he measures the rate of inflation. Some researchers use a general price index as represented by the GDP deflator. Others, again, maintain that the GDE deflator is the proper measure, while still others would use the consumption deflator. Should these deflators not be available, one could use wholesale or retail price indexes. It might not make much difference which measure is used, but one must at least know which one it is. There are, however, problems of far greater subtlety to be dealt with when the use of data is at stake. When statements are made about the rate of inflation, it is equally important to indicate from which to which point on the time scale the measurement extends. Three persons could make statements about the rate of inflation in the year ahead, but whereas the first compares yearly averages, the second uses July figures, and the third measures from December to December. It is obvious that, even with the same models, these people would quote different rates. Merely making pronouncements on the inflation rate, with no exact indication as to which data sequence and method of measuring were used, must unavoidably lead to confusion regarding how forecasters view the future.

Thirdly, forecasters must be very explicit regarding the assumptions they make in respect of the environment within which their forecasting process operates. If the model in question is of the regression type (such as econometric models) the assumptions regarding the future course of the exogenous variables need to be spelt out clearly. Typical exogenous variables are magnitudes such as the extent and time structure of State expenditure and revenue; the gold price; commodity prices on the world market; trends in foreign exchange rates; the extent and rate of increase in the overseas demand for South African goods; liquidity requirements in respect of the monetary banking sector, and many other magnitudes which do exert an influence on the economic system, but are not in turn directly influenced by the system. Given a certain model (verbal, geometrical or algebraic) and a specific data base, a new set of forecasts would be obtained for every grouping of exogenous variables. It therefore follows that, viewed from this angle also, the mere recording of a future value of some or other endogenous economic variable is of little significance. Before any importance can be attached to these forecasts, we must know in which environment of exogenous influences they are made.

The foregoing considerations in respect of the presentation of forecasts can be summarised as follows:

(i) there must be an indication of the forecasting model used, and this must be available for examination;

(ii) it must clearly be stated what data are being used, and how magnitudes are measured;

(iii) a complete set of assumptions regarding the exogenous variables and parameter changes must be furnished;

(iv) where subjective adjustments have been made in the model, or in the results, they must be indicated as such.

Lastly, it is necessary that someone who wishes to be known as a regular economic forecaster should keep a record of his forecasts, and as time passes and the future becomes the past, a scientific comparison should be drawn between forecast and realised values. From this, a picture of the accuracy of his forecasts can gradually be built up. This would surely lead to greater circumspection and a greater sense of responsibility in forecasting, and at the same time be helpful in tracing *bona fide* defects in the forecasting model with a view to eliminating them.

4 THE QUALITY OF FORECASTING IN SOUTH AFRICA

Within the framework of the foregoing considerations regarding the various types of forecast and guidelines for useful, sound and responsible forecasting, we can now look at the South African situation, and try to determine where we stand in respect of pronouncements on the economic future. To this end, a representative extract has been made from the available published information on short- and medium-term forecasts. There are several other forecasting models of whose existence we are aware, but on which no further information is available. Judging solely on the basis of what little information has filtered through, their performance is, however, more or less on a par with that of those efforts of which descriptions follow:

South African forecasting models

On a short-term and medium-term basis, the work of the Bureau for Economic Research at Stellenbosch University must be amongst the best known in South Africa. The methods it uses are generally known, namely a mixture of opinion surveys, extrapolation of national accounting figures, and econometric techniques. Apart from the fact that the so-called 'Konjunkturtest Method', which forms the basis of the Bureau's forecasts, has been described in specialist literature, the Bureau itself has repeatedly publicised its methods. The assumptions under which its calculations are made, are also normally to be found fairly clearly in their own published work. Except perhaps for a need for more detailed knowledge regarding the specific nature of their models and calculations, and in particular their subjective adjustments, the approach of the researchers of the Bureau conforms, broadly speaking, to the formal requirements set out in this paper. All that remains (and this the Bureau neglects!) is to draw an historical comparison between the forecast and realised values with a view to determining the reliability of their methodology and results.

In addition to the Bureau, there are several other private and semi-private institutions carrying out research and publishing information on the economic future. The economic departments of the various types of financial institution in South Africa are especially well known in this regard. There are also other institutions, some of which publish their forecasts, and others that make theirs available only to a select audience. Even so, one does occasionally get the chance to peruse some of their work.

The press, and especially the financial press, is another prolific source of forecasts on the economic future. They write firstly, of course, about the forecasts of the institutions mentioned above, but also publish general views on the future courses of various economic magnitudes. This is done on a continuous basis. Sometimes the source is the editorial staff itself, but mostly the reports deal with what some or other 'well-known' economist had to say — either in an exclusive interview, or at a conference or function. Naturally, exact quantitative figures are quoted freely!

From tables furnished later on in this paper, it is clear that the forecasts of the press and the economic service departments of financial and other institutions, comply with very few of the stated formal requirements. Their general defence would probably be that these forecasts are written for a broadly based audience. In my view, it nevertheless remains important that these requirements be borne in mind when the future is discussed, as these views can influence thinking on the future. There must surely be ways of ensuring that whenever statements about the future are made, they are reliable, useful, responsible and verifiable — without sacrificing the general appeal which the report or publication should hold for the average reader.

Lastly, *ad hoc* studies on the future are undertaken periodically by research institutes (especially at universities) on behalf of some institution or other. These studies are usually of a confidential nature and therefore not available for analysis. Nevertheless, it is my belief that my experience will be endorsed by others, namely, that the vast majority of studies of this type do not conform to the requirements as set out earlier — and as regards accuracy, they usually fare very poorly. Much of this kind of research is, however, aimed at so far ahead in the future that it has not yet been possible to compare realised and predicted values.

The nature and accuracy of forecasts in South Africa

From the following tables an idea can be formed of the manner in which forecasts in South Africa are presently available to the general user, as well as of their general accuracy.[1] To obtain a common point of reference, the prediction errors of some well-known models in the USA are tabulated (Table 1). Although there is a continuing debate about the usefulness of models and about the relative performance of the various models, the table below at least shows that predictions regarding the magnitudes of the overall national income (GNP,

---

[1] The data supplied in these, consist of extracts from the results of research currently being conducted by the Institute for Econometrics in an attempt to record on a continuous basis the nature (methodology and quality) of econometric predictions in South Africa. We are greatly indebted to Miss Ingrid Meyer for her tireless work in this regard.

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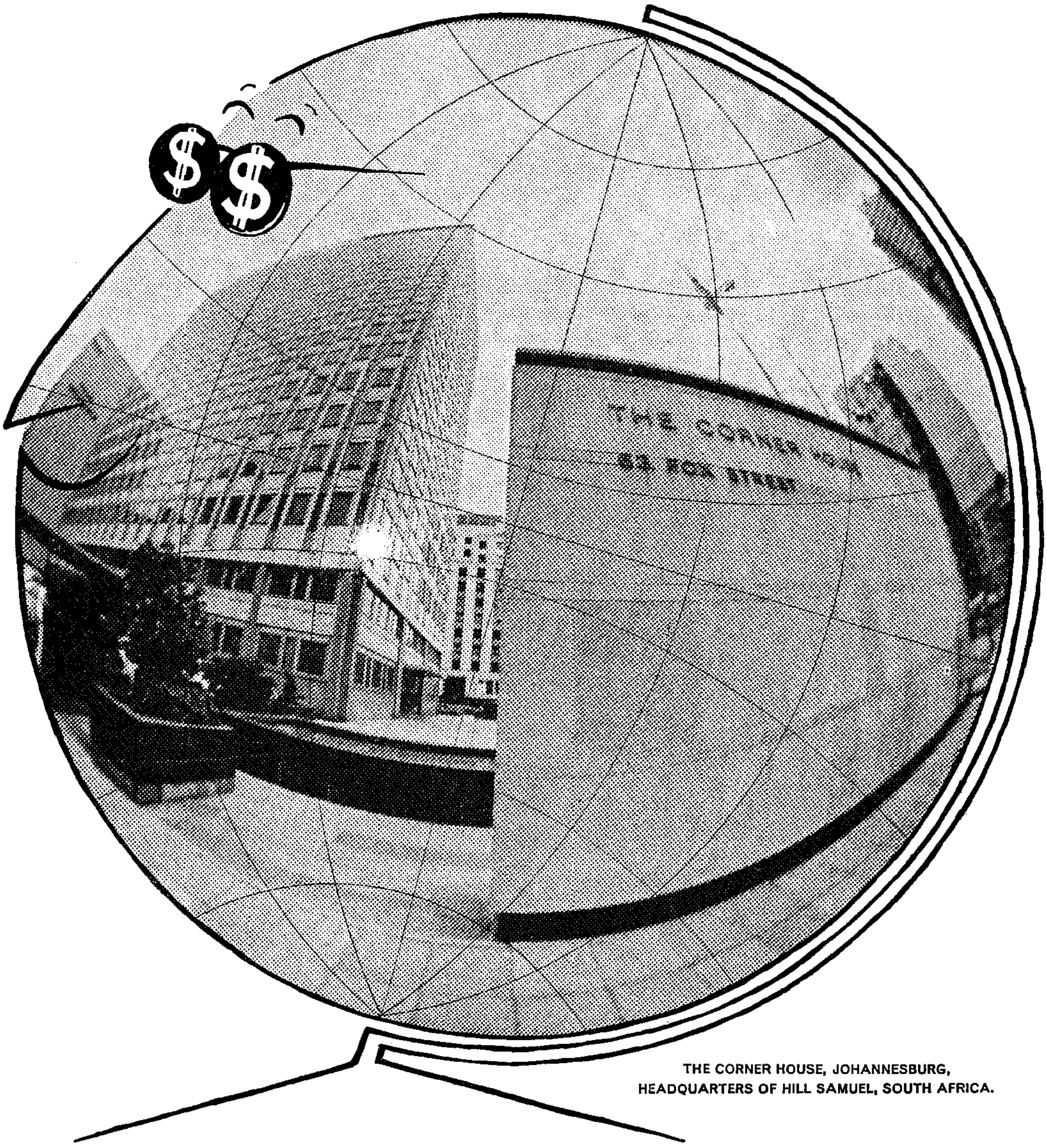

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GDP, etc.) can be forecast with a degree of accuracy of within one per cent, for as long as eight quarters ahead. It is, of course, important to be accurate within one per cent regarding the level of the GNP. If, for instance, a forecaster is on average three per cent wide of the mark, this means that his forecast of a six per cent growth rate, could just as well indicate three or nine per cent. Percentage errors for inflation, as measured by the GNP deflator, are not available, but the real error is. If we bear in mind that indexes usually vary roughly between 50 and 150, it is clear that the prediction error in respect of GNP deflators is also in the vicinity of slightly less than one per cent.

Tables 2.1 to 2.5 show the estimated values in respect of the GDP, GDP deflator, Consumer Price Index, investment, and balance of payments on current account as published by the Bureau for Economic Research. We have regularly taken the first forecast made when the forecasting period was still fully in the future. The revised prospects, issued in the course of the year being speculated about, are naturally much nearer the mark — but we do not regard these as true forecasts. Against the predicted values are set the realised values as presented in later publications of the Bureau, so we can assume that there is no difference in underlying data and measuring methods.

The real difference between estimated and realised values is then calculated, and on this basis an error average, the so-called square root of the percentage mean square error, is also worked out for those periods for which real and estimated values are available.

The forecasts of the Bureau are of course calculations for one period ahead, as fresh inputs are used from year to year. This must be set apart from forecasts for two and more periods into the future which function on the basis of the prediction for period t + k serving as input for the prediction for period t + k + 1. Forecasts of the latter type are by nature subject to cumulative error accumulation, and therefore less accurate than one-period-ahead calculations. The comparable figures in Table 1 are those in respect of column A (one period ahead).

Tables 3a to 3c show the results of the forecasts of all the other types of institution engaged in activities of this nature in South Africa, in respect of the GDP, inflation, and balance of payments. As forecasts of this type do not comply with the requirements as set out earlier on in this paper, and particularly as they are not presented regularly on a constant comparative basis, it has not been possible to calculate formal error magnitudes. However, by referring to the real values in Tables 2a to 2e, the reader can form a fairly clear picture of the accuracy of the forecasts in question.

5 CONCLUSION AND CLOSING REMARKS

When stock is taken of the usefulness and responsibility of economic forecasts, two broad criteria should, in my opinion, apply: firstly, the methodology in the presentation must conform to certain requirements, as explained earlier and summarised at the end of section II; and, secondly, the historical record of the forecasts must of course show a satisfactory degree of accuracy so that they can be regarded as credible when the forecasting period still lies in the future.

It has been stated earlier that on the basis of the facts expounded in this paper, only the Bureau for Economic Research complies with the first criterion, namely the presentation requirement. As regards the criterion of accuracy, the reader can surely draw his own conclusions from the available information. But it would appear to me that no institution in South Africa gives satisfaction on this score. Not only are the forecasts inaccurate throughout, but they are conflicting (within as well as among institutions) and also vague in many instances. The forecasting mechanism in South Africa is therefore unreliable. It goes without saying that greater responsibility is called for. The economic decision makers (on the private as well as public level) cannot be isolated from the divergent pronouncements that are continuously being made regarding the economy. Some are more easily influenced than others, and some even put all their faith in the forecasters — although the available information shows that, judged on present performances, they would have been no worse off without the forecasters. If the various speakers on the future wish to make a real contribution to economic progress, they will definitely have to display a greater sense of responsibility not only in respect of their mode of presentation, but also as regards accuracy. We leave it to the reader to judge the various institutions on their current performances, and to decide whether they should be classified as prophets, predictors or forecasters.

Table 1
Prediction errors of some well-known models[1]

	Model		Periods into the future		
			A	B	C
			1	4	8
a	GNP, current prices Percentage, RMS error†				
b	GNP deflator, RMS error†				
1	Wharton, Mark III	a	0,40	0,93	0,98
	Quarterly model	b	0,93	0,94	1,28
2	Brookings	a	0,60	0,85	0,85
	Quarterly model	b	0,42	0,91	1,70
3	Fair	a	0,38	0,62	—
	Quarterly model	b	0,21	0,76	—
4	F R B	a	0,43	0,87	1,32
	St. Louis	b	0,60	1,70	2,60
5	Wharton	a	0,68	1,96	
	Year model	b			

[1] Meyer, I., *Die voorspellingskrag van ekonometriese modelle,* unpublished manuscript, Institute for Econometrics, Pretoria University, 1976. (To be published soon.)

†Percentage root mean square error.

Table 2.1
Bureau for Economic Research, Stellenbosch
GDP — market prices — current prices (R millions)

Year	Real	Totals Predicted	Difference
1968	10 169	10 435	266
1969	11 303	11 305	2
1970	12 332	12 420	88
1971	13 740	14 160	420
1972	15 657	15 012	−645
1973	18 799	17 385	−1 414
1974	22 612	21 787	−825
1975	25 771	26 085	314
1976		28 130	
1977		32 226	

RMS
error % = 3,82

Table 2.2
Bureau for Economic Research, Stellenbosch
GDP — Deflator

Year	Totals		
	Real	Predicted	Difference
1968	3,2%	3,0%	−0,2
1969	4,1%	3,0%	−1,1
1970	4,1%	3,5%	−0,6
1971	6,6%	5,75%	−0,85
1972	8,6%	6,25%	−2,35
1973	15,6%	7,8%	−7,8
1974	11,4%	10,0%	−1,4
1975	11,8%	10,0%	−1,8
1976		7,8%	
1977		10,6%	

RMS
error % = 33,11

Table 2.3
Bureau for Economic Research, Stellenbosch
Gross domestic investment — current prices —
R millions

Year	Totals		
	Real	Predicted	Difference
1968	2 387	2 560	+173
1969	2 947	2 845	−102
1970	3 647	3 060	−587
1971	4 071	3 745	−326
1972	3 833	3 347	−486
1973	4 871	4 325	−546
1974	6 899	6 104	−795
1975	7 755	7 190	−565
1976		7 165	
1977		8 132	

RMS
error % = 10,23

Table 2.4
Bureau for Economic Research, Stellenbosch
Consumer price index

Year	% change		
	Real	Predicted	Difference
1968		2,45%	
1969		3,0%	
1970			
1971	5,7%		
1972	7,3%		
1973	9,6%	6,5%	−3,1
1974	11,6%	8,75%	−2,85
1975	13,5%	10,5%	−3,00
1976		8,5%	
1977		9,5%	

RMS
error % = 22,12

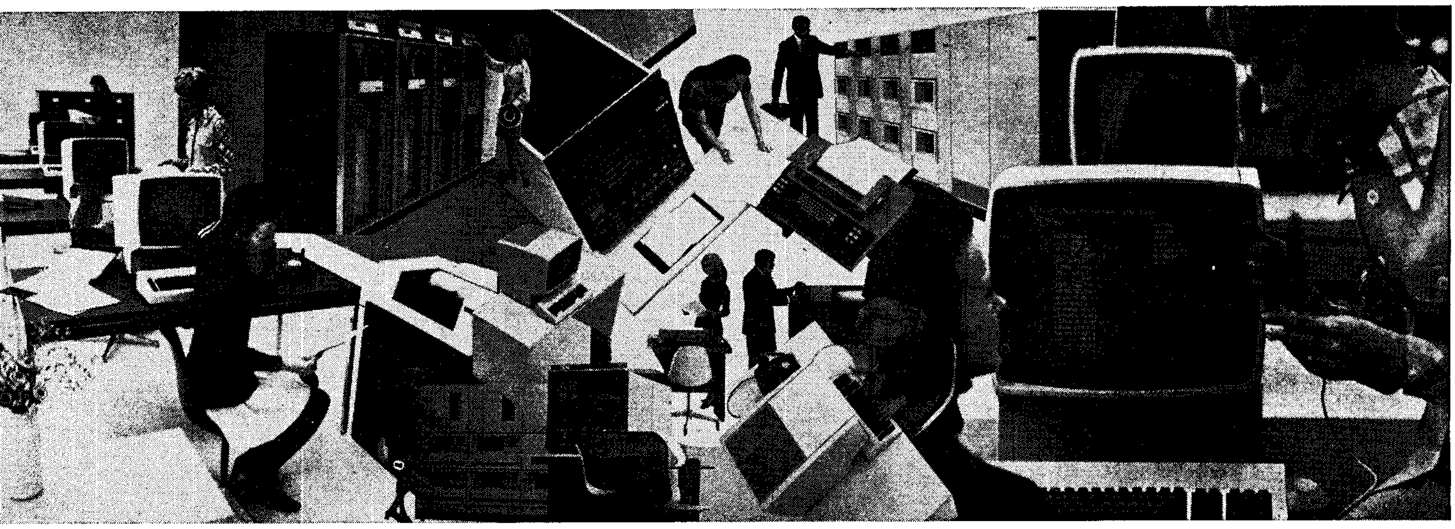
Table 2.5
Bureau for Economic Research, Stellenbosch
Balance of payments : Balance on current account —
R millions

Year	Totals		
	Real	Predicted	Difference
1968	78	−45	−123
1969	−245	−200	+45
1970	−827	−210	+617
1971	−974	−735	+239
1972	−6	96	+102
1973	96	−450	−546
1974	−860	−518	+342
1975	−1 616	105	+1 721
1976		−575	
1977		−1 174	

RMS
error % = 87,14

Table 3a
GDP

Model or source of prediction	Nature of data and measuring method	Assumptions and subjective adjustments, if any	Forecast
1 Model unknown. Forecast made in the Standard Bank Review, September 1973, as part of their review of the economic situation, p 2	Unknown	Implicitly contained in a sketch of the general economic situation, pages 1 and 2	During the remainder of 1973, the growth rate in the real GDP should reach 5,75 per cent
2 Standard Bank Review, November 1973. Model unknown, p 1	Unknown	1 An average agricultural season 2 A free market gold price of ± $100 per fine ounce 3 No serious international crises due to a shortage of oil and raw materials 4 Bigger consumer spending, stockpiling and investment in machinery and equipment 5 Other assumptions implicit, contained in the general review, pages 1 and 2	A growth rate consideably higher than 5,75 per cent in real GDP during 1974



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Model or source of prediction	Nature of data and measuring method	Assumptions and subjective adjustments, if any	Forecast
3 Standard Bank Review, January 1974. Model unknown. Revised estimates after the oil crisis, p 2	Unknown	Implicitly and explicitly contained in the review	A growth rate of 5 per cent or more in real GDP during 1974
4 Standard Bank Review, June 1974, p 2	Unknown	1 An upswing in real private fixed investment 2 High rates of expenditure by the public sector 3 A positive contribution to growth by the agricultural sector	A satisfactory growth rate in the economy as well as in industry during 1975
5 Financial Mail, 4th October 1974, p 23	Unknown	Unknown	A growth rate of between 4 and 5 per cent in real GDP in 1975. (The general theme is, a slowing down in the tempo of economic growth: 'The Boom is over')
6 Financial Mail, 8th November 1974, p 548 (Senbank)	Unknown	1 Gold price ± $175 2 Normal climatic conditions 3 Considerable capital inflow 4 High Government expenditure	A growth rate of between 3,5% and 4% in real terms during 1975
7 Ekonomiese Spieëlbeeld, Nedbank, April 1975	Unknown	Unknown	Growth in real GDP nearer to 4% during 1975
8 Financial Mail, 21st November 1975, p 738. Several persons quizzed	Unknown	Unknown	Predictions re growth in real GDP for 1975: (a) 3% (e) 3% (b) 2,5% (f) 2,5% (c) 2,5% (g) 2,5% (d) 2,2%
9 Standard Bank Review, October 1975, p 4	Unknown	1 Little or no increase in Government expenditure 2 Slower growth in salaries, wages, profits 3 Strict monetary measures 4 Sluggish demand	Growth (real) in vicinity of 0 (nil) to 2% during 1976
10 Financial Mail, 21st November 1975, p 738. Several persons quizzed	Unknown	Unknown	Predictions re growth in real GDP for 1976: (a) 2% (e) 2% (b) 3% (f) 1,5% (c) 3% (g) 1% (d) 3% (h) 3%
11 Financial Mail, 2nd January 1976, p 9	Unknown	Unknown	A growth rate of 2,5% in real GNP during 1976
12 Standard Bank Review, January 1976, p 3	Unknown	Unknown	Growth rate of not more than 2% in 1976

Table 3b
Inflation

	Model or source of prediction	Nature of data and measuring method	Assumptions and subjective adjustments, if any	Forecast
1	Ekonomiese Spieël-beeld, Nedbank, July 1973	Unknown	1 Less imported inflation 2 Lower flat rentals 3 Lower interest rates 4 Lower cost per unit in production	Rise in consumer price index in 1973 between 7,5% and 8,5%
2	Standard Bank Review, Supplement, December 1973, p 18	Unknown	Unknown	Inflation will remain at a fairly high level during 1974
3	Economic Round-up Nedbank, July 1974	Unknown	Unknown, except for a statement that a good agricultural harvest might keep inflation in check via lower food prices	Increase of between 10% and 15% in consumer prices during 1974
4	Standard Bank Review, January 1974	Unknown	1 Rising prices in rest of the world 2 Good agricultural harvest	Rise in consumer price index during 1974 approximately 10%
5	Standard Bank Review, January 1975	Unknown	1 Lower inflation rates overseas 2 Decrease in domestic demand 3 Decreased activity in commerce and industry	Inflationary pressure during 1975 considerably lower than in 1974
6	Standard Bank Review, November 1975	Unknown	Effect of devaluation	14% rise in consumer price index during 1976
7	Financial Mail, 14th February 1975, p 500, Prediction for Nedsual	Unknown	Unknown	Inflation rate of 16% in 1975
8	Financial Mail, 3rd October 1975. Prediction of Strydom/ Steenkamp	Unknown	Unknown	Inflation 19,5% at annual rate during last quarter of 1976, due to devaluation. Without devaluation, 11% to 12%
9	Financial Mail, 2nd January 1976, p 9	Unknown	Unknown	Rise of 12% in consumer price index during 1976
10	Barclays National Review, March 1976	Unknown	1 Effects of devaluation 2 Economy 'on a war footing' 3 Upward adjustments in salaries and wages 4 Voluntary incomes and prices policy	

Table 3c
Balance of payments

	Model or source of prediction	Nature of data and measuring method	Assumptions and subjective adjustments, if any	Forecast
1	Standard Bank Review, May 1973, p 2	Unknown	1 Lower goods exports 2 15% increase in imports of goods 3 Increase in net service payments 4 14% increase in value of net gold production 5 No increase in transfer receipts	Deficit of R300m on current account of balance of payments during 1973
2	Financial Mail, 8th November 1974, p 548 (Senbank)	Unknown	1 Gold price $175 2 Normal weather conditions 3 Considerable capital inflow	Increase of between R400m and R500m in SA's gold and foreign exchange reserves during 1975

Model or source of prediction	Nature of data and measuring method	Assumptions and subjective adjustments, if any	Forecast
3 Financial Mail, 3rd October 1975, p 47 (Strydom/Steenkamp)	Unknown	Unknown, except for the fact that the Rand has been devalued	The Rand value of imports should rise by 13,8% above what it would have been without devaluation
4 Standard Bank Review, November 1975, p 4	Unknown	1 Gold price $160 2 8% rise in world commodity prices 3 Normal agricultural year 4 Continuation of restrictive monetary and fiscal measures	A decrease during 1976 in the deficit on current account to approximately R1 200m
5 Financial Mail, 21st November 1975, p 38 (Predictions by several persons)	Unknown	Unknown	Deficit on current account in 1976: (a) R700m (b) R800m (c) R1 100m (d) R1 000m (e) R1 000m (f) R750m (g) R800m

References

In addition to sources mentioned in the text, the following publications can be regarded as a general background to this paper:

1 Klein, L. R., *An essay on the theory of economic prediction,* Sanomaprint, Helsinki, 1968

2 Fromm, G. and Klein, L. R. *A comparison of eleven econometric models of the United States,* American Economic Review, May 1973

3 Hirsch, A. A., *The BEA quarterly model as a forecasting instrument,* survey of current business, August 1973

4 McNees, S. K., *How accurate are economic forecasts?* New England Economic Review, December 1974

5 Christ, C., *Judging the performance of econometric models of the US economy,* International Economic Review, February 1975

6 Buro vir Ekonomiese Ondersoek, Stellenbosch, *Vooruitsigte* (successive years since 1965)

7 Financial press and reviews of financial institutions

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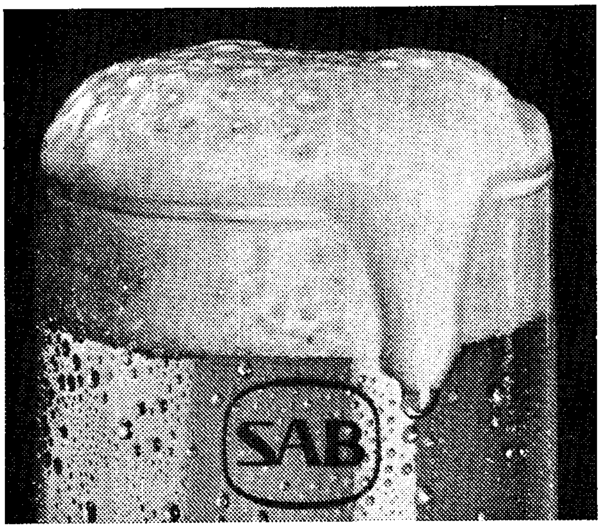

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The Johannesburg Stock Exchange as an efficient market

ABSTRACT

This note reviews the evidence for and against the assumption that The Johannesburg Stock Exchange is an efficient market. After considering the results of statistical tests and trading rule simulations on share price sequences, and analysing the performance of mutual fund portfolios, it concludes that the evidence supports the assumption. This conclusion has important practical implications for portfolio managers.

1 INTRODUCTION

For more than fifteen years American academics have debated the economic process that underlies the pricing of ordinary shares. The controversy revolves around the so-called 'efficient market hypothesis' (henceforth 'EMH') which states that the market prices of securities at any time 'fully reflect' all available information.

The validity or otherwise of this hypothesis is of great practical significance. For example, it implies that the study of trends and patterns in past price behaviour will not allow one to predict the future performance of a given share. Consequently the activities of chartists, and indeed the whole field of technical analysis, are of no value to investors. It further implies that fundamental analysis — i.e. the acquisition and analysis of company financial statements, directors' reports, earnings and dividend records, and the like — also cannot be expected to allow superior investment performance. Given the importance of these two categories of analysis in the traditional approach to portfolio management, the depth of the controversy becomes evident.

Two studies of shares listed on The Johannesburg Stock Exchange ('JSE') have recently appeared[1,2] in South African journals. Since the authors arrive at conclusions[*] that are contradictory and not supported by the evidence presented, we anticipate some confusion in the minds of their readers. This situation is not unlike that which existed in the early stages of American research, and it seems desirable that we should learn from that experience.

In this note we shall review the evidence as far as it supports or denies the assumption of efficiency for the JSE; in so doing, we shall also refer to the findings of our own research in this field.

2 THE EFFICIENT MARKET MODEL

The major didactic work on efficient markets is that of Fama,[3] as modified.[4,5] We shall follow closely his outline and terminology.

The definitional statement that, in an efficient market, security prices 'fully reflect' all available information is so general that it has no empirically testable implications. Most research has therefore been based on the assumption that the conditions of market equilibrium can somehow be stated in terms of expected returns. The basic model of market equilibrium is then the 'fair game' expected return model[†] which states that

$$E(\tilde{x}_{t+1} \mid \phi_t) = 0 \qquad \text{I}$$

or alternatively

$$E(\tilde{z}_{t+1} \mid \phi_t) = 0 \qquad \text{II}$$

where $x_{t+1} = P_{t+1} - E(\tilde{P}_{t+1} \mid \phi_t)$

or $z_{t+1} = r_{t+1} - E(\tilde{r}_{t+1} \mid \phi_t)$

Here E = expected value operator

P_t = price of the security at time t

r_t = one period percentage return = $(P_{t+1} - P_t) / P_t$

ϕ_t = symbol representing whatever set of information is assumed to be 'fully reflected' in the price at time t, and

a tilde indicates a random variable.

The variable x_{t+1} thus denotes the 'excess' market value of the security at time t+1, i.e. the difference between the observed market price and the expected value of the price that was projected at t on the basis of the information set ϕ_t. Equation I defines the expected value of x to be zero in the 'fair game' model.

Two important special cases of this general 'fair game' model can be derived. The first is the submartingale which arises as follows:

If for all t and ϕ_t

$$E(\tilde{P}_{t+1} \mid \phi_t) \geqslant P_t \qquad \text{III}$$

or equivalently

$$E(\tilde{r}_{t+1} \mid \phi_t) \geqslant 0 \qquad \text{IV}$$

then the price sequence $\{P_t\}$ is said to follow a submartingale[‡] with respect to the information sequence $\{\phi_t\}$. If equations III and IV hold as equalities the price sequence follows a martingale.[‡] The properties of these processes are described in 6 and 7.

The second special case of the general 'fair game' model is the 'random walk'. This case arises when the stochastic process[§] that generates the one-period returns r_t has specific properties such that the returns are independent and their distributions repeat themselves through time (see 8 for the theory of random walks). This model implies much more than the general 'fair game' model of equations I and II. Therefore, empirical evidence that conflicts with the random walk model would not necessarily constitute a denial of the EMH.

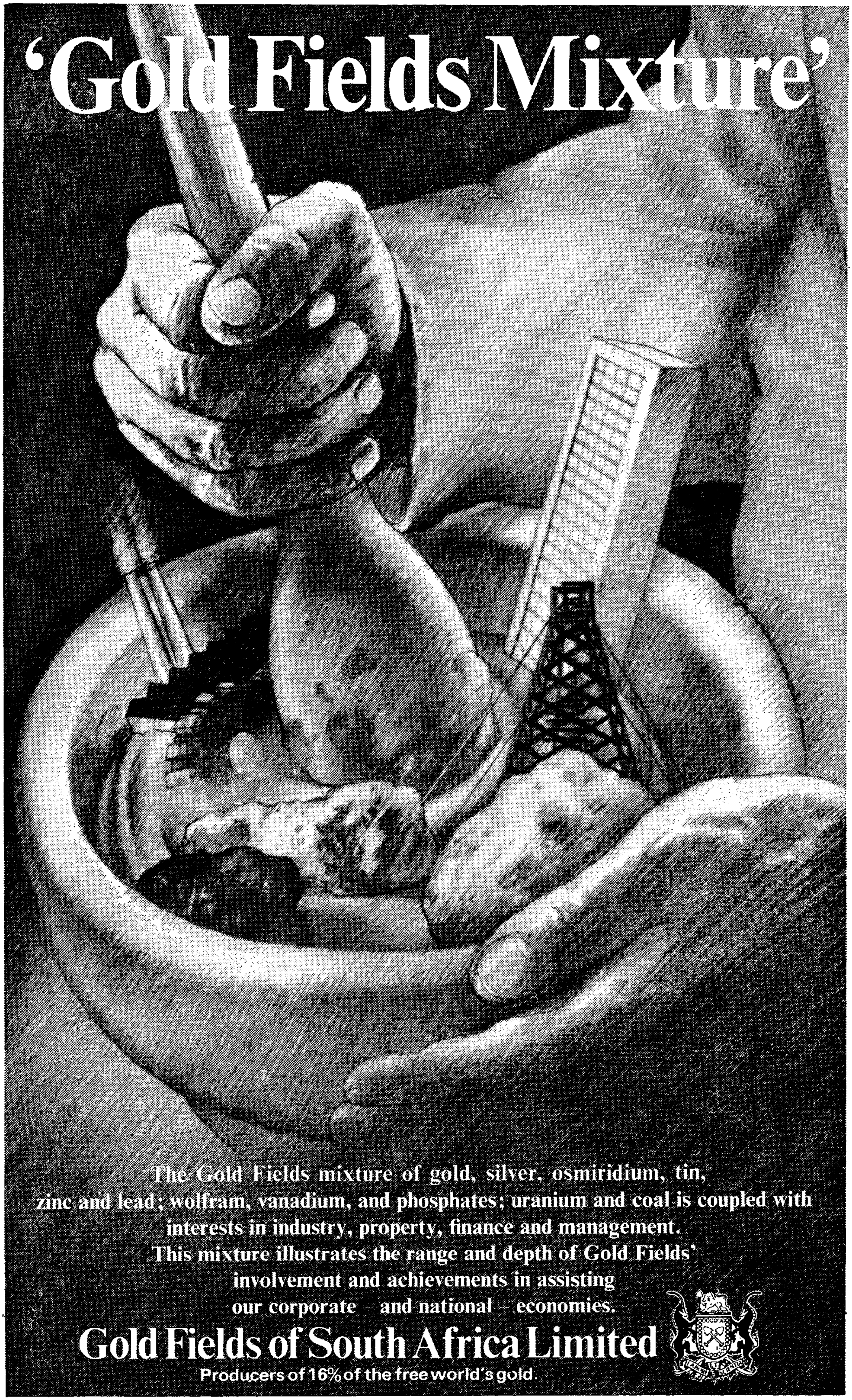
---

[*] See section 3 below.

[†] A game having zero as the expected winnings per play is called a fair game.

[‡] In brief, if a price sequence follows a submartingale, the expected value of the next period's price is equal to or greater than the current price. If it follows a martingale the expected price *change* is zero.

[§] A stochastic process can be conveniently imagined to consist of the performance of a succession of random experiments, each experiment determining the value of one random variable.



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The efficient market model described above is concerned with market expectations and therefore it is not possible to test it directly. Empirical work has thus focused on the testable implications of the model. Historically, four major categories of tests have been devised:

(a) Statistical tests on price sequences

(b) Evaluation of trading rules

(c) So-called 'semi-strong' tests of whether prices adjust efficiently to specific information

(d) Portfolio performance tests.

As far as we are aware, semi-strong tests of type (c) have not yet been performed for shares listed on the JSE. However, all of the others have been, and the findings are reviewed below.

3 STATISTICAL TESTS ON PRICE SEQUENCES

Early work in the field focused on statistical tests of the independence or otherwise of successive share price changes. These tests involved the estimation according to exact formulae of various statistics for a sample of empirical data, and then comparison of the results with what would be expected under the assumption of independence. If the two sets of results conform closely, the statistician would conclude that the price changes were independent. In a now classic study, Fama[9] analysed a five-year record of the daily price changes of the thirty industrial stocks that comprise the Dow Jones Industrial Average of the New York Stock Exchange ('NYSE'). One of his main conclusions was that the independence assumption was 'an adequate description of reality'.

Fama's research served as model for three studies of JSE shares. Two of these[1, 2] involved tests on industrial shares only, while the third[10] included tests on shares in mining companies. Both serial correlation and runs tests have been used. In all cases there was some evidence that the price changes were not completely independent. In our study we found that although the apparent deviations from independence were small, they were consistent with a situation in which a time trend or bunching of observations occurred.[10] This finding was significantly different from that of Fama for the NYSE.

The implications of the findings must now be considered. Should one conclude, as does Hadassin,[2] that the JSE 'has been proved to be an inefficient market' and thus 'chartists . . . should be able to make greater gains than those of the market'? Or should one observe conversely, as do Graves and Money,[1] that the autocorrelations are so small as to be 'useless' and therefore 'any form of technical analysis based only on past prices is worthless'? In our view neither conclusion is justified by the evidence presented so far.

Statistical tests of this nature can and have been criticised on quite fundamental grounds. We shall mention four of these. The first two pertain to the conclusions of 2, while the third and fourth pertain to both 1 and 2:

(a) Since such tests are concerned with the independence or otherwise of price changes, they are in fact tests of the random walk model rather than of the EMH. Rejection of the former does not necessarily invalidate the latter.[3]

(b) Non-stationarity of the model, as for example under the sub-martingale of equation III, poses a problem because the usual statistic for correlation assumes a constant mean. Therefore, if no correction for non-stationarity is made, a test for un-correlatedness based on the sample correlation coefficient will be biased toward rejection.[4]

(c) There is evidence[10] that the distributions of price changes for shares listed on the JSE exhibit even more pronounced leptokurtic* properties† than do the NYSE shares reported on by Fama.[9] The empirical distributions seem to conform to a class of non-Gaussian stable distributions‡ which have, inter alia, the property that the variance does not exist except in the special Gaussian case. Since the common statistical tools are based on the assumption of finite variance, they need to be interpreted with caution.[9, 10]

(d) Finally, and perhaps most importantly, the simple linear relationships which underlie the serial correlation model are too unsophisticated to identify the complex non-linear 'patterns' sought by chartists in share price records.[12] To investigate such relationships we must turn to the stricter tests of sections 4 and 5 below.

Given these criticisms, we must conclude that, whereas the small correlation coefficients are consistent with the EMH, they do not prove its validity. Conversely, the observed deviations from independence do not justify rejection of the hypothesis. We shall, therefore, avoid generalised conclusions until we have reviewed the evidence from the other two categories of tests.

4 EVALUATION OF TRADING RULES

Trading rule ('TR') tests have played an important role in the evolution of efficient market theory; in fact, it has been contended that the EMH is directly testable only via such procedures.[13] These tests involve computing the returns that a stock market trader might have achieved had he based his purchase and sales decisions on a mechanical trading rule. The returns generated in this manner have invariably been smaller than those resulting from a simple buy and hold ('B&H') strategy. It can be shown that this would be a major consequence of market efficiency.[3, 5]

Consider, for example, a trading rule which operates as follows: A buying signal is generated if the price of a particular share is greater than some moving average of price by at least x% *and* the volume of shares traded is greater than a moving average of volume by at least y%. A selling signal is generated if the price of the share is less than the price moving average by at least x% *and* the volume of shares traded is greater than the volume moving average.

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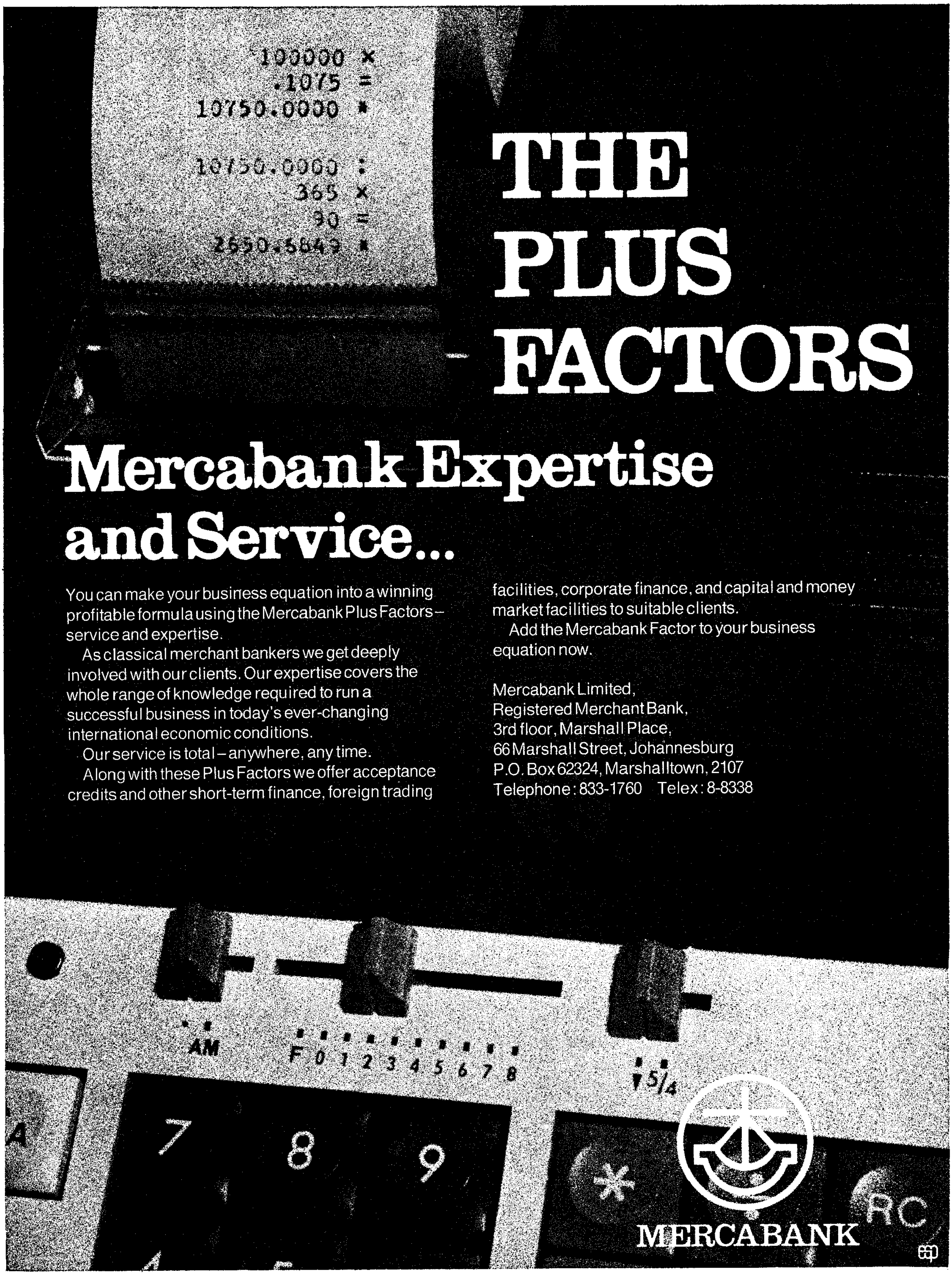
*The term leptokurtic is used to indicate that there is a relatively high concentration of observations around the modal value and in the extreme tails when compared to the Gaussian distribution.

†In addition there are important differences between the distributions of gold mining shares and those of other shares.

‡We did not investigate the possibility that the empirical distribution might conform more closely to the Student distribution (see 11).



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Let us measure the performance P of this TR as the geometric mean of the wealth ratios of the individual transactions. If the above TR were applied* to the historical price record of, say, OK Bazaars, one finds that P = 0,705. Measured according to the same criterion, a naive B&H strategy would generate a performance P = 1,69. Since the B&H strategy has outperformed the TR strategy, the results are consistent with the EMH.

We caution the reader at this stage about the interpretation of results from TR tests. For example, Praetz[14] has recently asserted that the comparison is biased against the TR due to differences in the expected returns from the two strategies. Furthermore, the question of short-term interest on available cash when not invested needs to be considered, and finally, the key aspect of consistency of superior performance must be demonstrated. These questions are beyond the scope of this note, and the interested reader is referred to our detailed analysis in (15). There we applied four trading rules to twenty-four JSE shares, and found that the TR consistently underperformed the B&H strategy. In addition, we specifically investigated whether certain of the large correlation coefficients observed in the earlier statistical tests of (10) could be utilised to earn superior returns. Again the B&H return was found to be consistently greater than the TR return. Although these results do not, of course, prove the validity of the EMH, they must be seen as support for it.

5 PORTFOLIO PERFORMANCE TESTS

The final category of tests has focused on the performance of professionally managed portfolios and, specifically, on the performance of mutual funds. If such portfolios achieve consistently superior performance relative to that of the market as a whole, some element of inefficiency in the pricing process would be indicated. Tests elsewhere have been consistent in finding that no fund achieved such superior performance.

Initial measurement on South African mutual funds have been reported[16,17] but were unsatisfactory in at least two respects. In the first place, the South African mutual fund industry was still in its infancy at the time of this early research (1971) and so only limited amounts of data were available for analysis. Secondly, more rigorous criteria of performance are available than were then used. For example, Kerbel[16] found that the ex post risk-return co-ordinates of South African mutual funds do not cluster around a line joining the risk free rate and the ex post return on the market portfolio. He views such clustering as a requirement for portfolio efficiency (in the Markowitz sense), and he thus concludes that the 'funds cannot be said to have been generally well managed'. However, Jensen[18] has shown that portfolio efficiency cannot be defined without taking into account the *ex ante* expected returns on the market portfolio. Accordingly, portfolio efficiency is not a suitable measure of *ex post* portfolio performance, and the conclusion of poor management is thus not justified.

We have carried out a more rigorous analysis[20] of the performance of South African mutual funds using the greater volume of data that is now available. We modelled our procedures closely on those established by Jensen[18,19] and thus used as our measure of performance the parameter α in the equation

$$(R_j - R_F) = \alpha + \beta\,(R_m - R_F) + u \qquad \text{v}$$

Here R_j = return on the security
R_F = estimated risk-free rate
R_m = return on the 'market portfolio'
β = 'systematic risk' of the security
u = error term with expected value of zero

There are various problems associated with the use of equation v. For example, it requires that the parameter β be both stable and stationary. Du Plessis[17] has reported limited tests on South African mutual fund betas and concluded that they appear to be remarkably stationary. However, in our view, this conclusion was not justified since he considered only two funds and for one of these the beta increased by 25% over two consecutive two-year periods. Our measurements[20] of beta have provided some evidence of stability but little justification for the assumption of stationarity. Nevertheless, the model of equation v can still be used to make meaningful statements about portfolio performance since, under these circumstances, it will emphasise any evidence of the portfolio manager's forecasting ability.[19]

In our analysis[20] we measured the performance of the eleven South African mutual funds under various assumptions. In one of these assumption sets we ignored

(a) dividend declarations, and

(b) the bias which is introduced by the model's implicit assumption that the funds are always fully invested in equities† (a situation prohibited by the Unit Trusts Control Act)

Under these circumstances we found that during the period 30 June 1973 to 30 September 1976, the South African mutual funds earned on the average 1,6% per annum (compounded continuously) less than they should have earned given their level of systematic risk.

In addition to these average results, we found no evidence that any individual fund was able consistently to outperform any other or significantly to outperform the market.‡

These findings are in good agreement with those reported by Jensen for the American mutual fund movement. They are also consistent with the EMH.

6 SUMMARY AND CONCLUSIONS

In this note we have reviewed the evidence for and against the assumption that the JSE is an efficient capital market. In the case of the statistical tests on price change sequences we found some evidence of deviations from strict independence. However, in view of the limited relevance of such tests and the small degree of dependence observed, we choose to interpret them as being, generally speaking, consistent with the EMH.

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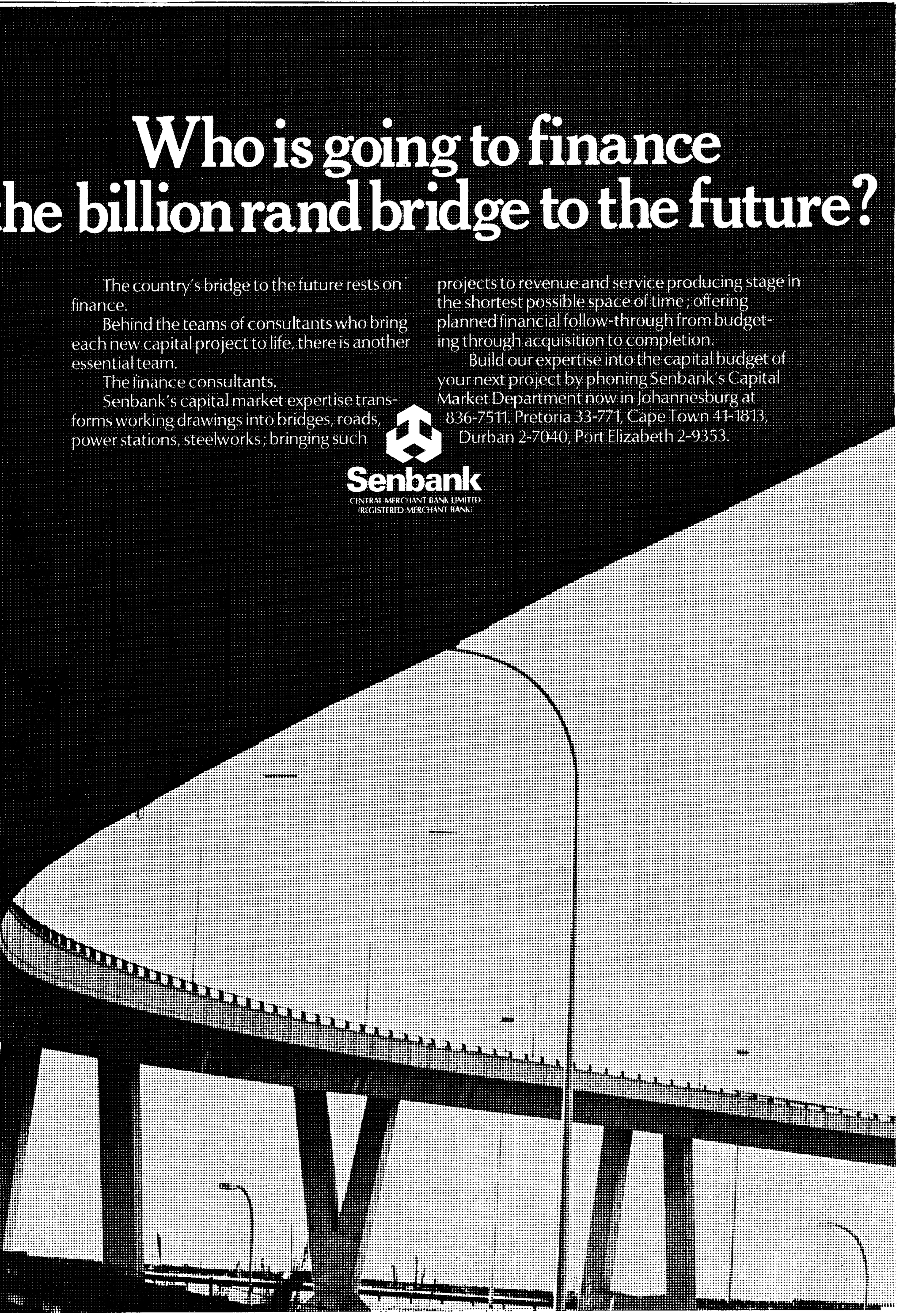
*Over the period from 22nd February 1971 to 22nd February 1976 and with x = 5%, y = 100%.

†Consideration of these issues is beyond the scope of the present note. The interested reader is referred to 20 for a fuller discussion.

‡We comment in passing that these findings do not necessarily imply criticism of the mutual fund managers. In an efficient market, no portfolio manager will be able to achieve consistently superior performance, yet he will have to incur costs to comply with statutory reporting requirements, and so on.



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In the two other and stronger form tests the results were unequivocable: neither trading rules nor (risk-adjusted) mutual fund managers were able to outperform the market. These findings are in agreement with the results of similar studies on the American stock markets, and are consistent with the EMH. Of course, 'consistent with' does not constitute proof of hypothesis validity. However, taking all the evidence together, we must conclude that there is persuasive support for the view that the JSE is an efficient capital market. That being so, the practical implications stated in the second paragraph of this note are relevant.

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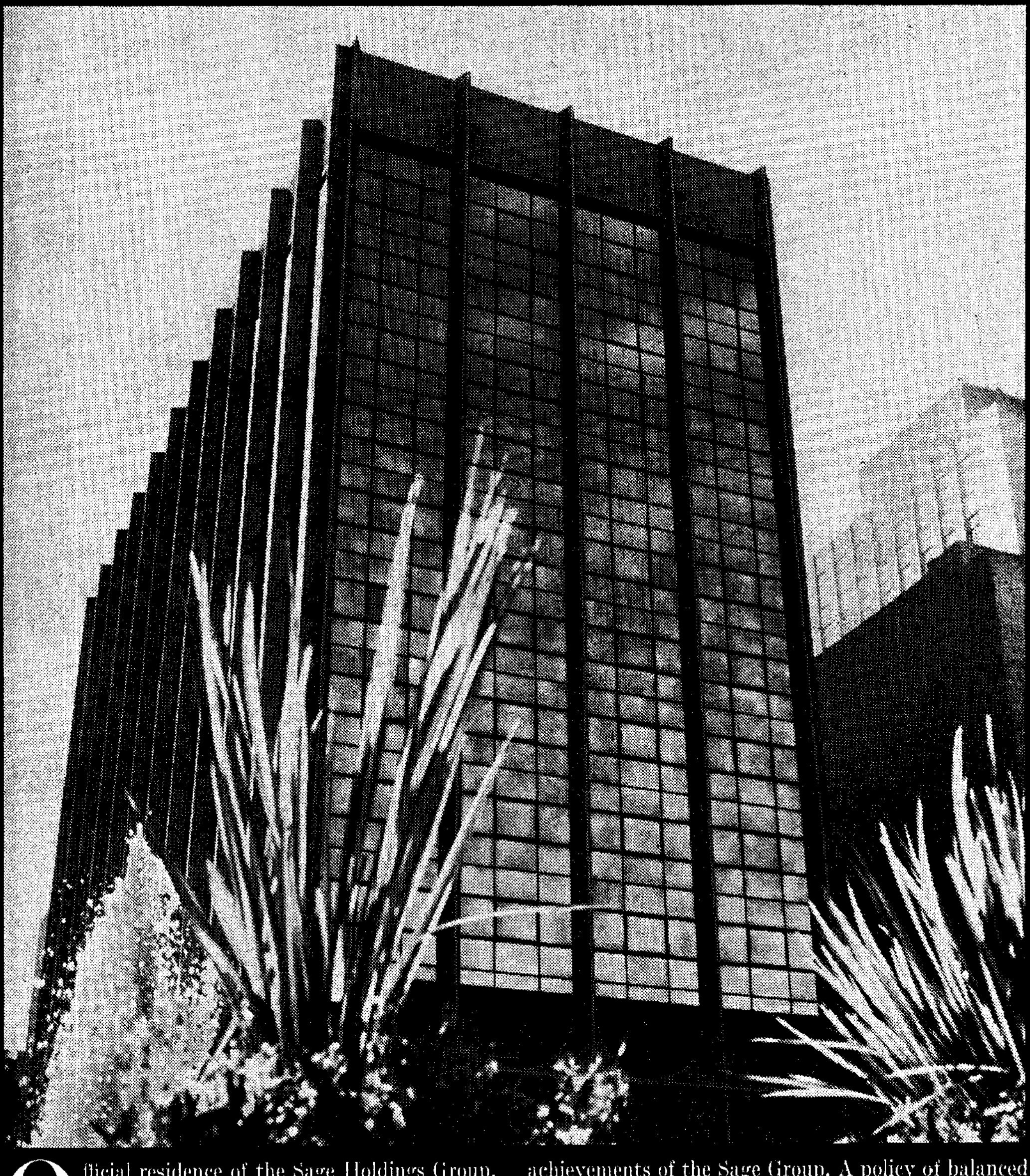

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PNB15960

By J. E. Whillier, BSc (Min.)(Witwatersrand)

Simplified method of assessing the value of a South African gold mine

1 INTRODUCTION

The primary objective of establishing any mining operation in a capitalist economy is to produce metals or minerals at a profit. Without the expectation of sufficient reward in the future there can be no incentive to divert substantial sums of money into relatively risky ventures, particularly as these have the additional investment drawback of a long development and construction phase before the cash flow becomes sufficiently large to provide a return on the capital invested. The value of any mine to an investor is determined primarily by the magnitude of the profits which can be earned and these, in turn, are dependent upon the annual metal output, operating life, commodity price, capital and working costs, and taxation.

When a new mine is to be established it is accepted practice for the technical consultants to disclose in the published prospectus of the company concerned a summary of the sampling data from the prospecting programme and to indicate the anticipated production, life and costs. Such disclosure is essential if the public is to subscribe the working capital. It is then left to the individual investor to decide on the significance of these data and to estimate the future trend of commodity prices, in order to assess the profit earning capability of the mine. In practice, the conscientious analyst will use a number of production rates and price trends to measure the attractiveness of the new mine under different circumstances.

Within a few years of the initial output being attained, it will be possible for the consultants to assess whether the mineral content is high enough to justify further expansion and, if so, whether this ought to be financed from existing profits or the raising of loans.

2 CORRELATION OF SAMPLING RESULTS WITH ACTUAL RECOVERY

Each quarterly report from a producing gold mine discloses results of sampling undertaken from the tunnels which are developed into the unmined blocks of reefs. Certain of the mining groups present figures for each individual shaft while others are reticent and give the data only for the mine as a whole though it is difficult to justify the lack of disclosure on investment grounds.

Where possible, each shaft should be valued separately and each year's sampling results should be added to those of preceding years for the purpose of calculating averages. In practice there will be little purpose in retaining the figures for those portions of a mine which have already been worked out and a 'moving average' for, say, a five year period will usually provide an adequate base from which to project future recovery grade. The quarterly figures may, for example, indicate that 500 metres were sampled, containing 36 grams of gold per ton over a 40 centimetre reef width, equivalent to 1 440 centimetre grams (cmg). If the five year moving average of the cmg value is 1 850 cmg, dividing this figure by the official ore reserve width, as published annually, say, 120 centimetres will give an *in situ* reef value of 15,4 grams per ton over a practical mining width. However, it is generally found that the official ore reserve value is less than this calculated figure and that it, in turn, has to be adjusted further in a downward direction to allow for losses of gold in mining and treatment.

Were the official ore reserve figure to be 12,5 grams per ton and the actual recovery (i.e. after losses) to be 10,0 grams per ton:

the ratio of ore reserve value to sampling value would be

$$\frac{12{,}5}{15{,}4} = 0{,}81$$

and the ratio of actual recovery to sampling value would be

$$\frac{10{,}0}{15{,}4} = 0{,}65$$

It is necessary to calculate these ratios separately for each mine because the circumstances of each will vary; nevertheless, some inter-mine comparisons may sometimes be of value.

Obviously were the sampling values from year to year to show a persistent uptrend, a period of rising gold production would be indicated and vice versa unless it was also expected that an improvement in the gold price would result in a utilization of lower grade ore.

By studying the production records of a number of adjacent mines, as well as available geological reports, a reasonable knowledge of the value distribution of a mining area can be built up. Such knowledge is essential to an intelligent projection of future gold recovery trends and no effort should be spared acquiring it.

3 RATE OF MINING, QUANTITY OF METAL PRODUCED AND LIFE

The prospectus of a mining company will indicate its anticipated milling rate but this may well be enlarged if sufficient payable ore becomes available in subsequent years. A number of mines in South Africa indicate each year their anticipated production rate and this is of great help to the shareholder and analyst. However, if no such forecast is given, it is reasonable to assume that current production tonnages will be milled in future years provided operating conditions are expected to remain stable.

If operating conditions are changing, the analyst must make his own estimates based on the information available to him. (See Appendix I.) If 2 million tons is to be milled (line 9) with an average recovery of 10,0 grams per ton (line 15) then the mine will produce 20 000 kilograms or 20 tons of gold.

The remaining life of an existing operation can be determined to a reasonable degree of accuracy by using the shareholders' plan of the underground workings to determine the unmined area of reef remaining, e.g. 2 500 hectares (line 3), which when multiplied by the published ore reserve width (e.g. 1,20 metres, line 4) gives a volume of 30 million cubic metres, or 78 million tons (line 6) at a flat dip or 85 million tons if the reef dips (i.e. slopes) at 25 degrees. From this plan, too, it should also be possible to estimate the percentage extraction of the ore body that has been obtained, say, 70% (line 7), leaving an effective 54,6 million tons for a flat reef (line 8) and a life of about 27 years (line 10) at a constant mill rate.

4 METAL PRICES

Since there is no realistic way of accurately predicting metal prices, the analyst must make his own assumptions. For the purpose of this study, a starting gold price of $130 per ounce is made for 1977, escalating thereafter at 2½% per annum compound. It is then a simple matter to convert this to rand per kilogram, e.g.

$$\frac{\$130}{1{,}15^{*} \times 31{,}1^{\dagger}} \times 1\,000 = \text{R3 635 per kilogram}$$

*R1,00 = $1,15

†31,1 grams per troy ounce

Our theoretical mine, producing 20 000 kilograms of gold each year would then earn revenue of R72,7 million in 1977 (line 16), figures for all future years over the life of the mine being calculated in a similar manner subject, of course, to the allowance made for the gold price escalation.

5 WORKING COSTS AND CAPITAL EXPENDITURE

For 1977, working costs are assumed to escalate by 15% over those for 1976, giving a figure of R20,00 per ton milled (line 11). Although no further cost rises are assumed for the sake of simplicity, it is obvious that allowance would have to be made for these if they were considered to be likely.

Capital expenditure even on a fully equipped mine varies considerably from group to group. The need to improve working conditions generally saw a vast surge in spending in the past three years. For 1977, again for simplicity, a figure of 10% of total working costs will be assumed, i.e. 10% of line 17, viz R4 million (line 18). The analyst should endeavour to ascertain whether major spending is contemplated in the future with regard to this figure as it would affect profits available for distribution. Unfortunately there is no empirical way of computing such expenditure for the years ahead and guidance from the mines is not always available.

Capital spending can be regarded as a cost item for all practical purposes and is deducted directly from revenue to arrive at a figure for profit at the mine (line 19).

6 LEASE AND TAXATION PAYMENTS

Although mining companies own their mineral rights, the right to mine for precious metals is vested in the State which cedes this right in exchange for a proportion of mining profits. A typical lease formula might take 15% of profits (reduced, however, by a revenue allowance, traditionally 6% for those mines established in the 1950's — line 20). A relatively unimportant surcharge is added to the lease formula which is ignored in this example.

The standard rate of gold mining taxation is 60% of profits, again reducing these by an appropriate revenue allowance such as the 6% indicated above and after deducting lease payments (line 24).

Lease payments are irrevocably fixed for normal mining operations but the scale of mining taxation, as with other company taxation rates, does change from time to time with an overall upward bias.

In the March 1976 Budget the Minister of Finance increased the surcharge on the taxation of mining companies to 10% (line 25) and raised the loan levy applicable to them to 15% of the taxation payable excluding the surcharge — see line 26. As this loan levy is returnable no later than seven years after payment it should, theoretically, be regarded as a sum which will ultimately revert to shareholders. However, given the persistence of current inflation rates its purchasing power then would be relatively modest and it is, thus, reasonable to regard it as a cost.

7 NET PROFIT ATTRIBUTABLE TO SHAREHOLDERS

The net profit after all deductions (line 27) belongs to shareholders given that nothing needs to be retained to finance major projects in future years and that there are no loans that require repayment.

If it is assumed that the company we are considering has 15 million shares in issue, a distributable profit of R9,5 million (line 27) would make possible the payment of a 63 cent dividend.

In section 4, it was assumed that the gold price would escalate by 2½ per cent annually. Were the gold output to remain constant each year, revenue would rise by only 2½ per cent annually. The net profit (line 27) would rise slightly more rapidly (Appendix II, line 11), permitting a gradual increase in the dividend (lines 12 and 13).

Appendix II summarises the production and financial situation for each of the next five years and then shows the position as it would be in the 10th and 27th year.

In the remaining 27 years of its life, our theoretical mine would pay out to its shareholders a large aggregate amount of dividends. However, as this money would be received in instalments, and much of it after the lapse of a great many years, its worth would be much less to the investor than were he to receive it all immediately.

8 DISCOUNTING FUTURE DIVIDENDS BACK TO THE PRESENT

To calculate the present value of the expected income from a mine each anticipated dividend payment needs to be discounted at a specified rate of interest subject to the lapse of time before it is received. This can be done easily enough by using a set of compound interest tables.

The rate of discount that should be used has been argued interminably by various authorities. For the purpose of this exercise a suitable starting point in the debate may be a consideration of the interest rates on low risk building society shares of about 10 per cent. Government and Escom stocks yield 1½ to 2½ per cent more and unsecured bonds from high class companies yield 13½ per cent. To the extent that any mine has certain inherent technical and ore value risks, a shareholder may consider 13½ per cent to be a minimum. However, if he expects the gold price to rise in real money terms, he may be prepared to lower his yield expectation slightly.

To curtail discussion at this point, we assume a discount rate of 12 per cent. Each year's dividend is then adjusted downwards by the discount factor and these annual discounted dividends are then totalled to arrive at the so-called present value — usually on a per share basis. (See Appendix II.)

Note how rapidly the present value falls as the interval increases before the dividend is received and how significant are the first few years as far as present value is concerned.

This total present value can be compared with the share price as quoted on any stock exchange. The discounted value may be greater than, equal to, or less than the price depending both on the assumptions made about the future of the mine and the mood of all investors, both local and foreign. At this juncture, an investor or potential investor will need to know whether the company which he has analysed in so much detail represents the best available investment in the gold share market and his only recourse then is to analyse a number of other mines for comparative purposes.

Under no circumstances should comparisons be made between short life mines and long life mines, or between highly profitable mines and marginal mines unless the analyst has a vast accumulation of data and experience.

Thus, comparisons should only be effected by the novice where mines are similar in most important aspects, such as annual output of metal, life and total expenditure (including both working and capital costs).

The price placed on shares by buyers and sellers changes from time to time, particularly if there is thought to be an imminent change in the profit earning capacity of the company. Thus, if the metal price is expected to rise sharply or if the gold output is expected to jump as mining moves into a high grade area, buyers will strive to secure the shares ahead of the expected increase in dividends and the share price will escalate.

Another factor affecting share prices is a change in the dividend yield requirement if interest rates in general change.

9 AMORTISATION

The total present value of the future flow of dividends, discounted at an appropriate rate, will give a net yield greater than the discount rate if the share price is less than the present value (assuming all the input assumptions are correct). The net return is less than the discount rate if the present value is less than the share price.

Thus, if the present value of an assumed investment is, say, 550 cents per share, the share price is 400 cents and the discount rate is 12 per cent, the net yield would be somewhat higher than 12 per cent but the actual yield would need to be determined by discounting at a variety of slightly higher rates until, by trial and error, the correct one was found — a tedious procedure.

This net yield takes into account the fact that every mine has a finite life and that dividends will cease when the ore-body is finally depleted. It recognises the necessity for the investor in a mine to replace the capital he spent on acquiring his shares by buying a new investment in the place of the one that is being mined out. In practice, such amortization can be effected by reinvesting a proportion of each dividend and allowing the capital sum to be enlarged by accumulating all dividends or interest received on a compound basis. The annual reinvestment can be determined simply from the basic compound interest formula.

$$C = D\,(I + R)^n;\ \text{transposing, } D = \frac{C}{(I + R)^n}$$

where C — capital (equivalent to share purchase price)
D — annual reinvestment
R — annual interest rate (say 10%)
n — number of years before mine shuts down.

It is important to note, however, that amortization of the kind described above, does involve a complication for investors subject to a significant rate of tax.

Although the dividends they receive from the mine effectively contain an element of capital repayment, the revenue authorities tax their dividend receipts at the full rate applicable to dividend income.

10 GENERAL

The factors which have the greatest influence in determining profits and hence the value of the investment are the recovery grade and the metal price. These are the two most difficult to quantify over the full life of a mine.

The simplified valuation technique has the merit of being within the capacity of anyone who is prepared to study the basic geology, the mineral distribution patterns and the regular reports issued by mining companies. However, there is no short cut to success and a good analyst will be prepared to study the subject and the industry concerned conscientiously.

Before deciding that a given share or group of shares is relatively attractive (or unattractive) on the basis of his calculations, the novice would be well advised to compare his findings with those of other analysts. Regard should also be paid to the tax status of the particular investor.

The use of a computer makes it a relatively simple matter to analyse the whole gold mining industry, using a number of parameters for the input data.

APPENDIX I

The valuation of a South African gold mine

1	Original lease area	3 000	hectares
2	Mined to date	500	hectares
3	Unmined	2 500	hectares
4	Ore reserve width	1,20	metres
5	Relative density	2,6	
6	Reef tons (3.4.5)	78,0	million
7	Overall extraction rate	70	per cent
8	Mineable tons	54,6	million
9	Annual milling rate, tons	2,0	million
10	Life (8 divided by 9)	27	years
11	Cost per ton milled	20,0	rand
12	Gold price, per ounce	130	dollars
13	Gold price, per kilogram	3 635	rand

14	Annual milling rate, tons	2,0	million
15	Recovery grade, per ton milled	10,0	grams
16	Revenue (13.14.15)	72,7	rand millions
17	Total costs (11.14)	40,0	rand millions
18	Capital expenditure	4,0	rand millions
19	Profit at mine (16–17–18)	28,7	rand millions

Taxation calculated — one decimal place

19	Profit at mine	28,7	rand millions
20	Revenue allowance, 6% of (16)	4,4	rand millions
21	Profit subject to lease payment (19–20)	24,3	rand millions
22	Lease at 15% of (21)	3,7	rand millions
23	Balance of profit (21–22)	20,6	rand millions
24	Taxation @ 60% of (23)	12,4	rand millions
25	Surcharge at 10% of (24)	1,2	rand millions
26	Loan levy @ 15% of (24)	1,9	rand millions
27	Net profit after lease, tax, surcharge and levy (19–22–24–25–26)	9,5	rand millions

---

APPENDIX II

Profit, dividend and present value

1	Year	1	2	3	4	5	10	27
2	Cost, RPT	20,0	20,0	20,0	20,0	20,0	20,0	20,0
3	Price, $ per oz	130	133	136	140	143	166	253
4	Mill, MTPA	2,0	2,0	2,0	2,0	2,0	2,0	2,0
5	Grade, GPT	10,0	10,0	10,0	10,0	10,0	10,0	10,0

The financial figures are rounded off to the nearest R million in table below:

6	Revenue	73	74	76	78	80	93	142
7	Costs	40	40	40	40	40	40	40
8	Capex	4	4	4	4	4	4	4
9	Profit at mine	29	30	32	34	36	49	98
10	L & T*	20	20	22	23	25	34	71
11	Net profit	9	10	10	11	11	15	27
12	Dividend	9	10	10	11	11	15	27

The dividend and value below are based upon the actual financial figures as calculated and not on the summarised figures above.

13	Dividend, cps	63	67	70	73	77	99	183
14	PV† each dividend, cps	57	53	50	46	44	32	9

*Includes surcharge and loan levy

†Discounted @ 12,0%

By Professor I. R. Woods, BCom (Witwatersrand) MCom PhD (Natal)

An analysis of the possible effects of a rights issue on the issuing company's share price

A study of the effects of a rights issue of new ordinary shares on the price of the issuing company's existing ordinary shares should span at least the period from shortly before *announcement* of the issue to shortly after the shares switch from a cum rights to an ex rights basis on the stock exchange. This is because the market price of the old shares might react to the announcement and because the shares ex rights should normally be priced lower than they were cum rights, the drop being calculated in terms of the well-known 'parity price formula'.[1]

It is possible that insider trading or leakage of information will cause price to react before announcement. It is also possible that the inability of the market to forecast the longer term effects of an issue will result in the immediate ex rights price not fully reflecting these effects.

The aims of this paper are briefly to outline the main price-influencing factors of a rights issue and to illustrate in symbolic form the combined effects of these factors plus the ex rights drop-off in price. Throughout we assume that the issue is of the simple variety, i.e. a sale of new ordinary shares *pro rata* to the ordinary shareholders in the issuing company, where the new shares rank *pari passu* with the old and where their issue price is below the current market price of the old for the duration of the issue.

It seems to us that all of the main price-influencing factors of a rights issue are subsumed under the following four headings:

1 The rate at which the marginal sector of the market discounts the entire stream of future expected dividends per share, or the factor which it applies to the next expected dividend or earnings per share in order to determine share value. Such a factor, which acts as a surrogate for the market rate of discount but which does not 'discount' the entire stream of future dividends, would be the minimum acceptable dividend yield or earnings yield, or the maximum acceptable price/earnings ratio. It is assumed in this analysis that share price is determined via the minimum dividend yield (or the 'required dividend yield') acceptable to the marginal sector of the market.

As this first factor required some explanation we return to it in the next section of the paper.

2 The issuing company's dividend payout ratio. If a change in this is announced simultaneously with a rights issue, share price might react to the change as well as to the rights issue. Strictly speaking, a change in the payout ratio is largely, if not entirely, exogenous to a rights issue,[2] but we list it here because such a change is sometimes associated with a rights issue.

If no change occurs in the minimum acceptable dividend yield, an increased payout ratio will tend to bring about an increase in share price, and conversely for a decreased payout ratio. If no price reaction occurs when the payout ratio is altered, which would accord with Modigliani-Miller reasoning,[3] the explanation in terms of the model presented later is simply that the price effects of a higher (lower) dividend per share are exactly offset by a rise (fall) in the dividend yield required by the market.

3 The degree and direction of financial leverage in the issuing company. Any price-raising effects of upward leverage would tend to be reduced by a rights issue since the issue reduces the degree of capital gearing in the company, thus reducing the extent of upward leverage and future dividends per share. The converse would apply where leverage is downward.

Thus, assuming no change in the minimum dividend yield acceptable to marginal investors, the price of the company's existing ordinary shares should tend to fall on the announcement of a rights issue when the company is experiencing upward financial leverage and rise where it is experiencing downward financial leverage.[4] However, the required dividend yield might react on announcement of the rights issue because of the implications arising from the effects of the issue on leverage — for instance, the implications for growth, the firm's financial risk complexion, etc. Such reaction would either reinforce or offset the effects of the reduction in leverage on future dividends and therefore on price.

4 The expected profitability of the new capital. Clearly, this is particularly important and the possible effects on share price are obvious. In the model presented below we split this aspect in two, viz: book profitability[5] and whether or not the market value of the existing shares equals their asset value (defined as book value).[6] This dichotomy is consistent with the practice of showing profits as a percentage of book values of share capital, total assets, etc., and also the practice of distinguishing between the market value of a share and the share's book value.

For simplicity, we consider only *after-tax* profitability.

It should be pointed out that it does not follow that if the new capital is expected to earn a lower (higher) accounting rate of return (whether based on book or market values of assets) in the early years, this necessarily means that a lower (higher) *true* return (i.e. internal rate of return, or DCF yield) is anticipated since the accounting rate might later

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rise (fall), with the possible result that the new money might, in fact, earn a higher (lower) true return than the old. If this is a real and foreseeable possibility, an efficient stock market will take it into account in establishing a share price which is reasonably correct in terms of true DCF principles. In terms of our analysis, the adjustment (if any) to share price would be made via an adjustment to the required dividend yield in order to reinstate the expected true yield on the share to a competitive level.

MARKET RATE OF DISCOUNT

We define this as the minimum true yield (internal rate of return) acceptable to the marginal investor(s). It is r in[7]:

$$P = \sum_{n=1}^{\infty} \frac{D_n}{(1+r)^n} \qquad (1)$$

where P = ex div share price at the beginning of a dividend period;
D = expected value of the marginal investor's (or investors') subjective probability distribution(s) of dividends per share per period; and
n = the period.

However, the minimum dividend yield acceptable to the marginal investor(s) (which is sometimes referred to in this paper as the required dividend yield) is d in:

$$P = D_1/d \qquad (2)$$

where P is as defined above and D_1 is the marginal investor's (investors') subjective probability distribution of dividend per share at the end of the first period only.

It should be evident from (1) and (2) that provided $D_1 > 0$ and given the entire stream of expected dividends, there must be a unique value of d which corresponds to a given value of r. Thus d and r are connected.[8] Likewise, it can be shown that the required earnings yield or the required price/earnings ratio are related to r.

As stated earlier, we assume that share price is determined via the required dividend yield, as shown in (2). We adopt this approach instead of the direct DCF approach reflected in (1) because the latter is generally, though not always, avoided in practice[9] owing to the obvious problems entailed in forecasting dividends far into the future.

A change in d could result from a rights issue for a variety of reasons — e.g. altered total risk complexion of the firm, improved marketability of shares, etc.[10] As can be seen from (2), P is inversely related to d.

From (1) it can be seen that P varies inversely with r and directly with the average compound rate of growth in D (which rate we shall symbolise as g). Since dividend yield is defined as D_1/P, it follows that d varies directly with r and inversely with g (*cet. par.*). Thus the effects of a rights issue on d can be subdivided into its effects on r and g.[11]

In so far as the pricing implications of portfolio theory are concerned, whereby only a share's systematic risk is relevant (the unsystematic risk having been 'washed away' by Markowitz diversification),[12] these should be incorporated in the market rate of discount or its surrogate. In view of this, we do not henceforth explicitly mention the possible portfolio effects of a rights issue; they are subsumed under item (1) in the previous section of this paper.

TWO FOCAL POINTS

In an efficient market, any anticipated effects of the four categories of price-influencing factors should occur at the time of *announcement* of a rights issue or shortly thereafter, insider trading and leakage of information aside. Then some weeks, possibly months, later when the shares switch from a cum rights to an ex rights basis on the stock exchange, share price should fall (*cet. par.*) in accordance with the parity price formula.[13] These are the two focal points for the effects of a rights issue on the price of the issuing company's old shares.[14]

All too frequently, the text-books emphasise the second of these focal points while the price-effects of the first are either glossed over or ignored completely. If the first is ignored and if a short-term view is taken, it is easy to 'prove' that shareholders are no better or worse off after a rights issue than they were before, provided they do not ignore their rights. In fact, if price falls at the second focal point in accordance with the parity price formula (as it ought to, *cet. par.*) shareholders will, at least in the short-term, be worse off as a result of the issue if price fell on announcement, and better off if price rose on announcement. The reaction of share price to the *announcement* of a rights issue is therefore important in the context of the goal of maximising shareholder wealth.

As pointed out earlier, one aim of this paper is to illustrate in symbolic form the combined effects of the four categories of price-influencing factors plus the ex rights drop-off. However, while the formulae in our model are, we submit, useful for analytical and expositive purposes, we make no claim that they are of much practical use for the simple reason that the anticipated ex rights price can be estimated more quickly by attaching values to D_1 and d in equation (2) above.

In order to clarify the analysis and highlight the essentials, we make ten simplifying assumptions. These are listed in the appendix.

A PRICE-EFFECTS MODEL

The model presented below analyses the relationship between share price shortly before the announcement of a rights issue (P_1) and price shortly after the shares go ex rights on the stock exchange (P_3). Thus both the announcement effects and the ex rights drop-off are incorporated. As emphasised earlier, the implications for shareholder wealth depend not merely upon a comparison of the cum rights price (P_2) with P_3 but upon a comparison of P_1 and P_3.

The symbols used are as follows (note that assumptions 5 and 6 in the appendix are particularly relevant):

P_1 = share price immediately before the announcement of a rights issue;
P_2 = the cum rights price (i.e. post-announcement);
P_3^* = the unadjusted[15] ex rights price obtained by inserting P_1 instead of P_2 into the parity price formula[16];

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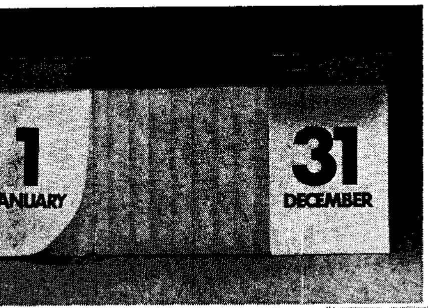

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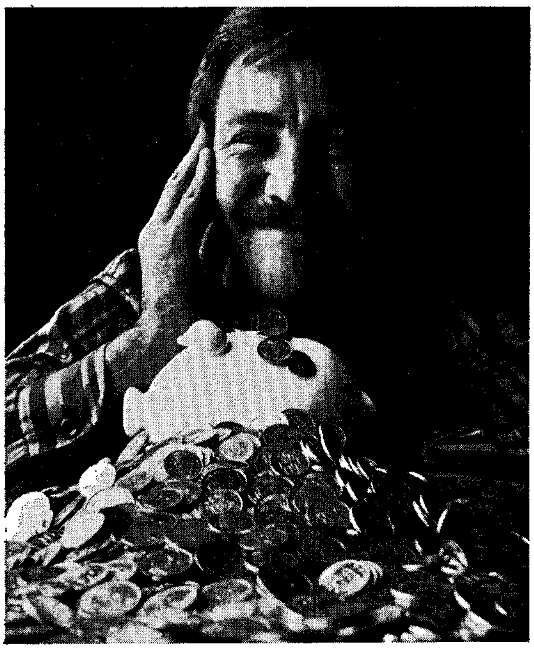

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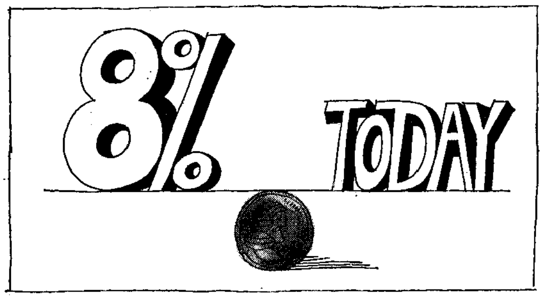

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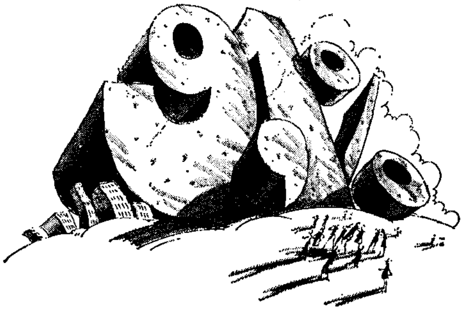

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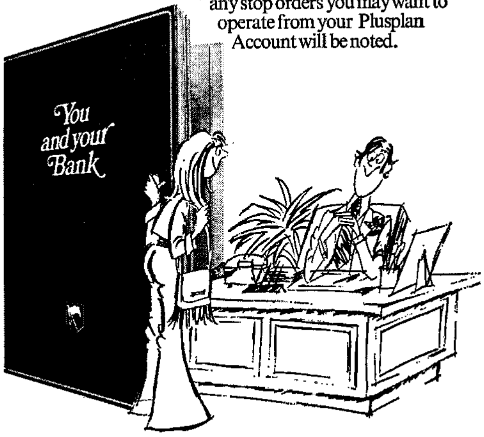
We can arrange for transfers to be made direct from your Standard current account to Plusplan, and of course any stop orders you may want to operate from your Plusplan Account will be noted.



Do I have to have an existing account at the Standard?

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P_3 = the adjusted value of P_3^* and therefore the expected ex rights price;

d_o = required dividend yield before announcement $= \dfrac{\text{dividend per share } (D_1) \text{ before announcement}}{P_1}$;

d_n = required dividend yield after the issue $= \dfrac{\text{dividend per share } (D_1) \text{ after the issue}}{P_3}$;

R_o = dividend payout ratio before announcement $= \dfrac{\text{dividend per share before announcement}}{\text{earnings per share before announcement}}$;

R_n = dividend payout ratio after the issue $= \dfrac{\text{dividend per share after the issue}}{\text{earnings per share after the issue}}$;

L_o = degree of leverage before announcement[17] $= \dfrac{\text{net ordinary profit (earnings) before announcement}}{\text{net ordinary assets before announcement}} \times \dfrac{\text{total assets before announcement}}{\text{net profit (before interest) before announcement}}$;

L_n = degree of leverage after the issue $= \dfrac{\text{net ordinary profit (earnings) after the issue}}{\text{net ordinary assets after the issue}} \times \dfrac{\text{total assets after the issue}}{\text{net profit (before interest) after the issue}}$;

N_o = average book rate of net profit (after tax, before interest) on total capital before announcement $= \dfrac{\text{net profit (before interest) before announcement}}{\text{total assets before announcement}}$;

N_n = average book rate of net profit (after tax, before interest) on total capital after the issue $= \dfrac{\text{net profit (before interest) after the issue}}{\text{total assets after the issue}}$;

A_o = asset value per ordinary share before announcement $= \dfrac{\text{net ordinary assets before announcement}}{\text{number of ordinary shares before announcement}}$;

A_n = asset value per ordinary share after the issue $= \dfrac{\text{net ordinary assets after the issue}}{\text{number of ordinary shares after the issue}}$

The following expression then holds:

$$P_3 = P_3^* \cdot \frac{d_o}{d_n} \cdot \frac{R_n}{R_o} \cdot \frac{L_n}{L_o} \cdot \frac{N_n}{N_o} \cdot \frac{A_n/P_3^*}{A_o/P_1} \qquad (3)$$

This shows how the unadjusted ex rights price (P_3^*) must be adjusted for the effects of the announcement of the issue in order to give the true ex rights price (P_3). The five adjusting factors (the last five terms of (3)) correspond to the four categories outlined in the first section of this paper, bearing in mind that the fourth category (expected profitability) is split in two and is represented by the last two terms of (3).

That formula (3) holds can be proved by looking to the definitions of the symbols. If we substitute these definitions for the relevant symbols in the formula and cancel identical terms, we are left with:

$$P_3 = P_3 \times \frac{\text{earnings per share before announcement}}{\text{earnings per share after the issue}} \times \frac{\text{net ordinary profit (earnings) after the issue}}{\text{net ordinary profit (earnings) before announcement}} \times \frac{\text{number of ordinary shares before announcement}}{\text{number of ordinary shares after the issue}}$$

Since the product of the third and fourth terms on the right-hand side equals the reciprocal of the second term, all three terms also cancel out. This leaves P_3 on the right-hand side, thus validating the formula.

Formula (3) simplifies to:

$$P_3 = \frac{d_o}{d_n} \cdot \frac{R_n}{R_o} \cdot \frac{L_n}{L_o} \cdot \frac{N_n}{N_o} \cdot \frac{A_n}{A_o} \cdot P_1 \qquad (4)$$

This is our main formula. In words, it states that the ex rights price (P_3) is obtainable by multiplying share price before announcement (P_1) by:

$$\frac{\begin{array}{c}\text{dividend yield}\\\text{before announcement}\end{array}}{\begin{array}{c}\text{dividend yield}\\\text{after the issue}\end{array}} \times \frac{\begin{array}{c}\text{payout ratio}\\\text{after the issue}\end{array}}{\begin{array}{c}\text{payout ratio}\\\text{before announcement}\end{array}} \times \frac{\begin{array}{c}\text{leverage}\\\text{after the issue}\end{array}}{\begin{array}{c}\text{leverage}\\\text{before announcement}\end{array}} \times \frac{\begin{array}{c}\text{profitability}\\\text{after the issue}\end{array}}{\begin{array}{c}\text{profitability}\\\text{before announcement}\end{array}} \times \frac{\begin{array}{c}\text{asset value}\\\text{after the issue}\end{array}}{\begin{array}{c}\text{asset value}\\\text{before announcement}\end{array}}.$$

A further abbreviation is possible because the last three terms of (3) can be replaced by $\dfrac{E_n/P_3^*}{E_o/P_1}$, where E_n is earnings per share after the issue and E_o

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earnings per share before announcement. It can be proved that this is valid, i.e. that

$$\frac{E_n/P_3^*}{E_o/P_1} = \frac{L_n}{L_o} \cdot \frac{N_n}{N_o} \cdot \frac{A_n/P_3^*}{A_o/P_1} \qquad (5)$$

simply by substituting the definitions for the symbols on the right-hand side of (5) in the same manner as with formula (3). After cancelling identical terms we are left with (on the right-hand side):

$$\frac{P_1}{P_3^*} \times \frac{\text{net ordinary profit (earnings) after the issue}}{\text{number of ordinary shares after the issue}} \times \frac{\text{number of ordinary shares before announcement}}{\text{net ordinary profit (earnings) before announcement}}$$

Symbolically this reduces to $\frac{P_1}{P_3^*} \cdot \frac{E_n}{E_o}$, thus proving (5).

Formula (5) simplifies to:

$$\frac{E_n}{E_o} = \frac{L_n}{L_o} \cdot \frac{N_n}{N_o} \cdot \frac{A_n}{A_o} \qquad (6)$$

Substituting (6) in (4) we get:

$$P_3 = \frac{d_o}{d_n} \cdot \frac{R_n}{R_o} \cdot \frac{E_n}{E_o} \cdot P_1 \qquad (7)$$

Clearly, (7) is less analytical than (4), our main formula.

The second and third terms on the right-hand side of (3) can be replaced by E_{yo}/E_{yn} where E_{yo} is earnings yield before announcement and E_{yn} is earnings yield after the issue. Because

$d_o = D_o/P_1$, where D_o is dividend per share before announcement,
$d_o = D_n/P_3$, where D_n is dividend per share after the issue,
$R_n = D_n/E_n$, and
$R_o = D_o/E_o$,
it follows that:

$$\frac{d_o}{d_n} \cdot \frac{R_n}{R_o} = \frac{D_o}{P_1} \cdot \frac{P_3}{D_n} \cdot \frac{D_n}{E_n} \cdot \frac{E_o}{D_o} = \frac{E_o/P_1}{E_n/P_3} = \frac{E_{yo}}{E_{yn}} \qquad (8)$$

Substituting (8) in (4) we get:

$$P_3 = \frac{E_{yo}}{E_{yn}} \cdot \frac{L_n}{L_o} \cdot \frac{N_n}{N_o} \cdot \frac{A_n}{A_o} \cdot P_1 \qquad (9)$$

which gives us an earnings yield approach to finding the ex rights price from the price before announcement, provided that earnings yield is interpreted as the minimum acceptable to marginal investors. Formulae (3) and (4) give a dividend yield approach.

We can quite easily modify formula (9) to give a price/earnings approach. Since the price/earnings ratio is the reciprocal of the earnings yield,

$$\frac{E_{yo}}{E_{yn}} = \frac{P_3/E_n}{P_1/E_o}$$

Substituting this in (9):

$$P_3 = \frac{P_3}{E_n} \cdot \frac{L_n}{L_o} \cdot \frac{N_n}{N_o} \cdot \frac{A_n}{A_o} \cdot E_o \qquad (10)$$

Thus we see that there are several ways of illustrating the links in the chain leading to P_3. Our preference is for formula (4) in this respect as it shows the most detail.

OTHER FORMULAE

Other writers have published formulae concerning the price effects of rights issues.[18] Since space precludes a full examination of these formulae, we shall comment briefly only on the approach recommended by Merrett, Howe and Newbould.[19] They propose the following formula for ascertaining the ex right prices:

$$\frac{\text{value of shares before new issue + new capital raised}}{\text{number of shares after new issue}} \times \frac{\text{return after new issue}}{\text{return before new issue}}$$

However, the formula is vague as it stands since its terms are not adequately explained — they can have several different meanings.[20]

Weston, using the Merrett, Howe and Newbould approach as a basis, selects the following version of their formula:[21]

$$\frac{\text{market value of shares pre-issue and new capital raised}}{\text{number of shares after issue}} \times \frac{\text{dividend paid post-issue}}{\text{dividend paid pre-issue}}$$

But he, too, does not clarify his terms.[22]

However, these formulae do seem to have practical relevance since, on average, the ex rights price apparently approximates the price as predicted by them.[23] We do not claim that our formulae as presented in the preceding section are superior in the applied sense. All we claim is that our formulae are superior theoretically since they show more clearly the main factors which might affect share price when a company makes a rights issue, and since they are validated *a priori*.

APPENDIX: THE SIMPLIFYING ASSUMPTIONS

1 The ex rights price of the issuing company's existing ordinary shares will be as shown by the parity price formula.[24]

2 There is only one announcement of the rights issue.

3 The effects on share price of the announcement of the issue occur at the time of announcement. There is no anticipation of such effects by the market, and there is no delay in the appearance of these effects once the announcement has been made. Moreover, the rights issue does not cause dealings in the shares, which would otherwise have occurred in the cum rights period, to be delayed until the shares are traded ex rights.

4 The proceeds of the rights issue are to be used entirely to finance expansion of the company, i.e. to increase its fixed and/or current assets, as distinct from repaying prior charge capital.

5 The estimates of what dividends, earnings, net profit, etc., will be after the issue are the expectations of the marginal sector of the market since it is this sector which determines share price. The corresponding estimates for before the issue are what the expectations of the marginal sector *would have been if no rights issue were made.*

6 Dividends are paid once per period (e.g. one year) by the company, the next one being due at the end of the period which starts from the closing date of the rights offer. This date is also the base for estimates of dividends, earnings and net profit; these estimates refer to the end of that period only and not to any future periods.

7 Share price is taken to be net of any cash dividend which is imminent and subsequent dividends are to be the same on each new share as on each old. Thus by price we mean the 'clean' price in that it is not necessarily the current market price but that price minus any imminent dividend (or portion thereof if shareholders' income tax is taken into account).[25]

8 There is no gradual rise in share price as the company makes profits day by day or week by week. Such a rise should occur, in theory at least, since the company's net worth increases as profits are made, or, to put it differently, the next dividend gets closer as time progresses. This means that we ignore the time value of money over the relatively short period of time involved in a rights issue.

9 No exogenous factors intrude at any stage, from immediately before the announcement of the issue until the company has received its new capital, unless otherwise stated. Thus, share price can be influenced only by the rights issue, unless otherwise stated.

10 Flotation expenses are zero.

If assumption no. 1 were relaxed, only the extent of the ex rights drop-off would be affected. There should be no effect at the time of announcement. The consequences of relaxing simplifying assumptions nos. 2, 3 and 4 — the 'condensation' assumptions — would simply and obviously be that the price effects might be spread over a longer, perhaps a very much longer, period of time than that assumed in our model. Simplifying assumption no. 5 is essential to any price analysis and cannot meaningfully be dropped. Simplifying assumptions nos. 6, 7, 8 and 9 enable us to consider the effects of the rights issue in isolation; one consequence of relaxing no. 8 would be that share price would be slightly lower on announcement than the level assumed in our analysis. Finally, the effects of relaxing simplifying assumption no. 10 would normally be small, and we do not comment further on them here.[26]

As a result of these simplifying assumptions, no change can occur in share price from the time the rights issue is announced until the company has received its new funds, unless a change is brought about by the rights issue itself. Price *might* react on the *announcement* of the issue and it *ought to* fall later *when the shares go ex rights* on the stock exchange, provided that the issue price of the new shares is below the market price of the old (which is usually, though not always, the case).

FOOTNOTES

1 The formula is:

$$P_3 = \frac{nP_2 + bI}{n + b}$$

where P_3 = first ex rights price;
P_2 = last cum rights price;
n = number of old shares that entitle the holder to buy b new shares;
b = number of new shares one may buy if n old shares are held;
I = issue price of each new share.

2 The change can be related, if only remotely, to a rights issue. For instance, the company might have to rely relatively more on retained earnings (i.e. reduce its payout ratio) as a source of future finance if the expansion resulting from the issue has to be continued and cannot be financed easily from other sources.

3 Miller, M. H. and Modigliani, F. 'Dividend Policy, Growth and the Valuation of Shares.' *The Journal of Business,* vol. XXXIV, No. 3, October 1961.

4 Woods, I. R.: *A Theoretical Study of Rights Issues and Capitalization Issues.* Unpublished PhD thesis. Durban: University of Natal, 1975, ch. 8.

5 The book profitability of the new funds is defined as the increase in net annual profit in relation to the increase in share capital and reserves. Book profitability before the issue is defined as the relationship of net annual profit (before deducting interest and assuming no rights issue) to the book value of total assets before the issue.

6 Asset value per share is defined as the book value of net ordinary assets (i.e. after subtracting prior charge capital) divided by the number of ordinary shares outstanding.

7 r is the anticipated true yield before deducting personal income tax, and ignoring trading costs.

8 This relationship is considered more fully in Woods, I. R. *op. cit.* chs. 3.1 and 3.2.

9 Bing, R. A. 'Survey of Practitioners' Stock Evaluation Methods.' *Financial Analysts Journal,* vol. 27, no. 3, May — June 1971.

10 These are listed and examined in Woods, I. R. *op cit.* ch. 3.3.

11 In the perpetual-growth valuation model, $r + D_1/P + g$. Here, while the direct relationship between dividend yield and r and the inverse relationship between dividend yield and g are also evident, these relationships are furthermore shown *explicitly* as $D_1/P = r - g$.

12 See, *inter alia,* Markowitz, H. *Portfolio Selection: Efficient Diversification of Investments.* New York: John Wiley and Sons, 1959; and Francis, J. C. *Investments: Analysis and Management.* 2nd edition. New York: McGraw-Hill, 1976, part 5.

13 See footnote 1.

14 Where a preliminary and then a more detailed announcement is made, the first focal point becomes blurred. Presumably the more detailed announcement should have greater effect.

15 I.e. not adjusted to allow for the *announcement* effects on price. P_3^* is what the ex rights price would be if there were no change in price on announcement.

16 See footnote 1.

17 This measure of leverage is:

$$\frac{\text{book rate of return on equity capital}}{\text{book rate of return on total capital}}$$

18 The main two are: (1) Evans, G. H. 'The Theoretical Value of a Stock Right.' *Journal of Finance,* vol. X, no. 1, March, 1955. (2) Merrett, A. J., Howe, M. and Newbould, G. D. *Equity Issues and the London Capital Market.* London: Longmans, Green and Co., 1967, p. 50.

19 See preceding footnote. For a fairly detailed examination of Evan's approach, see Woods, I. R. *op. cit.* ch. 11.4.

20 In the first term, is the 'value of shares before new issue' the pre-announcement or the post-announcement price, i.e. P_1 or P_2? With regard to the second term, is the return a rate or an absolute figure? Does it refer to earnings or dividends? Is it or is it not a true DCF return?

21 Weston, C. R. 'Adjustment to Future Dividend Rates in the Prediction of Ex-rights Prices.' *Journal of Business Finance and Accounting,* vol. 1, no. 3, Autumn 1974, p. 335.

22 With regard to the first term, Weston does not state whether the market value should be share price before or after announcement. He chooses the former for his empirical study without saying why (*op. cit.* p. 336).

He also states that 'no correction has neen made for any changes in the general trend of share prices . . . for the one day from the last day of cum-rights trading to the close of the first day ex-rights' (*ibid.*). This is puzzling since if a correction were made (and we believe it should) it should be for the *entire* period commencing with the date of the pre-announcement share price chosen for the first term of the formula, and not merely for the last day or so of that period.

Furthermore, the absence of any correction for general price moves makes Weston's finding that the formula overestimates the ex rights price in bear markets and underestimates it in bull markets, not at all surprising.

23 This is a conclusion which these four writers reach in their empirical studies. However, while Merrett, Howe and Newbould assumed that the second term in their formula is unity, Weston allowed for changes in dividend payments. He found that this increased the accuracy of the formula.

24 See footnote 1. This assumption condenses essentially to: all of the rights are taken up (even if partly by the underwriters). See Woods, I. R. *op. cit.* ch. 7.1.

25 For an examination of the possible tax effects on the dividend content of share price, see Woods, I. R. *op. cit.* ch. 15.1.

26 *Ibid.* ch. 6.2, considers flotation expenses in detail.