The Investment Analysts Journal

Number 24 November 1984

Die Beleggings-Navorsers Tydskrif

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Inhoud

This issue in brief

The economics of information

In modern industrial economies, one of the roles of markets is to disseminate information. Indeed, from a policy point of view, this might be regarded as their most important function. Official action, therefore, which interferes with market freedom, has the effect of distorting information, and that must adversely affect efficiency. The trouble with traditional economic theory, ie equilibrium theory, is that is does not satisfactorily accommodate information as an element critical to economic processes. This is examined by Dr P. D. F. Strydom in a searching inquiry into the subject.

Portfolio theory is elegant but useless

This paper, by P. A. Bowen of the University of Natal, has as its purpose an examination of the usefulness of portfolio theory to investors, as opposed to speculators, in the real world. After examining the underlying logic of portfolio theory, the conceptual differences between it and what happens in practice, and the problems encountered in its implementation, he comes to some rather damaging conclusions. These are deserving of the attention of all academics who propound portfolio theory as a workable system.

Leverage=Risk? Empirical findings for the JSE

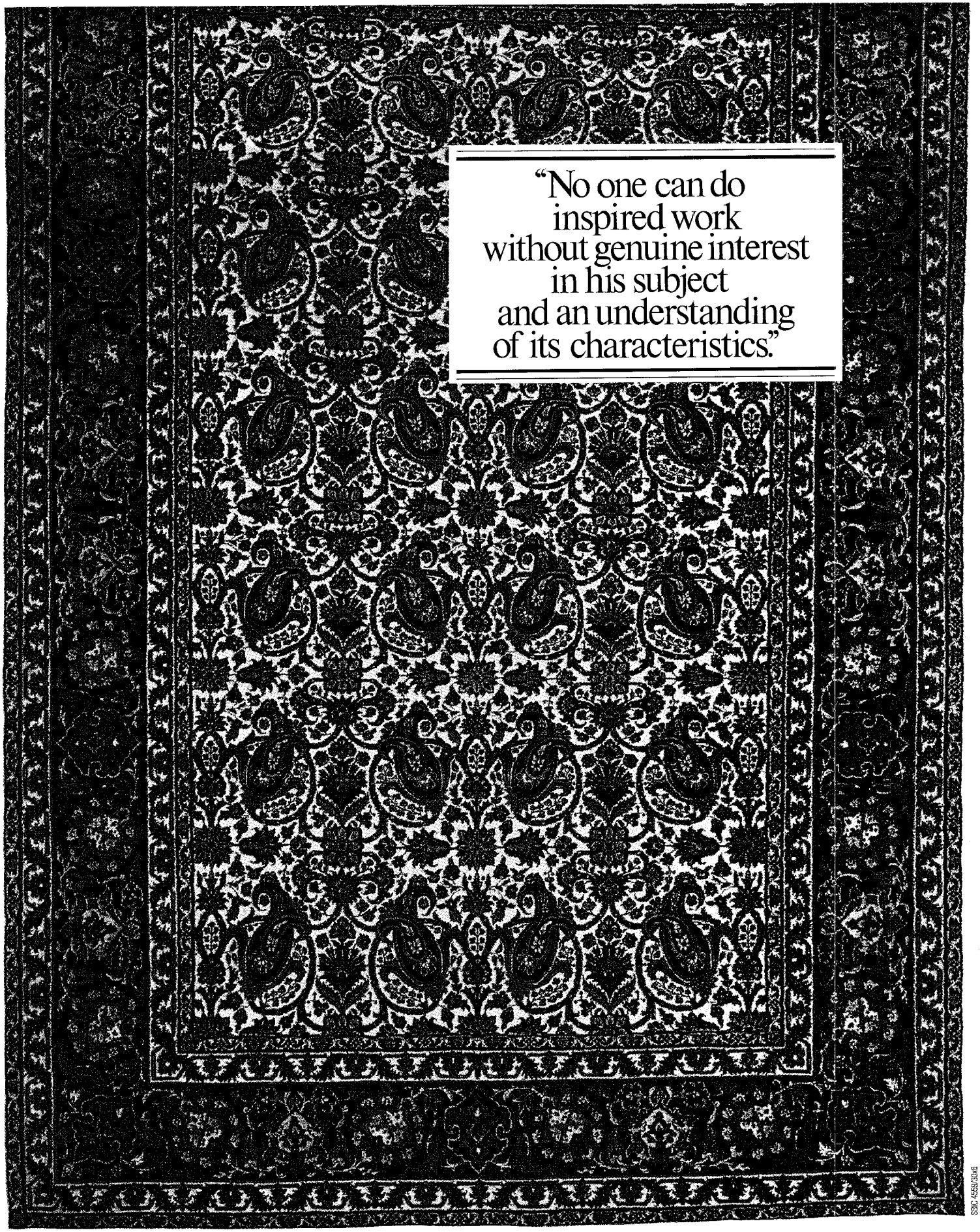
The relationship between market determined measures of risk and accounting decision variables used by corporate managements is clearly important in any consideration of the theory and practice of managerial finance. Unfortunately, investigation has revealed that the theoretical measures of risk developed by researchers in America have only limited practical applicability in South Africa. The problem is examined in detail in an empirical investigation reported on by Messrs Retief, Affleck-Graves and Hamma, respectively a doctoral student at the Stellenbosch Business School, Professor of Business, Cape Town, and Professor of Finance at the Stellenbosch Business School.

Bond immunisation in South Africa

Trevor Blench and Professor John Afflect-Graves examine, in this article, the risk to which investors in fixed interest securities are exposed due to changes in interest rates and how such risk may be minimised in order to assure a predetermined return over a selected target period. The technique described is of particular interest to institutional investors with calculatable future contractual obligations to policy holders and other beneficiaries.

The role of share risk measurements in the management of investment portfolios

Brian Gilbertson is well known to readers of the IAJ for his earlier contributions on market efficiency and portfolio theory. In this Investment Basics article, he deals clearly and fully with the complex matter of risk measurement and its relevance to investment management.



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The Investment Analysts Journal

Twenty-fourth issue

November 1984

As we go to press with this issue of the journal, a general cut in prime overdraft rates has been announced. To the extent to which this has occurred because of a slackening in the demand for credit there is nothing to be said in contradiction of the development. However, what has the outward appearance of an adjustment to market forces, can also be seen as an accommodation to powerful protest on the part of vested interests that have not enjoyed the taste of the monetary medicine that has been administered since 2 August. In recent weeks, criticism from such interests has gathered force and it has reached a point where doubt has come to be cast on the whole De Kock experiment involving greater emphasis on market as opposed to State regulation of the economy. At best, this criticism has amounted to a veiled demand for a U-turn on the present restrictive monetary direction of the authorities. At worst it has amounted to an open call for a return to direct controls. It is being argued that South Africa is too small a country, and its socio-political problems are too complex, to permit the luxury of free markets. We should be under no illusion about what these demands amount to. They amount to nothing less than a willingness to sacrifice freedom from bureaucratic regulation on the altar of short-term expediency.

One has the impression, perhaps mistakenly, that Dr De Kock has his back to the wall and is fighting, not only to save a particular approach to monetary management, but is fighting also to save his professional reputation. Were the calls for direct controls eventually to be heeded, Dr De Kock could be forced to resign. That would be a tragedy not only for the financial sector of the economy but for the whole country.

It does not help matters that the successes of monetary policy during the past few years have been few and its failures many, but it is important that it should be understood why monetary policy has not yet yielded its promised rewards. Three reasons should be mentioned.

The first concerns the decline in the gold price and the drought, both developments beyond the control of the authorities. These developments have greatly complicated the problems of monetary management because of their effect on the balance of payments and the rand exchange rate. They would, however, have had to be faced even by officials pursuing different policies and it is doubtful whether they would have coped better in the circumstances. They might well have done a lot worse! It would be nice if monetary stability could be imposed by decree, but in a world of considerable global fluctuation this is not possible.

The second concerns fiscal policy. This has cut right across monetary policy and is a major cause of monetary policy veering off course. Let there be no mistake about it, notwithstanding the fact that the published deficit before borrowing has been kept within "respectable" limits in relation to money GDP. Not only have Exchequer issues risen from around 22 per cent of GDP

Die Beleggingsnavorsers Tydskrif

Vier-en-twintigste uitgawe

November 1984

Tydens die ter perse gaan van hierdie uitgawe van die tydskrif is 'n algemene verlaging van prima oortrekkingskoerse aangekondig. In soverre dit aan 'n afname in die vraag na krediet toegeskryf kan word, kan niks teen die stap gesê word nie. Wat egter oënskynlik soos 'n aanpassing by markkragte lyk, kan ook beskou word as 'n skikking ná sterk protes van die kant van gevestigde belange wat nie van die smaak van die monetêre medisyne wat sedert 2 Augustus toegedien is nie, gehou het nie. Kritiek deur dié belange het die afgelope weke in hewigheid toegeneem en het die punt bereik waar die hele De Kock-eksperiment, wat groter klem lê op die reëling van die ekonomie deur markkragte, in teenstelling met reëling deur die staat, in twyfel getrek word. In die gunstigste geval het die kritiek op 'n bedekte eis neergekom dat 'n regsomkeer in die huidige beperkende monetêre beleid van die owerheid gemaak word. In die ergste geval het dit op 'n openlike eis om die herinstelling van direkte beheermaatreëls neergekom. Daar word aangevoer dat Suid-Afrika 'n te klein land is en sy sosio-ekonomiese vraagstukke te ingewikkeld is om die weelde van vrye markte te duld. Daar behoort by ons geen wanindruk te wees oor waarop dié eise neerkom nie. Dit kom neer op niks minder nie as bereidwilligheid om vryheid van burokratiese reëling op die altaar van korttermyngerief op te offer.

'n Mens kry die indruk, miskien verkeerdelik, dat dr De Kock met die rug teen die muur is en veg, nie net om 'n besondere benadering tot monetêre beheer te red nie, maar ook om sy professionele aansien te red. Indien daar uiteindelik aan die eise om direkte beheermaatreëls gehoor gegee sou word, mag dr De Kock gedwing word om te bedank. Dit sou 'n tragedie wees – nie net vir die finansiële sektor van die ekonomie nie, maar ook vir die hele land.

Sake word ook nie bevorder deur die feit dat die monetêre beleid gedurende die afgelope jare bra min sukses behaal het en dikwels gefaal het nie. Dit is egter belangrik om te begryp waarom die monetêre beleid nie die beloofde belonings opgelewer het nie. Drie redes dien gemeld te word.

Die eerste rede het met die daling in die goudprys en die droogte te doen, albei verskynsels waaroor die owerheid geen beheer het nie. Hierdie ontwikkelings het die uitoefening van monetêre beheer baie bemoeilik vanweë die uitwerking wat dit op die betalingsbalans en die randwisselkoers het. Hulle sou egter aanvaar moes word selfs al het amptenare 'n ander beleid gevolg, en dis te betwyfel of ander maatreëls in die omstandighede beter resultate sou behaal het. Hulle kon selfs baie swakker gevaar het! Dit sou aangenaam gewees het indien monetêre stabiliteit verorden kon word, maar in 'n wêreld waar aansienlike skommeling algemeen voorkom, is dit nie moontlik nie.

Die tweede rede het met fiskale beleid te doen. Laasgenoemde het inbreuk gemaak op monetêre beleid en is 'n belangrike rede waarom die monetêre beleid van rigting

The following firms have, in addition to our advertisers, assisted in the financing of this issue of the journal and thanks are due to them for their kindness.

Bo en behalwe ons adverteerders, het die onderstaande maatskappye hulp verleen met die finansiering van hierdie uitgifte van die tydskrif en hulle bedank vir hulle vriendelikheid.

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in 1980 to over 30 per cent, but the total public sector borrowing requirement (PSBR) has ballooned and could exceed 14 per cent of GDP this year. This is a far better measure of what has actually been happening because the PSBR includes all state and para-statal bodies not just the borrowing needs of the central government. In recent years these have been given the appearance of decline because borrowing by such authorities, which had previously been included in the main Budget, have been transferred elsewhere. Last March we were told that Government expenditure would rise by 11,7 per cent in 1984/5. This has now been revised upward to 21,5 per cent. On 19 September, when the new Minister of Finance announced his package of spending cuts, it was revealed that had these not been made, the increase in spending this fiscal year would have amounted to 24,4 per cent. The only real reason why the official deficit before borrowing has remained within "respectable" limits has been because tax revenue has risen together with expenditure, and it has done so because GST has been increased from 6 per cent to 10 per cent (basic foods now excluded), and because the rand exchange rate has collapsed, thus boosting the rand value of profits from exports, and particularly from exports of gold.

It is worth noting the link that now exists between the exchange rate and what happens domestically with fiscal policy. The collapse in the rand from $0,7740 to $0,6135 between end May and end July can be explained by the realisation in financial markets that the overshooting in spending was proving far worse than anyone had ever believed possible only a few months before. The further slump in the rand to $0,5000 on 30 October, dates from the moment of the Minister's spending cut announcement. Clearly, the financial markets were not persuaded that the cuts amounted to anything like what was needed to demonstrate that the underlying disequilibria, which were the heart of the problem, were being properly addressed. Yet despite this, the complaints about monetary stringency continued, and they have become louder in recent weeks.

One can sympathise, of course, with people in the private sector feeling aggrieved. They are being hammered by some of the most severe monetary measures ever adopted in this country, and they are having to face, as a consequence, a sharp decline in business activity. But a tight monetary policy is unavoidable given what has happened on the fiscal front. Any premature monetary easing can only put the rand exchange rate more at risk because it could be taken as a signal for spending to start increasing again. Were that to happen the present gross undervaluation of the rand would be corrected not by a recovery in the exchange rate itself, but in a further and sharp rise in the domestic price level. This surely is what must be avoided although one gets the impression that inflation is still viewed here as a lesser evil compared with unemployment or social unrest. Sadly, the threat of inflation itself to job creation (which has been convincingly demonstrated over the last decade) is taken as either long-term or academic, and the link between social unrest and political grievances (the continuation of which has little *directly* to do with monetary policy) is played down.

The third reason why monetary policy has not yet provided its promised rewards in South Africa since 1980 has to do precisely with attitudes such as those just described. Because the connection between inflation and economic underperformance is viewed as distant or theoretical, greater weight is usually given to more

verander het. Dat dit so is, staan vas, ondanks die feit dat die gepubliseerde tekort voor lenings binne "aanvaarbare" perke in verhouding tot geld-BBP gehou is. Nie alleen het skatkis-uitgiftes van ongeveer 22 persent van die BBP in 1980 tot meer as 30 persent gestyg nie, maar het die totale leningsbehoefte van die openbare sektor (OSLB) skerp gestyg en kan vanjaar 14 persent van die BBP oorskry. Hierdie is 'n baie beter maatstaf van wat in werklikheid gebeur het, omdat die OSLB alle staats- en parastatale liggame insluit, en nie net die leningsbehoeftes van die sentrale owerheid nie. Dit het die afgelope jare oënskynlik gedaal, omdat lenings deur dié owerhede wat in die verlede in die hoofbegroting ingesluit was na elders oorgeplaas is. Ons is verlede Maart meegedeel dat staatsuitgawes in 1984/5 met 11,7 persent sou styg. Dit is nou opwaarts hersien tot 21,5 persent. Op 19 September, toe die nuwe Minister van Finansies sy pakket vir die besnoeiing van uitgawes aangekondig het, is daar onthul dat indien dit nie gedoen sou word nie, uitgawes in die huidige belastingjaar met 24,4 persent sou gestyg het. Die enigste ware rede waarom die amptelike tekort voor lenings binne "aanvaarbare" perke gebly het, is omdat inkomste uit belasting saam met uitgawes gestyg het en dit wel omdat AVB van 6 persent tot 10 persent (basiese voedsel nou uitgesluit) verhoog is en die randwisselkoers verswak het en sodoende die randwaarde van winste uit uitvoere, en veral die uitvoer van goud, opgestoot het.

Dit is die moeite werd om te let op die huidige verband tussen die wisselkoers en dit wat binnelands met die fiskale beleid gebeur het. Die daling van die rand van $0,7740 na $0,6135 tussen einde Mei en einde Julie kan verduidelik word deurdat die finansiële markte tot die besef gekom het dat die buitensporige besteding veel erger was as wat enigeen slegs enkele maande vantevore ooit kon voorsien het. Die verdere insinking van die rand na $0,5000 op 30 Oktober het begin toe die Minister sy maatreëls vir die besnoeiing van uitgawes aangekondig het. Die finansiële markte was klaarblyklik nie daarvan oortuig dat die besnoeiings hoegenaamd voldoende bewys was dat die onderliggende onewewigtighede, wat die kern van die probleem was, behoorlik aangepak word nie. Die klagtes oor monetêre strengheid het desondanks voortgeduur en het die afgelope weke luider geword.

'n Mens kan natuurlik simpatiseer met die privaatsektor wat verontreg voel. Hulle word met van die strafste monetêre maatreëls wat nog in dié land toegepas is gemoker, en moet gevolglik 'n skerp daling in sakebedrywighede in die gesig staar. Maar 'n streng monetêre beleid is onvermydelik in die lig van dit wat aan die fiskale kant plaasgevind het. Enige voortydige monetêre verslapping sal die randwisselkoers net in gevaar stel, omdat dit beskou sal word as 'n teken dat besteding weer kan begin styg. Indien dit sou gebeur, sou die huidige geweldige onderwaardering van die rand reggestel word, nie deur die herstel van die wisselkoers self nie, maar deur 'n verdere, skerp styging in binnelandse pryspeile. Dit moet stellig voorkom word, hoewel mens die indruk kry dat inflasie hier te lande steeds as 'n kleiner euwel beskou word indien dit met werkloosheid of burgerlike oproer vergelyk sou word. Die bedreiging wat inflasie self vir die skepping van werkgeleenthede inhou, geniet ongelukkig (soos die afgelope dekade oortuigend bewys is) òf 'n langtermyn- òf 'n akademiese beskouing, en die verband tussen burgerlike oproer en politieke griewe (waarvan die voortsetting weinig direk te doen het met monetêre beleid) word op die agtergrond gehou.

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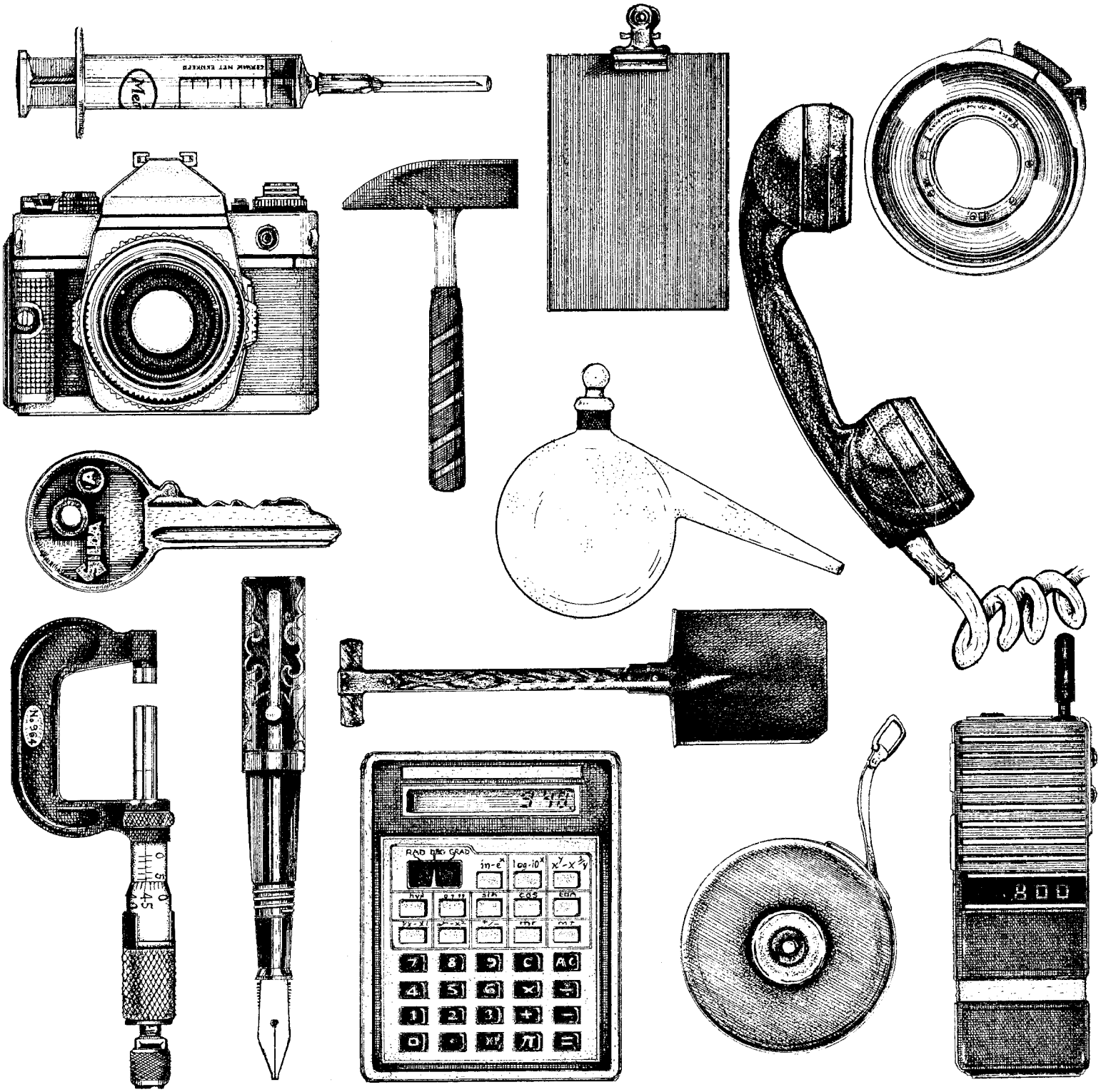

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immediate problems. Balance of payment problems, in particular, have tended to be given priority when these have become pressing. Yet deeper analysis reveals that the problem of inflation and the problems of the balance of payments are inextricably linked. Without coming to terms with excessive inflation (excessive in terms of intercountry comparisons as well as in absolute terms), there can be no *lasting* correction of our balance of payments difficulties. Social unrest is to be deplored and must be taken seriously. But it should not be used as a red herring to justify a compromising of needed resolution with respect to macroeconomic management. Too frequently in the recent past, "political" pressure has been brought to bear on the monetary authorities to soften their stand on policy at the precise moment when their actions were beginning to have the right effect.

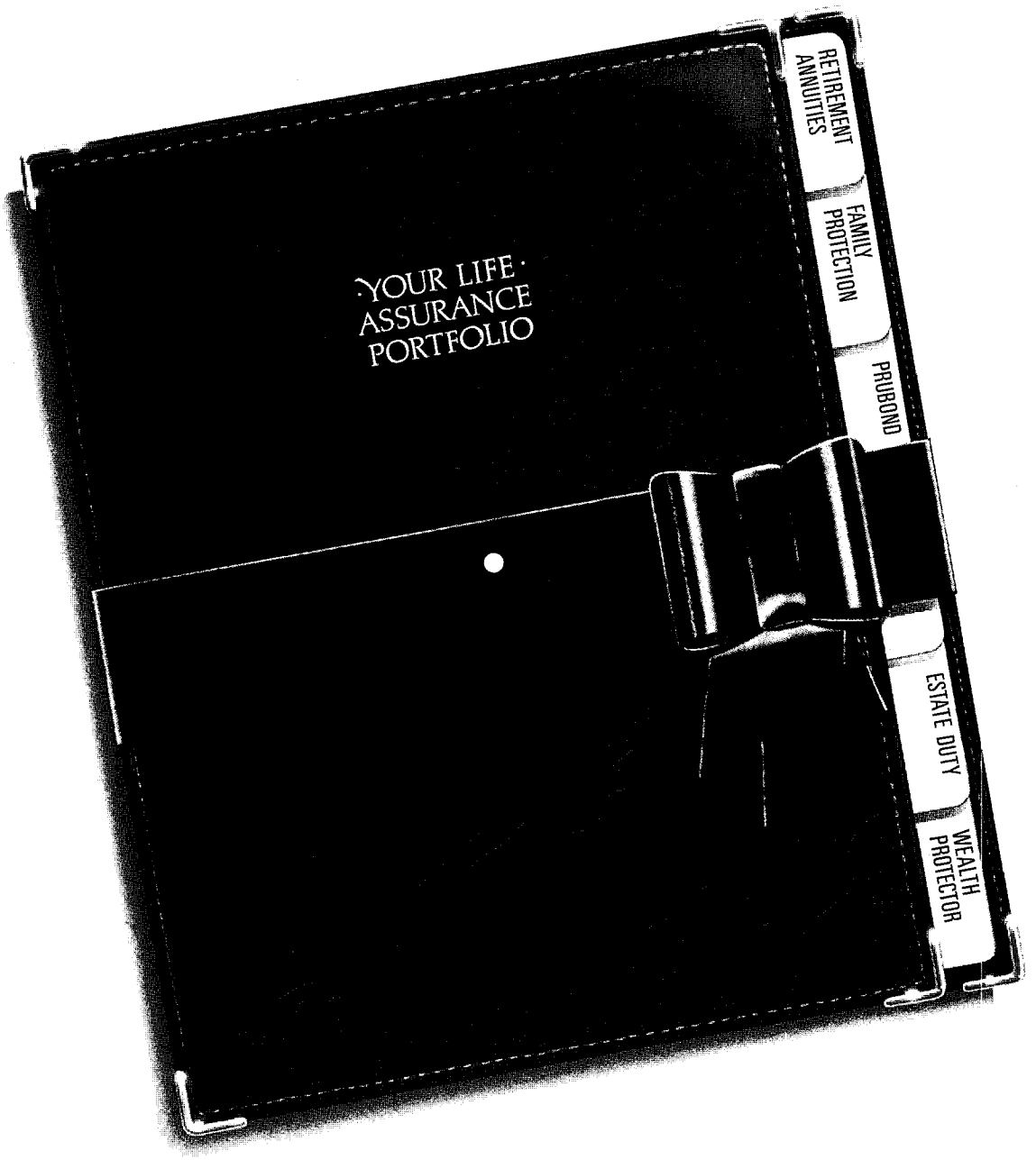
It must be hoped that what is now being witnessed in the cutting of short-term interest rates, is not another example of the effectiveness of this "reverse" moral suasion. If it is, the time will be short (twelve to eighteen months perhaps) before interest rates will have to be raised again, and then to levels even higher than they are now. It should not be expected that South Africa can solve, in sixteen weeks of monetary stringency, problems which have taken up to six years to solve in developed economies abroad. This is not to argue in favour of a needless drawing out of deflation here. Every job lost is to be lamented in a country where so many people live close to the breadline. The argument in favour of "vasbyt" is that the correction it would involve would be shorter, and in the end less damaging, both to employment and to stability.

The editor

Die derde rede waarom die monetêre beleid in Suid-Afrika sedert 1980 nog nie die beloofde belonings opgelewer het nie, het presies te doen met houdings soos dié wat hierbo beskryf is. Aangesien die verband tussen inflasie en ekonomiese onderprestasie as ver verwyderd of teoreties beskou word, word groter gewig gewoonlik aan meer onmiddellike probleme geheg. Veral betalingsbalansprobleme was geneig om groter voorkeur te kry wanneer dit dringend geword het. 'n Deegliker ontleding bring egter aan die lig dat die inflasieprobleem en betalingsbalansprobleme onafskeidbaar van mekaar is. As daar nie 'n oplossing vir oormatige inflasie (oormatig wat vergelykings met ander lande betref en in absolute terme) gevind word nie, kan ons betalingsbalansprobleme nie blywend reggestel word nie. Burgerlike oproer is te betreur en moet met erns bejeën word. Dit moet egter nie gebruik word om die aandag af te trek ter regverdiging van 'n kompromis wat betref die nodige besluite ten opsigte van makroëkonomiese beheer nie. "Politieke" druk is al te dikwels in die verlede op die monetêre owerheid uitgeoefen om sy beleidstandpunt te verander presies op die tydstip toe sy optrede die regte uitwerking begin toon het.

Hopelik is die verlaging van korttermynrentekoerse nie nog 'n voorbeeld van die doeltreffendheid van dié "teenoorgestelde" morele oorreding nie. Indien wel, sal dit slegs 'n kort rukkie duur (miskien twaalf tot agtien maande) voordat rentekoerse weer verhoog sal moet word, en dan wel tot 'n vlak wat die huidige peil selfs oorskry. Daar moet nie verwag word dat Suid-Afrika probleme, wat in ontwikkelde ekonomieë in die buiteland tot ses jaar geduur het om opgelos te word, binne sestien weke van die monetêre strengheid sal oplos nie. Hiermee word nie 'n pleidooi ten gunste van die onnodige uitrekking van deflasie hier te lande gelewer nie. Elke werkgeleentheid wat verloor word, moet betreur word in 'n land waar so baie mense feitlik net die bestaansminimum het. Die argument ten gunste van "vasbyt" is dat die regstelling wat dit behels korter en op die langer duur minder nadelig vir werkverskaffing en stabiliteit sal wees.

Die redakteur



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P. D. F. Strydom

The economics of information*

Introduction

The economics of information has developed along the lines of two major contributions in the early 1960s by Stigler (1961) and Machlup (1962). The one school of thought analysed information in terms of probability theory, and in this sense it could be claimed that information economics became closely linked with equilibrium economics (Stigler 1983). The other school associated the economics of information closely with the so-called knowledge industries, in which case the dissemination of knowledge became the focal point of interest.

It is claimed here that there is no meaningful link between the economics of information and equilibrium economics, and the economics of information should develop independently of equilibrium economics. Although the dissemination of knowledge is an important aspect of the economics of information, the subject should be encouraged to develop in a different direction which is closely related to the "value added" of the Machlupian knowledge industries.

Recently Stonier (1983) analysed information within the framework of a production function. In this sense information becomes an input or a factor of production together with capital and labour. Unfortunately, this approach puts the subject of information economics within the static framework of equilibrium economics, a paradigm which is dominated by perfect foresight. We maintain that the problem of information cannot be analysed meaningfully within the framework of a neoclassical production function.

Information and equilibrium economics

In this paper the term equilibrium economics is used to describe that particular intellectual framework in economic analysis which dispenses with time (Hicks, 1979). In equilibrium economics the future and the present collapse into a single dimension of logical time where what is happening now will also happen in future. In such a world, the suggestion by Hicks (1979) is appropriate, viz. we can "go straight ahead, setting our mathematical engines to work on it churning it out." This analytical framework is primarily static while it is characterised by the hypothesis that the equilibrating forces overrule the forces that induce change. Equilibrium economics has had substantial support in the literature. In the Walrasian mathematical framework, the static assumptions of the model imply instantaneous adjustments which, in the terminology of Lachmann (1977), means that the correct information about equilibrium prices and quantities should be readily available to all market participants. This means that market participants have perfect foresight, and consequently we are addressing a world with no uncertainty. As indicated by Walsh and Gram (1980), such a static framework means that there can be no speculative gains or losses owing to uncertainty. More importantly, with no uncertainty, there is no entrepreneur in the sense employed by Schumpeter or Knight. The instantaneous adjustments in equilibrium economics are only possible because of the perfect foresight with which market participants are endowed. Because of the static framework of these models, they can only address equilibrium situations, and as indicated by Torr (1983), equilibrium economics has nothing to say about non-equilibrium situations since no trading is allowed at non-equilibrium prices.

From this exposition it is evident that equilibrium economics is characterised by a framework with perfect foresight attributed to market participants, and instantaneous adjustments. Within such a framework there is no uncertainty, and information dissemination through the market process has no meaning. As soon as we enter the orbit of uncertainty, we no longer have perfect information and in the terminology of Baumol and Quandt (1964) decision-making is optimally imperfect. We address the problem of optimal solution as opposed to a maximal solution, the maximal solution being attainable within the framework of perfect foresight. In the absence of perfect foresight, the plans of market participants do not match instantaneously. In fact, they diverge, and their diverging creates opportunities that could be exploited advantageously by those with superior information (Rizzo, 1979). We can, thus, address the problem of information economics meaningfully only if we depart from the intellectual namework of equilibrium economics. Information only has meaning in a world of uncertainty.

Information and knowledge

Linguistically, knowledge refers to the sum of what is known, while information is associated with items of knowledge. Machlup (1962, p. 15) drew attention to "the *act* of informing and the *state* of knowing". One could, therefore, follow Lachmann (forthcoming) and distinguish between the stock of knowledge and the flow of information. In a changing world, the flow of information is not only important in the sense that one may alter one's plans according to the latest information, but one should constantly assess one's stock of knowledge for revision and replacement (see also Torr, 1980).

The post-industrial economy

Since it has been established that investment in information in the sense used by Alchian (1970) is only relevant in the world of uncertainty, it is in order to identify the major elements of change and uncertainty in the present industrial society. The acknowledgement of these forces of change is in direct contrast with the static framework of equilibrium models.

We have experienced a gradual change from a primarily agricultural economy to a post-industrial economy over the past two centuries. In the major industrial countries manufacturing industry is retreating relative to service industries, resulting in an important structural change.

*The author is indebted to Dr R. W. Bethlehem for his helpful comments on an earlier draft of this paper. He is, however, exonerated from any responsibility for the views expressed.

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The changing pattern in the economies of the major industrial countries can, in particular, be demonstrated by the changing patterns in employment statistics. Beaufils (1983) has demonstrated that the share in total employment of the tertiary sector increased markedly from 1973 to 1982 in France, West Germany, the UK, Italy, the USA and Japan. Over this period, the share of secondary industry in total employment fell in all these countries. On the other hand, the tertiary sector has established itself as the major source of employment in the industrial countries. The rising economic importance of the service sector is of particular interest since this sector has become very active in the disseminaton of information (see also Stonier (1983) on this point). It is also clear that the service sector is itself undergoing a structural change from being a sector which primarily supported the products of other industries to a sector which produces a product in its own right. The production of information has become the prime business of many firms in the service sector. The changing patterns in banking confirm this conclusion. Banking is becoming more and more a fee earning business over and above its functions of deposit taker and lender. In many instances this fee earning activity is directly related to the field of information which is becoming a product which is packaged and passed on to clients through electronic systems. Information has become a sought after product in recent years owing to increased uncertainty in financial markets, and consequently the service sector has grown rapidly. The more market oriented approach which has been adopted by several governments since the 1970s whereby restrictive controls over markets were abolished, has triggered the evolution of new market processes that were previously non-existent. In the USA, for instance, the banking system has been liberalised on a grand scale, and banks are allowed to enter business areas from which they were previously excluded. Financial markets have become more active, not only in the USA but also in the major industrial countries, and the prices and quantities traded in these markets have shown more volatile patterns. Many markets that used to be regulated and controlled are now disseminating information to market participants.

Although we have concentrated on the impact of liberalisation on financial markets thus far, we cannot overlook similar developments in respect of manufacturing industry, particularly in the United Kingdom (see Mital, 1984).

Having considered the changing patterns in financial markets, and the structural changes in respect of the production of goods and services, our assessment is that in a dynamic world it is important to be informed, to have the latest information which markets are both reflecting and disseminating. The expansion and improvement in the communications network through satellite and optical fibre cables, together with microelectronic equipment, have enabled the service sector to become more efficient in the dissemination of market information (see Forester (1980) for details).

The production of information

Although the process of information distribution or transmission is interesting in itself, it is not of prime interest to the economics of information. We consider the dissemination of information by markets to be one of the prime functions of the market place while the economics of information is primarily concerned with the interpretation of the information. This is what lies at the centre of the new fee earning business in the financial sector, and in banking in particular. Market participants will decide on particular actions after having interpreted the information at their disposal. Information can be interpreted in various ways, for instance, by "gut feel", which means that the information is interpreted intuitively. It may also be interpreted in a purely routine fashion, and in this sense one may speak of a "rules of thumb" approach to information. The economics of information is primarily concerned with the systematic interpretation of information. This means that we cannot overlook the subjective element of this activity, and in the same direction Lachmann (forthcoming) has maintained that the interpretation of information should be seen as an act of the human mind. Since every human mind performs differently, we will end up with different interpretations of the same information. It is the subjective element which segregates the different interpretations. One may even speak of different types of "value added" whereby the final products differ as well. Once the market process has disseminated the information it has evaluated, market participants will seek competing interpretations, and in due course action will be triggered. Hirshleifer and Riley (1979), have maintained that the interpretation of information must allow market participants to overcome the uncertainty caused by the prospect of new information. In terms of the exposition presented here, it can be argued that market participants manage the uncertainty in terms of the interpretation of information. Since we are addressing a subjective process, market participants will manage the uncertainty in different ways.

Information as well as the interpretation thereof, viz. information and the "value added" version in terms of interpretation, have particular properties which demarcate them from conventional products (see Hirshleifer and Riley (1979) as well as Rader (1980) on this). Information is an inexhaustible product, its stock is not reduced by repeated use. Its availability to a particular user does not change for the next user. Furthermore, its possessor may pass it on or sell it without losing command over the use of the product. It is not protected by registered patents, and it does not carry copyrights nor does it qualify for royalties. As opposed to other products there are no physical units of output (Machlup, 1962, p. 44), and the "value added" is not readily established.

Conclusion

Although attempts have been made in the literature to link the economics of information with equilibrium economics, it is maintained here that the problems posed by the economics of information cannot be analysed meaningfully within the paradigm of equilibrium economics. While there is merit in viewing information economics from the point of view of the Machlupian knowledge industries, the dissemination of information should rather be considered as the function of markets. The economics of information becomes meaningful when it is associated with the interpretation of information. This puts the subject into a subjectivist framework since it is associated with actions of the human mind. Since every human mind operates differently, it is evident that we will have different interpretations of the information disseminated by markets. In this sense, the economics of information is concerned with a product which has certain characteristics that demarcate it completely from those that have been analysed in the literature by supply and demand schedules.

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SOUTHERN

P. A. Bowen

A hypothesis: Portfolio theory is elegant but useless

Portfolio theory is an elegant but useless creature with a prodigious appetite for data. It is the sterile offspring of an unlikely marriage of finance and mathematics.

Introduction

According to Sharpe (1970), a portfolio can be defined as "the totality of decisions determining an individual's future prospects." From this definition it is evident that a portfolio can consist of many types of assets such as property and other real assets, as well as financial assets.

The focus of this paper will be concentrated on financial assets which are readily marketable. However, much of what follows can be applied to other assets with some modification. For our purposes, a portfolio is a combination of liquid assets, and portfolio theory deals with the selection and management of these assets.

The objective of this paper is to present the advantages and disadvantages of investor (as opposed to speculator) portfolio theory and compare current practice in the real world with the existing state in theory, in order to test the validity of the initial hypothesis.

It appears that, on most issues, there is usually either vigorous approval of the logic or otherwise equally vigorous disapproval. Rarely is there unanimous agreement on any particular point of theory or interpretation of empirical data. One of the few non-controversial concepts in investment management today is Markowitz's idea that proper diversification reduces risk. But, for several reasons, even this idea becomes controversial upon attempts at practical implementation.

Underlying logic

Present-day theory of portfolio analysis prescribes a way of thinking about opportunities for investment. Instead of extensive evaluation of a single asset in isolation, the theory prescribes that investment policy can and should be formulated in the following manner: purchase an available asset if and only if that asset, when added to an existing portfolio, will cause a rise in overall personal satisfaction obtained from owning that portfolio. This may be brought about in the following ways:

1. The new asset can cause a net increase in total present expected return on the portfolio;
2. The new asset can cause a net decline in total risk exposure on the entire portfolio;
3. There can be some subjectively acceptable tradeoff between change in total risk and change in total expected return on the portfolio.

The object of optimal asset management is to identify and hold a portfolio which offers the minimum possible dispersion (minimum deviation) for a given or desired expected return. Therefore, in the classic Markowitz sense of portfolio selection, diversification becomes a search for a set of assets whose expected returns are high and where covariances of returns are low, or negative, thereby tending to produce a portfolio which promises to be both profitable and unlikely to deviate far from expectations.

The formal methods and procedures for portfolio analysis have been documented in detail by many scholars (eg Markowitz, 1959; Sharpe, 1963). It would, therefore, be superfluous to recount these in detail; more important is an understanding of some of the difficulties encountered in actual practice, and of suggestions as to how to overcome the difficulties.

Conceptual differences between theory and practice

There exists a wide disparity between the theory and practice of portfolio analysis and capital budgeting. The theory has been characterised by increased use of quantitative/mathematical tools and, whilst the practice has no doubt changed at the same time, business executives do not appear to have adopted many of the new techniques (Mao, 1970). The more fundamental differences are outlined below:

Concepts of risk

Theory – A central aspect is the concept of risk. Most financial writers argue that firms should choose portfolios rather than projects, and they measure the risk of a portfolio by the variance of its return.* This approach to the analysis of risk is a straightforward adaptation of Markowitz's quadratic programming model of portfolio selection.

Although the variance is easy to manipulate mathematically, financial writers have not been completely satisfied with the concept of risk. Markowitz (1959) himself had reservations about choosing variance as a measure of risk. Markowitz preferred semi-variance but settled for variance because of its ease of computation.

Practice – Business executives tend to consider investment risk as the prospect of not meeting the target rate – and are thus primarily concerned with *downside* deviations from the target rate of return. It appears that when the investment decision involves only a small portion of the resources of a company, risk is thought of as the prospect of not meeting some target rate of return, ie possibility of a loss. Indeed, upside deviations are sometimes referred to as upside potential, implying they are desirable.

However, when the investment concerns a large proportion of the company's resources, risk also involves the danger of insolvency. Further, the emphasis on downside risk indicates that their concept of risk is better described by semi-variance than by ordinary variance. If semi-variance is used by business executives, it may also be a risk concept used by security investors. If so, the definition of the risk of individual securities within a portfolio needs to be adjusted.

*Return could refer to either internal rate of return, net present value, payback period or some other measure. The term "return" is purposely left undefined to facilitate the formulation of the argument.

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Methods of incorporating risk

Theory – Let us accept variance as a measure of risk. How does current theory incorporate risk into investment analysis such that, given two investments with different return and different risks, the factors can be adjusted to reach a single figure with which to compare the investments? Two methods are used: the certainty equivalent approach and the risk adjusted discount rate. Whichever approach is used, the investor must also decide between the single project or the portfolio framework of investment selection.

Practice – The main problem here is the uncertain nature of the forecasts available to the executive. The real difficulty is the search for a reliable probability distribution of returns to base the decision upon. Thus, if a theorist begins his analysis with an assumed probability distribution, he has assumed away one critical aspect of the problem involved.

Further, although firms do use the portfolio approach to investment, the method of implementation and the reasons for its use differ from current theory. According to current theory, the investor obtains cash flows for the set of investments and, from these, derives the means, variances and covariances of the returns. He then chooses that portfolio of investments which gives the best combination of risk and return. However, in reality, since these project analyses are submitted *independently* by separate divisions of a company, no allowance is made in the risk assessment for the covariances between projects, ie they are thought of in isolation.

Criteria for investment selection

Theory – Thus far the term *return* has been used in its generic sense, without defining it as internal rate of return (IRR), net present value (NPV), payback period or accounting profit, so that focus could be directed on the concept of risk. Current theory regards IRR or NPV as a better measure of return than either of the other two. Although theorists have advocated IRR and NPV for measuring return, they are aware that the majority of businesses still use the payback period and/or the accounting profit criterion (National Association of Accountants, 1967).

Practice – Mao (1970) found that in choosing between two investments, the application of an IRR (or NPV) criterion may result in the acceptance of those investments which have a higher level of earnings, but which also produce an erratic earnings per share pattern. Since the price-earnings ratio tends to vary directly with the stability of earnings, the strict application of an IRR criterion does not guarantee the maximum value for the firm. Mao (1970) contends that the payback period is primarily a risk measure, and this may account for its widespread use in practice.

Practical problems in implementation

Firstly, using the original Markowitz model, the input data requirements are voluminous for portfolios of practical size (Cragg and Malkiel, 1968). Estimates of covariance are difficult to obtain and, if obtained, often have doubtful precision and reliability (Dietz, 1966).

Sharpe's (1963) single index model helps to alleviate this difficulty but another problem arises in that many analysts, in actual practice, also use this single index model to *explain* expected returns for an individual security.

It is true that *the market* does influence individual returns (Fama, 1968) but it is also true that the sum of individual returns constitutes *the market.* Thus, since the individual returns interact to determine the market, a more general simultaneous system of equations may be more appealing for characterising price behaviour in financial markets (Fama, 1968).

A method of establishing the return on an individual security is by way of the Capital Asset Pricing Model, an offspring of portfolio theory – more about this later.

Secondly, because variance is used as *the* measure of risk, the model, if applied mechanically, as it often is in actual practice, can lead to wrong investment decisions (Renwick, 1969). It is important to note that variance is a useful surrogate for risk on account of its statistical properties. However, the formal definition of risk is: *a known probability distribution of possible outcomes.* Thus, variance fails to capture some elements of risk such as probability of loss or probability of bankruptcy. For a detailed analysis of risk, the reader is referred to Arditti (1967).

Further, because many analysts often think in terms of modal (ie most likely) values instead of mean values when anticipating returns, and fail to make the appropriate conversion, inputs to the model in practice often contain wrong or biased information.

Robichek, Cohn and Pringle (1972) documented their research into returns on alternative investment media and the implications thereof for portfolio construction. According to Robichek *et al* (1972), the reasonableness of predicting expected returns, standard deviations, and inter-investment coefficients is crucial to the success of a portfolio analysis. If mean returns and covariances tend to remain stable over time, then an analysis of *ex post* results will have value when it comes to making *ex ante* predictions. However, it is by no means safe to assume stability of these parameters over time, and considerable attention to this question is both justified and necessary.

Assumptions of general portfolio theory

According to Koutsoyiannis (1982) general portfolio theory is based on the following assumptions:

1. Capital markets are efficient in that the prices of securities reflect all available information and that prices of individual securities adjust very rapidly to new information;
2. The goal of the rational investor is to choose the portfolio which maximises his expected utility;
3. The utility derived from a portfolio depends on its mean (expected) return and its standard deviation;
4. The decison-maker is risk averse;
5. The decision-maker can rank the various portfolios on the basis of their expected return and standard deviation (risk), with a set of indifference curves.

Dealing with the first assumption listed above (and the one the writer deems to be one of the most important), several studies have provided evidence that capital markets are efficient. The various tests are well summarised (see Koutsoyiannis, 1982). Fama (1970) deals with the weak, semi-stong and strong forms of the efficient market models and concludes that, in short, the evidence in support of the efficient markets model is extensive and that (somewhat uniquely in economics) contradictory evidence is sparse. This is not to mean that all issues are closed as, for instance, attention needs to be given to the development and testing of models of market equilibrium under uncertainty.

The other very important assumption is the assumption that the firm's management (when dealing with firm investors) can express its risk preference in the form of a set of indifference curves with the usual properties. In other words, the firm-portfolio approach assumes that there exists a collective managerial function which gives rise to indifference curves similar to those of an *individual* investor. In fact, a group utility function can be derived only under very restricted assumptions (Wilson, 1968). Thus, according to Koutsoyiannis (1982), the *practical* importance of this approach is questionable, given the amount of information required. However, Van Horne *et al* (1977) argue that the framework for evaluating combinations of risky investments implied by the firm-portfolio approach is *quite useful* even if the managerial utility function is not defined, in that managers can use subjective judgement (based on return/risk trade-off) once the various options are plotted on a two-dimensional scattergram. Koutsoyiannis (1982), however, disagrees with this argument, citing Wilson (1968), whose research concludes that a group utility function could be derived only under very restricted assumptions.

Assumptions of the stockholder-portfolio approach: The capital asset pricing model (CAPM)

The CAPM is a refinement of the general portfolio theory and is based on the following assumptions:

1. Investors have homogeneous expectations, ie investors view the opportunity set of individual securities in the same way with respect to expected return and risk of each asset, and the correlations of the returns among all pairs of securities;
2. Capital markets are perfect, with no transaction or other costs, no taxes and (costless) information to all traders, who are price takers. Furthermore, capital markets are efficient;
3. Investors have identical time horizons;
4. Investors can borrow and lend funds at the riskless market interest rate.

While these restrictions may appear to be severely limiting, they are similar to those made in the standard economic theory of the firm and in the basic models of Modigliani — Miller, Gordon and others. Further, the critical extensions in the literature that seek to relax the basic CAPM assumptions yield results that are generally consistent with the basic theory (Weston and Brigham, 1979). In addition, according to Weston and Brignam (1979), the CAPM has been used in several property rate assessment cases and civic court actions in the USA, where its advocates have stood up well under expert cross-examination.

According to Koutsoyiannis (1982), when the above assumptions are relaxed, the CAPM can be used for an approximate estimation of the return-risk trade-off for individual securities or portfolios, but that *the model loses its precision.* Koutsoyiannis (1982) goes on to conclude that the presence of market imperfections and other assumptions render the CAPM strictly inapplicable. Some authors (eg Mayo, 1971) have developed models in which some of the assumptions of the CAPM are relaxed. Such theoretical work shows that the CAPM is fairly robust, in that its predictions are not substantially different as compared with those obtained when the assumptions are fulfilled. However, in general, the more serious the imperfections, the less precise and clear the model becomes.

Empirical evidence

Most advanced capital budgeting procedures appear to be used or seriously considered by a small number of firms, mostly large firms and in industries with high investment rates and rapid changes (Klammer, 1972). Most other firms tend to rely on methods which are simpler and theoretically less satisfactory (eg the payback method).

According to a survey conducted and documented by Klammer (1972), the percentage number of firms having full-time capital budgeting staff rose from 45% in 1959 to 56% in 1970. Surprisingly, only 31% of the respondents said they were using some specific, formal method of dealing with (analysing) risk. In fact, only 13% acknowledged determining probability distributions in risk analysis and only 3% undertook the measuring of the covariance of investments. When questioned about the use of management science techniques generally, the results were as follows:

	1970	1959
Computer simulation	28%	4%
Probability theory	32%	5%
Decision theory	9%	3%
Utility theory	4%	0%

Interestingly enough, firms in the heavy industry sector reported the heaviest use of advanced techniques.

Klammer (1972) concluded that the use of complex investment tools is increasing, albeit slowly, and that traditional methods, such as the payback method, are declining in popularity.

Mao and Helliwell (1969) conducted interviews with the operating and financial management of three Canadian companies. Admittedly, a sample size of three does not permit conclusive statements to be made but does provide areas for discussion.

Since the executive committees of the companies concerned evaluate all projects, they are in a good position to employ the portfolio approach. In fact, because all of the firms had more acceptable projects than their budgets would incorporate, capital rationing alone would force them to adopt it. Moreover, they were aware of the risk implications of the portfolio approach.

Although the committees employed the portfolio approach, neither the kind of data they received nor their concept of risk allowed them to understand fully the benefits of diversification. Moreover, their aversion to risk tends to exclude from consideration all but the relatively safe investment prospects. In other words, the proposals top management eceive do not contain the figures necessary for valuating project risks formally on a portfolio basis. This raises the question of what top management considers as investment risk and whether they take into account the correlation between projects in the measurement of risk. In all three companies, risk is understood as the variability of investment returns but the emphasis of the decision-makers falls heavily on the probability of loss.

Further, there is evidence that whilst executives may not understand the formal theory of diversification, they do know that diversification reduces risk. They do not understand, however, that, unlike return, the risk of a portfolio is not a linear function of the individual risks making up the portfolio.

Mao and Helliwell (1969) went on to make the following recommendations:

1. That much more research must be done on the market rate of substitution between risk and return before companies could use this concept in their decisions. Indeed, it may turn out that the risk characteristic of equity shares cannot be measured in such a way as to derive any useful estimate of the price of risk-bearing.
2. A better definition of risk at the conceptual level is necessary. It will probably become necessary to deal with inter-temporal as well as inter-project and inter-program covariances.
3. The theory of optimal capital structure must be made more specific and some quantification made of the consequences of alternative financing patterns if businessmen are to analyse investment and financing as inter-dependent decisions.

The writer took the step of approaching various institutions/firms continuously involved in investing, with a view to establishing the current state-of-the-art of portfolio theory as practised in South Africa. Obviously, the sample size precludes the drawing of definitive conclusions. The results are tabulated below:

Firm/Institution	Use of portfolio theory	Remarks
1. Firm of stock Brokers (1)	Non-existent	Determine the asset value of the company per share. This is used as a yardstick for comparing the strength of a company in relation to market prices.
2. Life sssurance company (1)	Yes	Undertake "beta" studies, relative risk studies and risk/return trade-off. Market is not perfect so portfolio theory not wholly applicable. Growing awareness of portfolio theory. Acts as a discipline. No computer simulation.
3. Firm of stock brokers (2)	Yes	Use portfolio theory – calculate beta's – published in reports.
4. Firm of stock brokers (3)	Non-existent	Use a purely subjective approach. Each partner may view the market differently.
5. Life assurance company (2)	Non-existent	Each investment is decided upon on its own merits (return, risk, etc). Aim primarily at debentures. (Blue-chips)
6. Life assurance company (3)	Yes	Used in portfolio selection.

From the above, it can be seen that the use of portfolio theory in South Africa does not appear to be widespread as yet, but is certainly undertaken by some institutions. A formal research survey would be needed to establish the exact extent of the usage.

Conclusion

The writer is of the opinion that attention should be directed to the words *useless* and *sterile* in the initial hypothesis, as these words encapsulate the issues at hand.

It is felt that no definitive conclusions can be drawn regarding the *potency* of portfolio theory, but serious drawbacks are the semantic and statistical barriers that exist, preventing the average businessman from coming to grips with the approach.

Indeed, this same point is made by Barr Rosenberg, the Berkeley professor who is one of the reigning "guru's" of portfolio theory, in arguing its merits. *If you were to explain in English and in neutral language the principles by which a portfolio is constructed under portfolio theory, one would find that many people who regard themselves as traditionalists would agree. So I think there is more aversion to the language used, and to the computers, than there is to the conceptual framework.*

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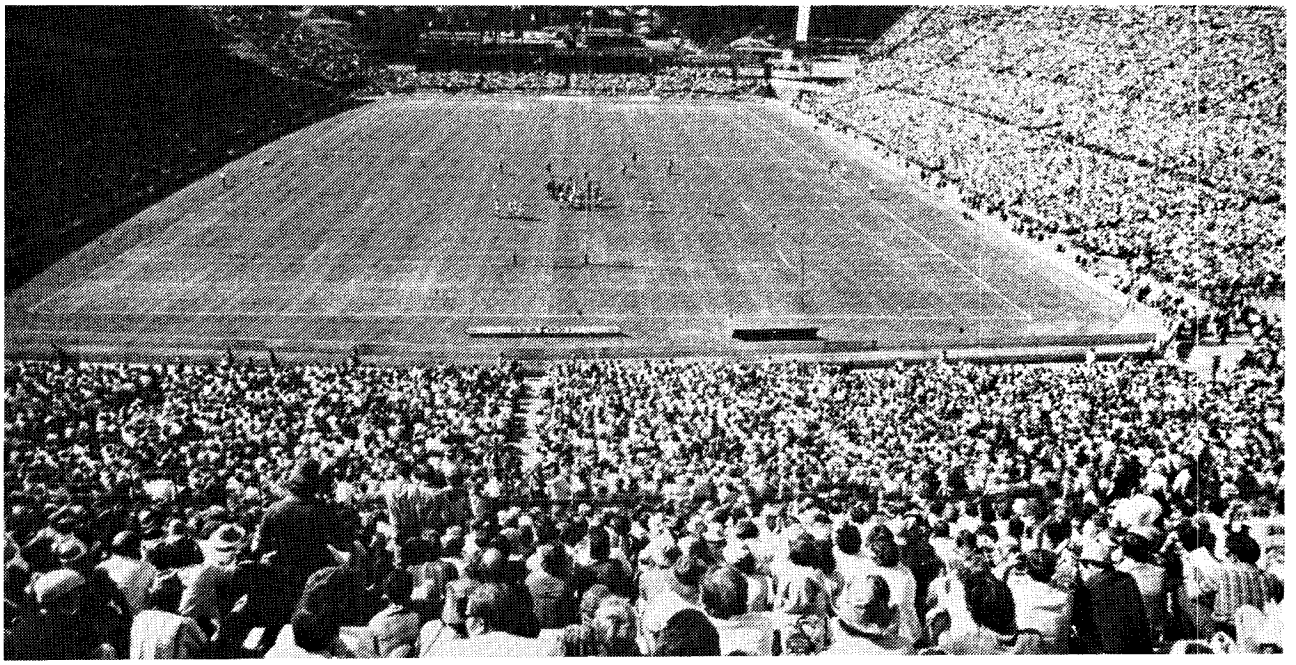

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VZ82/53252

J. le R. Retief, J. F. Affleck-Graves, W. D. Hamman*

Leverage=Risk? Empirical findings for the JSE

Review

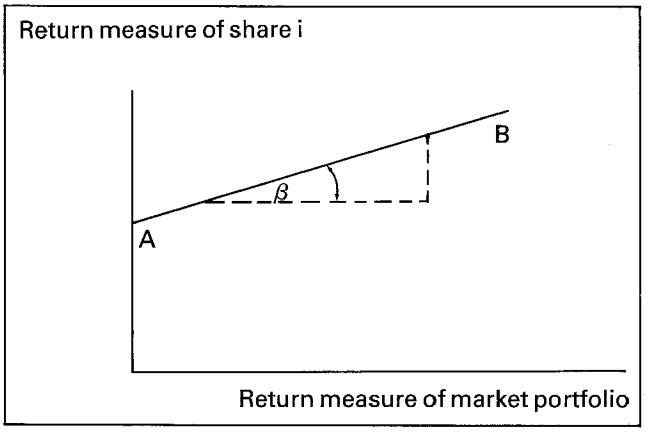
A recent study †examined the relationship between market determined measures of risk and company decision variables as reflected in reported accounting information. The results from this study clearly indicated that none of the recent more successful measures developed by American researchers have proven to be applicable when using South African data.

It is thus still far from clear which underlying accounting variables are perceived by the South African market as being important in indicating riskiness and how they can be incorporated into a model providing a suitable measure for risk.

Market determined measure of risk

The most widely used measure of market determined risk is the *Market Beta* of the capital asset pricing model (CAPM) which summarises the market equilibrium trade-off between expected return and risk. This beta simply indicates the sensitivity of a return measure of a share to movements of a market-wide index of shares and can be described by the slope of line AB in figure I below.

Figure I



If the slope is one, it means that returns for the share vary on a one-to-one basis with returns for the market portfolio. In other words, the share has the same unavoidable or systematic risk as the market as a whole. A slope steeper than one means that the share's return varies more than on a one-to-one basis with the return of the market portfolio. Put another way, it has more unavoidable risk than the market as a whole. This type of share is often called an "aggressive investment". A slope less than one means that the share has less unavoidable or systematic risk than the market as a whole and is often called a "defensive" investment.

Thus, beta represents the so-called systematic risk of a share due to underlying movement in share prices. This is that risk which cannot be diversified away by investing in more shares, as it depends on things such as changes in the economy and in the political atmosphere which affect all shares in general.

For the purpose of this paper market beta (Bm) is assumed to be the sole share-specific variable determining the relative riskiness of each share. Because of the implication of the CAPM this implies that market beta is the sole share specific variable determining expected return.

Market beta can be estimated using the following time-series regression:

$R_{it}=a_i+B_iR_{mt}+U_{it}$

where

R_{it}=the ex post return on share i in period t;

R_{mt}=the ex post return of the market portfolio in period t represented by the JSE Actuaries Industrial Index as from October 2, 1978 and the RDM 100 Industrial Index[1] prior to that;

a_i, B_i=the intercept and slope respectively of the assumed linear relationship between R_{it} and R_{mt}; and

U_{it}=the stochastic individualistic component of R_{it}.

Relationship to past research

In the first study between beta and possible underlying risk factors, Beaver, Kettler and Scholes (1970) discovered significant correlations between beta and dividend payout, financial leverage and earnings yield measures. Subsequent studies have concentrated on the relationship between beta and a single risk factor. Hamada (1972) showed that financial structure had an important influence on beta but disagreed with certain other authors over whether beta varies directly with the level of financial leverage. Hamada (1969) proved analytically that beta will increase as a company increases its leverage. He concluded that if the Modigliani & Miller corporate tax leverage propositions were correct, approximately 21% to 24% of the observed systematic risk of common shares (when averaged over 304 companies) can be explained merely by the added financial risk taken on by the underlying company with its use of debt and preferred share. In other words, financial leverage does count considerably. Finally, Baruch Lev (1974) devised an operating leverage variable which proved to have modest explanatory power.[2]

* Doctoral student, Stellenbosch Business School; Professor of Business Administration, Graduate School of Business, Cape Town; Professor of Finance, Stellenbosch Business School respectively.

† Retief, Affleck-Graves and Hamman: "On the measurement of Risk". Submitted to the Journal of Business Management, June 1984. This research forms part of a thesis for the degree of Doctor of Business Administration submitted to the University of Stellenbosch.

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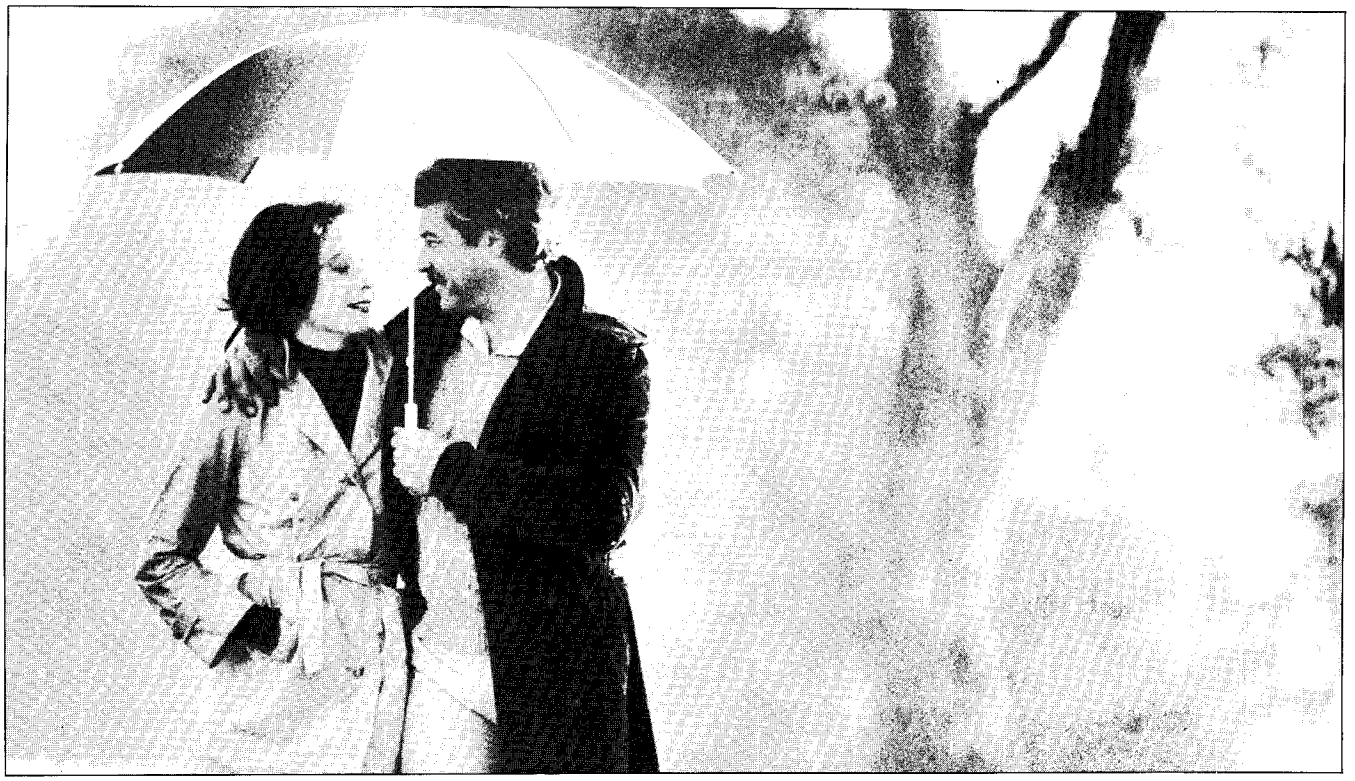

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In addition to these studies, Gonedes (1973) found beta to be significantly related to the covariability between annual first differences in a company's net income and those in the economy and appropriate industry. Other researchers sought to forge multivariate links between beta and several corporate risk factors. For example, Logue and Merville (1972) regressed the betas of 287 industrial common shares on nine financial variables. Only return on assets, asset size, and financial leverage variables appeared significant, but correlations were low with R^2 equalling 0,25.

Breen & Lerner (1973) divided 1 400 companies into 12 groups according to the month in which fiscal 1969 results were announced. They then regressed the betas in each month grouping on seven financial variables. They found that most variables were not significant, and those that were, were not consistently significant over time.

Rosenberg & McKibben (1973) examined 32 variables derived from both accounting and share market data. They found 13 significant variables but the directions of their relationship with beta (i e the signs of their regression coefficients) were generally unexpected. In addition, the variables had only 2% more explanatory power than the naïve assumption that beta=1 for all shares.

Lev & Kunitzky (1974) found beta to be significantly associated with dividend payout and indicators of smoothing in a company's capital expenditure, dividends, sales and earnings. The regression coefficients had expected signs and R^2=0,47.

Melicher (1974) found significant multivariate links between beta for electric utility shares during 1967–1971 and dividend payout, return on common equity, market activity, plant to total capitalisation and size. The pattern of signs was generally as expected and R^2 ranged from 0,33 to 0,41. Replication of the tests on the 1963–1967 period, however, produced very poor results.

In a follow-up study, Melicher and Rush (1974) sought to relate changes in betas from 1962–1966 to 1967–1971 to 11 financial variables. The results were discouraging. Only financial leverage, earnings growth, and plant to total capitalisation proved significant with R^2 ranging from 0,22 to 0,26.

Thompson (1976) formulated 43 variables to explain the beta of a common share by using prior research into corporate behaviour and characteristics and by developing a model. His model, based on a widely used share evaluation technique, revealed three major risk factors inherent in a share's beta. These risks stem from fluctuation in the earnings, dividends and an earnings multiple of the individual company.

Belkaoui (1978) concluded from evidence based on examining 55 Canadian companies that accounting based measures of risk are incorporated in the systematic risk of a common shares. A significant positive relationship was found between both the current ratio and long term debt to common equity and systematic risk. Pettit & Westerfield (1972), however, did not find significant correlations between liquidity and leverage against market beta.

In South Africa very few studies have emerged in this area. However, Retief (1980) investigated 5 return measures (return on assets, return on equity, ebit/average total assets, ebit/selected liabilities and return on book capitalisation) but found no significant results.

The above refers to only a few of the numerous studies attempting to establish the underlying determinants of systematic risk. What seems to be clear is that systematic risk is related in some way to risk factors in the underlying corporation. However, it still is far from clear which risk factors are important and these factors seem to vary between different markets and different economic climates and conditions.

Although many choices can be made this paper will only focus attention on the influence and importance of leverage (gearing) when assessing the perceived riskiness of a share.

Definitions

Many different definitions of leverage have been used in literature and considerable disagreement exists on the correct choice for a leverage ratio.

One of the more popular definitions is that of Beaver, Kettler & Scholes (1970) whose definition was total senior (ie preferred) securities (including current liabilities) divided by total assets. In this case, the numerator includes all fixed claim holders with prior claim to earnings to the ordinary shareholders.

Previous research by Beaver (1966) showed this form of leverage relationship exhibited the highest association with default risk. In a pilot study by Beaver, Kettler & Scholes (1970) several leverage ratios were analysed but the results were consistent with the study of Beaver (1966) that the definition described above was superior to all others tested.

However, to ensure that the chosen definition does not present itself as a special case, eight different definitions of leverage have been used in this study (see table 1).

The sample

For the empirical study, the largest time period from which market beta can be calculated was 1973–1982. This period was determined by the University of Stellenbosch Business School database.

Companies were selected on the basis of the following screening criteria:

(a) Data for all required variables had to be available for at least the full period.

(b) Financial year ends had to be in the same month.

(c) All companies that had financial year-end changes were rejected.

Table 1: Definitions of leverage

Symbol	Definition
F1	(Total assets − equity)÷(Total assets)
F2	(Long-term debt+prefs+minority interests+OD+short-term loans)÷(Total assets)
F5	(Long-term debt+OD+short-term loans)÷(Total assets)
F6	(Long-term debt+OD+short-term loans+minority interests)÷(Total assets)
F7	(Long-term debt+OD+short-term loans+prefs)÷(Total assets)
F8	(Long-term debt+OD+short-term loans+deferred taxation)÷(Total assets)
F10	(Long-term debt+OD+short-term loans+minority interest+deferred taxation)÷(Total assets)
F11	(Long-term debt+OD+short-term loans+prefs+deferred taxation)÷(Total assets)

e.g. For company i, year t

$$(Fi)_t = \frac{\text{(fixed assets and all other assets)} + \text{(current assets)} - \text{(equity)}}{\text{(total assets)}}$$

Then

$$Fi = \sum_{t=1}^{N} (fi)_{t/N}$$

Where

N = number of years in the time period studied
OD = overdraft

In order to increase the sample, consideration was given to include companies with financial years ending in other months. However, for the companies with financial years ending on different months, it was unclear how the return measure for the market index should be constructed. One alternative was to construct an index consisting only of other companies with the same fixed year-end. This was rejected because of the small number of companies in the case of some financial year-ends and because of the possibility of industry effects dominating such an index. The alternative of interpolating the individual company's earnings to the chosen year-end was rejected because of the possible presence of seasonality of earnings at the company level.

This selection procedure yielded the following:

(a) The sectors[3] resulted in a total of 272 companies with data complete for the entire period.

(b) 112 companies changed financial year-ends during the 10 year period of study (1973–1982) and were rejected.

(c) Financial year-ends per month of the remaining companies expressed as a percentage of the total remaining.

January	0,58%
February	9,64%
March	10,44%
April	1,34%
May	0,27%
June	50,02%
July	0,63%
August	1,17%
September	5,20%
October	0,63%
November	0,81%
December	19,27%
	100,00%

All companies with year-ends other than June were subsequently rejected.

(d) Companies with major structural changes, holding and investment companies were rejected.

Having applied all the above screening criteria, 63 companies remained in the sample[4] (i.e. 24,63% of the initial population).

Table 2 summarises some of the more important characteristics of the different leverage ratios for this sample.

Methodology

The beta concept is an ex ante concept, while the betas and other variables in this study were measured from ex post return data. Hence, the measurements are subject to error.

There are various ways of attempting to remove the measurement error from the observed values. The approach followed in this paper was to aggregate into portfolios and in effect diversify away, measurement errors at the individual security level. Clearly, in the absence of measurement error, aggregation of the data would make no sense, it would actually result in throwing away some information (Johnston, 1972). However, aggregation may be appropriate in the presence of measurement error. But, care should be taken when interpreting the statistics computed on

Table 2: Sample characteristics

Variable	Arith mean	SE of mean	Studentised mean	Unbiased variance	STD deviation	Coeff of variation	MAD	Min value	Max value	Range	Coeff of skewness	Coeff of kurtosis
F	0,5061	0,2138	23,669	0,0288	0,1697	0,3354	0,1303	0,0700	0,8860	0,8160	−0,5506	3,2230
F2	0,2234	0,0163	13,703	0,0167	0,1294	0,5792	0,0977	0,0000	0,6450	0,6450	0,5560	3,7943
F5	0,1849	0,0145	12,778	0,0132	0,1148	0,6211	0,0869	0,0000	0,5080	0,5080	0,6074	3,4757
F6	0,2126	0,0161	13,210	0,0163	0,1277	0,6009	0,0964	0,0000	0,6260	0,6260	0,6182	3,8404
F7	0,1956	0,0146	13,372	0,0135	0,1161	0,5936	0,0880	0,0000	0,5080	0,5080	0,4945	3,2631
F8	0,2034	0,0154	13,178	0,0150	0,1225	0,6023	0,0930	0,0000	0,5910	0,5910	0,5715	3,5929
F10	0,2311	0,0168	13,737	0,0178	0,1335	0,5778	0,1014	0,0000	0,6290	0,6290	0,5105	3,6498
F11	0,2141	0,0155	13,771	0,0152	0,1234	0,5764	0,0983	0,0000	0,5910	0,5910	0,4732	3,4027

aggregated data, especially the correlation coefficients which are expected to be larger when there is non-random grouping.

Also, for simplicity, equal tax rates were assumed for all companies. Ignoring different tax rates for different companies will lead to an additional source of error or noise.

Empirical results

In the light of the above discussion, the following empirical procedure was adopted. Portfolios of 1, 3 and 7 shares were formed by grouping adjacent shares after ranking in terms of the market beta. It should be noted that portfolio variables were calculated as the arithmetic average of the variables forming the portfolio.

Table 3 summarises the empirical findings of this study. The table lists the product-moment correlation coefficients between market beta and each of the leverage ratios. In addition, the t-value and the significance probability are given where the probability is that of obtaining a larger absolute value of t from data sampled independently from a bivariate normal distribution with zero correlation. For example, if the significance probability is less than 0,05 the correlation is significant at the 5% level. (This t-test is equivalent to the test that the regression slope coefficient is zero.)

From table 3 it is clear that all variables are significantly correlated to market beta at least at the 3% level.

The results[5] show without doubt and with significance that there exists a high correlation between the market measures of risk and leverage. Thus, for example, in the 7 portfolio case, the correlation between market beta and the F1 ratio is 0,98. This implies that over 96% of the variability in market beta can be explained by the leverage factor. In the case of the single companies, the correlation between F1 and the market beta was 0,56 indicating that over 31% of the variability in market beta for an individual company can be explained by leverage.

Also, it should be noted that the results indicate that:

(i) Correlation coefficients increase with increased portfolio size; and

(ii) the best results are obtained from the F1 ratio[6]. (This coincides with the findings of *Beaver* (1966).)

In order to demonstrate these results further, figures 1, 2 and 3 provide scatterplots of market beta versus F1 for portfolio sizes of 1, 3 and 7 shares.

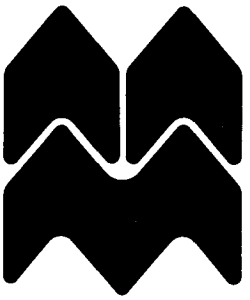
Table 3: Correlation: Leverage ratios with market beta

Leverage ratio	F1			F2			F5			F6		
Portfolio size	1	3	7	1	3	7	1	3	7	1	3	7
Multiple correlation coefficient (r)	0,56	0,789	0,982	0,433	0,625	0,871	0,377	0,515	0,746	0,427	0,617	0,866
t	5,27	5,60	13,57	3,75	3,49	4,69	3,18	2,62	2,96	3,69	3,42	4,58
degrees of freedom	61	19	7	61	19	7	61	19	7	61	19	7
Significance probability	0,000	0,000	0,000	0,000	0,002	0,002	0,002	0,017	0,021	0,000	0,003	0,003
Significantly correlated at 2½% level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leverage ratio	F7			F8			F10			F11		
Portfolio size	1	3	7	1	3	7	1	3	7	1	3	7
Multiple correlation coefficient (r)	0,385	0,523	0,755	0,381	0,537	0,784	0,434	0,636	0,878	0,390	0,545	0,803
t	3,26	2,68	3,04	3,22	2,77	3,35	3,77	3,59	4,84	3,31	2,83	3,56
degrees of freedom	61	19	7	61	19	7	61	19	7	61	19	7
Significance probability	0,002	0,015	0,019	0,002	0,012	0,012	0,000	0,002	0,002	0,002	0,011	0,009
Significantly correlated at 2½% level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Conclusion and implications

The definition of leverage (gearing) states that the larger the proportion of debt in a company's capital structure, the more highly "levered" the company. The higher the leverage, the greater the risk for the owners of equity, but the greater their prospect of profit if all goes well.

The results presented in this paper indicate that for an investor analysing a company in isolation, leverage should be an important consideration as regards assessment of the risk in that company. But, it is not the only factor that influences market beta as other factors account for approximately 68% of the variability in the beta coefficient.



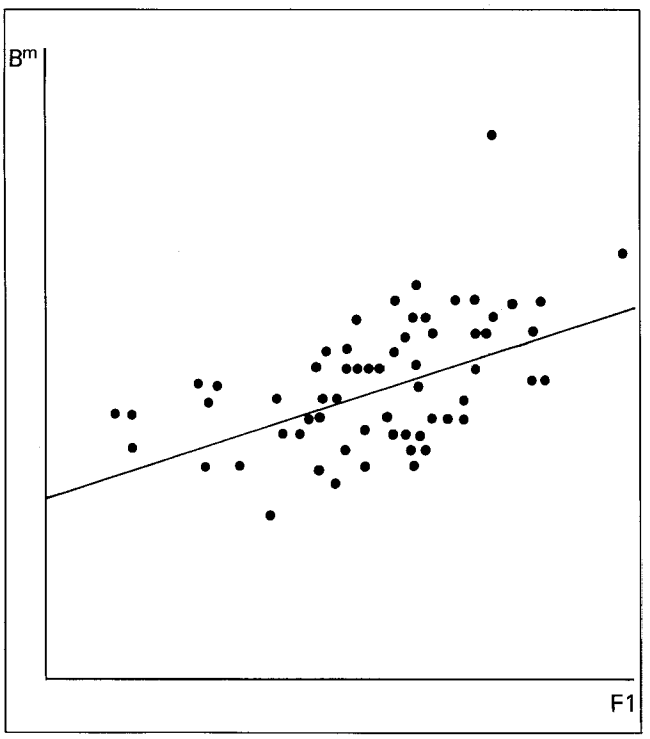
The AA Mutual Insurance Group

Five year group review

Thousands of rand	**1984 30 April**	1983 30 April	1982 30 April (see note)	1980 31 December	1979 31 December
Share capital and reserves	**32 426**	27 202	19 862	13 581	11 789
Total group assets	**257 688**	218 286	142 428	86 573	76 307
Short term business					
Gross premiums	**244 170**	208 407	171 443	74 599	68 402
Composition of gross premiums	**%**	%	%	%	%
Motor	**42,8**	40,4	40,3	42,4	41,7
Fire	**19,8**	24,5	24,8	20,0	22,1
Accident	**28,2**	26,4	26,2	23,4	19,5
Marine and aviation	**4,1**	3,9	3,2	2,1	2,0
Compulsory third party	**5,1**	4,8	5,5	12,1	14,7
	100	100	100	100	100
Premium income after reinsurance	**200 209**	162 089	116 790	56 754	50 201
Underwriting profits (losses)	**2 569**	1 663	(5 153)	(435)	533
Investment income	**8 469**	5 820	5 396	3 061	2 525
Profit before tax	**11 163**	6 889	92	2 339	3 011
Profit after tax	**6 617**	4 593	726	1 747	1 985
Insurance funds	**69 149**	56 753	34 376	22 089	20 157
Long term business (see note)					
Premium income after reinsurance	**20 751**	13 452	11 912	4 279	3 450
Payments to policyholders	**5 773**	3 877	3 936	1 505	969
Investment income	**8 376**	6 063	5 192	2 039	1 682
Life funds	**89 819**	76 251	45 020	28 075	21 880
Long term assets	**98 657**	83 436	50 782	31 285	24 952

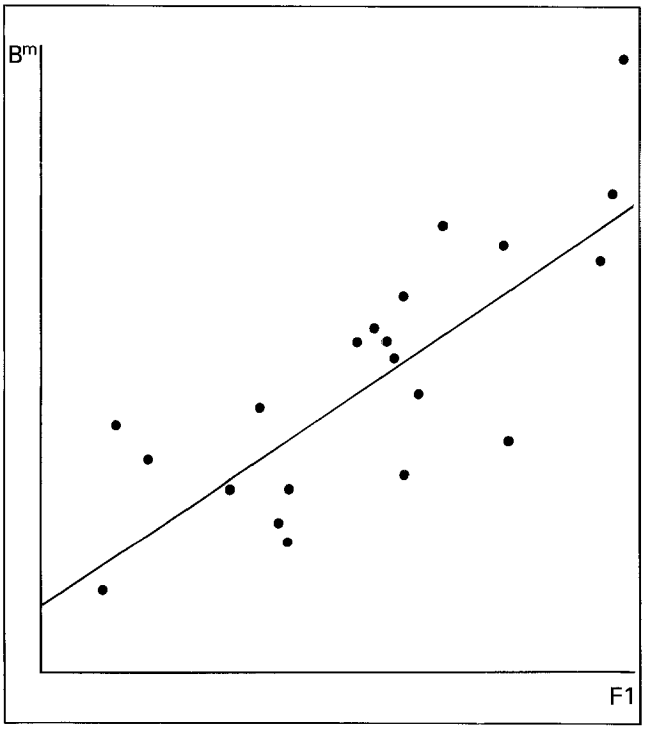
Note: The 1982 column covers a 16 month period for all categories except for NZISA (13 months).

Figure I
Correlation: F1-ratio with market beta portfolio size = 1



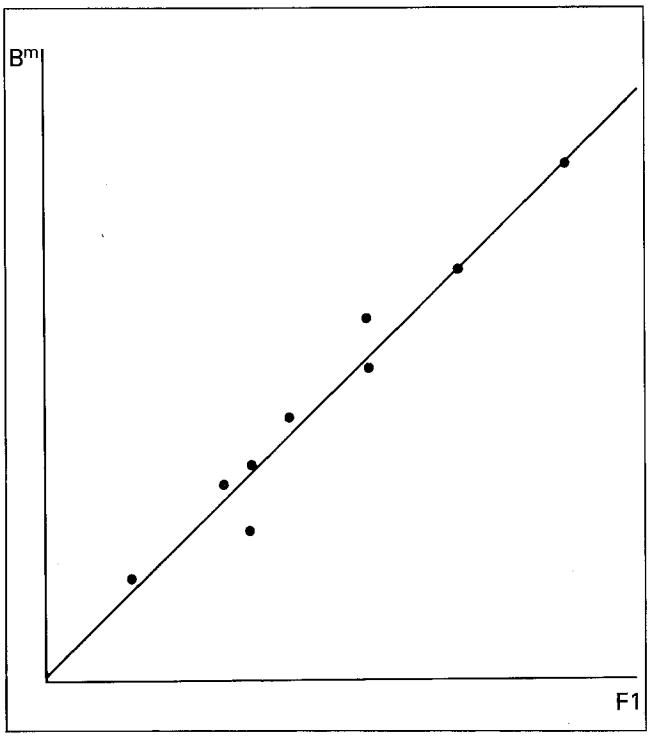
Correlation coefficient (r)	= 0,56
T-value	= 5,27
Degrees of freedom	= 61
Significance probability	= 0,000

Figure II
Correlation: F1-ratio with market beta portfolio size = 3



Correlation coefficient (r)	= 0,789
T-value	= 5,60
Degrees of freedom	= 19
Significance probability	= 0,000

Figure III
Correlation: F1-ratio with market beta portfolio size = 7



Correlation coefficient (r)	= 0,982
T-value	= 13,57
Degrees of freedom	= 7
Significance probability	= 0,000

On the other hand, for an investor making portfolio decisions, the leverage of the company is a crucial factor in assessing risk because at the portfolio level, leverage explains as much as 96% of the variability in the market beta. In essence, what appears to happen, is that the other risk factors that affect the riskiness of an individual share (eg business risk), are diversified away at the portfolio level. However, the leverage factor is largely unaffected by the diversification. It, thus, becomes the dominant risk factor.

Footnotes

[1] Since publication of the latter index does not include publication of dividend indices, daily dividend indices had to be simulated from the monthly JSE actuaries dividend indices until the end of September 1978. Thereafter, daily JSE actuaries dividend indices were available.

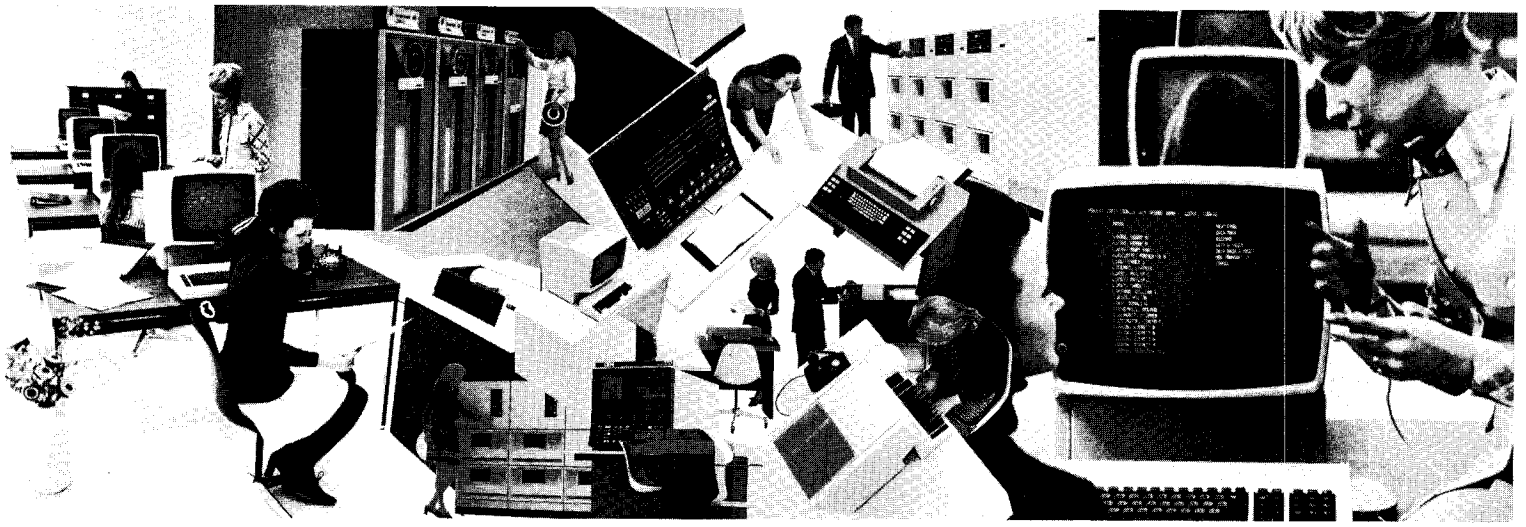
[2] Lev defines operating leverage as the ratio of the fixed to variable operating costs.

[3] See appendix for a description of sectors.

[4] See appendix for sample of companies and sector descriptions.

[5] These results were verified by re-running the tests on December companies as well as a combination of June and December companies. Results stayed the same.

[6] F1 = (fixed and other assets + current assets − equity)÷(total assets).



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Appendix
The final sample

Sector	Company name	Number
Industrial Holding	Anglo Transvaal Industries	10
	Industrial and Commercial Holdings Group	
	Industrial Investments	
	Metje & Ziegler	
	Micor Holdings	
	Picardi Beleggings	
	Protea Holdings	
	Rentmeester	
	South Atlantic Corporation	
	Tollgate Holdings	

Appendix
The final sample

Sector	Company name	Number
Beverage and Hotels	Picardi Hotelle	3
	Suncrush	
	Uniewyn	
Building	Everite	5
	Good Hope Concrete Pipes	
	Grinaker Holdings	
	Gypsum Industries	
	Murray & Roberts Holdings	
Chemical	Natal Chemical Syndicate	2
	Sentrachem	
Clothing	Consolidated Textile Mills	9
	Gubb & Inggs	
	Natal Consolidated Industrial Investments	
	Natal Canvas & Rubber Manufacturers	
	Rex Trueform Clothing Co.	
	The South African Woollen Mills	
	Seardel Investment Corporation	
	Silverton Tannery	
	Towles, Edgar Jacobs	
Food	T W Beckett & Co	2
	Irvin & Johnson	
Furniture	Beares	2
	Montays	
Engineering	Abercom Group	6
	Berzack Brothers (Holdings)	
	Claude Neon Lights SA	
	Globe Engineering Works	
	National Bolts	
	Steelmetals	
Electronics	Central African Cables	1
Motors	Alderson & Flitton Holdings	7
	Currie Motors (1946)	
	Eureka	
	McCarthy Group	
	Northern Free State Motors	
	Brian Porter Holdings	
	Welfit Oddy Holdings	
Paper	Consol	3
	Copi	
	Press Supplies Holdings	
Pharmaceutical and Medical	Amalgamated Medical Services	3
	General Optical Co.	
	The Union Cold Storage of SA	
Printing	Afrikaanse Pers	2
	Mathieson & Ashley	
Steel	Cullinan Holdings	1
Transport	Putco	3
	SA Marine Corporation	
	Trencor	
Stores	Garlick	4
	Greatermans	
	Gresham Industries	
	M & S Spitz Footwear Holdings	
	Total	**63**

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Trevor Blench and John F. Affleck-Graves

Bond immunisation in South Africa

Introduction

The fixed-interest market is exposed to a different set of risks from those encountered in other financial markets. The greatest risk in the fixed-interest sector is usually the risk of changes in market yields.

The risk of changes in interest rates means that bond-holders cannot know what their total return on a bond investment will be. Many investors turn to the fixed-interest sector when they wish to avoid or reduce risk. Immunisation is a technique of bond portfolio management, still new to South Africa, that enables investors to overcome interest rate risk and to assure themselves a certain return over their selected target period.

Interest rate risk

Changes in interest rates affect the performance of fixed-interest portfolios in two different ways. Firstly, they affect the capital value of a portfolio. This constitutes a risk if and when bonds are traded in the secondary gilts market before maturity. Some bonds are more price-sensitive, or volatile, to changes in yields than others, and are therefore more risky. Secondly, changes in interest rates affect the yields available on coupon income that is reinvested, and hence the interest on interest element of total return. This interest on interest element can be a very large proportion of total return. For instance, it amounts to 58% of total return on an 8%, 20 year bond, assuming a stable reinvestment rate of 8%. It rises to 67% of total return on the same bond if the re-investment rate rises to an average of 10%.

Interest on interest is very relevant to the concept and calculation of yield to maturity (YTM), the compound yield of a bond investment assuming reinvestment of coupon income. YTM assumes that coupon income will be reinvested at the same rate as that which obtained at the time the bond was purchased. For example, if an investor buys an 8%, 20 year bond at par at a YTM of 8%, he will only achieve an 8% return, on a fully compound basis, if he also reinvests all coupon income at 8%. If the reinvestment rate drops to an average of 5%, the total compound return on the investment will fall to 6,64%. On the other hand, if the average reinvestment rate rises to 10%, then the total return will increase to 9,01%. As investors cannot know in advance at what rate they will be able to reinvest their coupon income, they cannot know what their total return will be. Therefore, investors who enter the primary market to purchase new 20 year gilt or semi-gilt issues carrying a coupon of 12%, at a YTM of 12%, could realise a total compound return of anything between 9% and 15% depending upon the behaviour of interest rates over the holding period.

However, a change in market yields affects the two components of total return in opposite directions. A rise in yields causes the capital value of a bond portfolio to fall, but it causes interest on interest to increase. A drop in yields enhances the value of a bond portfolio, but it causes the interest on interest element to shrink. Hence, changes in capital value are to some extent offset by interest on interest, and vice versa. The technique of immunisation adjusts these two elements of total return in such a manner that they offset each other equally. The objective of the technique is, therefore, to protect the value of a bond portfolio from changes in value caused by changes in interest rates.

Duration

The technique of immunisation is based on the concept of duration, or mean life, which was developed by F. Macauley (1938) in America and extended by Hicks (1939) and Samuelson (1945). The duration of a bond is its weighted average period of repayment, including both coupon payments and capital repayment. The duration of a zero coupon bond is the same as its maturity because repayment is made in one lump sum on maturity. But if a bond pays coupons, it pays instalments on the debt, and consequently makes the average repayment period shorter than the maturity. Duration is calculated by taking the present value of all the expected cash flows from a bond investment; by weighting these present values as a proportion of the total present value of the bond; multiplying the weights of the present values of each cash flow by the term in years until that cash flow is expected; and by summing these products. The duration of a 9%, five year bond at a YTM of 9% is calculated in Table 1 below:

Table 1: Duration of a 5 year 9% coupon bond, YTM of 9%

Coupon payment	Term in years until cash flow	PV of cash flows at 9%	Weight of each PV	Term X weight
R4,50	0,5	4,3062	0,0431	0,0215
4,50	1	4,1208	0,0412	0,0412
4,50	1,5	3,9433	0,0394	0,0591
4,50	2	3,7735	0,0377	0,0754
4,50	2,5	3,6110	0,0361	0,0902
4,50	3	3,4555	0,0346	0,1038
4,50	3,5	3,3067	0,0331	0,1158
4,50	4	3,1643	0,0316	0,1264
4,50	4,5	3,0281	0,0303	0,1363
4,50	5	2,8977	0,0290	0,1450
100,00*	5	64,3928	0,6439	3,2195
		99,9999	1,0000	4,1342

*Redemption

Duration = 4,1342 years

Table 1 indicates that the duration of a bond is determined by the term of the bond, the coupon rate, and the YTM at the time duration is calculated. Duration is always shorter than maturity, except in the case of zero coupon bonds. Duration does not increase in direct proportion to lengthening maturity. A low coupon provides a longer duration, relative to maturity, than a high coupon on bonds of equal maturity. Low yields produce long durations, whereas high yields indicate short durations.

Immunisation

The concept of duration was used by the British actuary, F. M. Redington (1952), to develop the technique of immunisation. Although he developed this technique in 1952, it was not widely used until the late 1970s when highly volatile interest rates caused interest rate risk to become a serious concern. This led to new interest in Redington's work and major contributions have been made by Bierwag (1977), Leibowitz (1979), Gushee (1981) and Bierwag, Kaufman and Toevs (1983).

The duration of 4,1342 years, calculated for the 5 year bond in Table 1, is significant in that it is the period over which an investment in this bond will be immunised against interest rate risk. It is the period over which changes in interest rates will equally affect the capital value factor and the interest on interest factor of total return. Hence, duration is the fulcrum point about which changes in capital value are equally offset by interest on interest. Over this period of time, the bondholder can be certain of achieving the initial YTM on a fully compound basis.

Table 2 illustrates the point:

Table 2: Realised return from a 5 year 9% par bond over various periods

Reinvestment rate		Horizon period in years 1	3	4,1342	5
	Coupon income	R9,00	27,00	37,20	45,00
7%	Capital gain	6,80	3,40	1,60	0
	Interest on interest	0,20	2,50	5,10	7,80
	Total return	16,00	33,10	43,90	52,80
	Realised compound yield	15,43%	9,77%	9,00%	8,66%
9%	Capital gain	0	0	0	0
	Interest on interest	0,20	3,20	6,70	10,30
	Total return	9,20	30,20	43,90	55,30
	Realised compound yield	9,00%	9,00%	9,00%	9,00%
11%	Capital gain	−6,30	−3,50	−1,60	0
	Interest on interest	0,20	4,00	8,30	12,90
	Total return	2,90	27,50	43,90	57,90
	Realised compound yield	2,89%	8,26%	9,00%	9,36%

This table assumes the purchase of a R100, 5 year, 9% coupon bond, bought at a YTM of 9%. It then compares three different scenarios. In the first scenario, the interest rate falls to 7% and stays there for the remainder of the five years. In the second case, the interest rate stays at 9% for the entire five year period. In the third case, the interest rate rises to 11% and stays there until the end of the period. It will be seen that the initial YTM of 9% is fully achieved on a compound basis over the duration of the bond regardless of changes in interest rates, and this achievement occurs only over the duration and not over any other period. Hence, an investor who wishes to achieve a target return over a period of, say, five years must buy a bond not with a maturity of five years but with a duration of five years.

However, a feature of duration is that it does not elapse at the same rate as chronological time. For instance, the 5 year, 9% par bond that appears in Table 1 has a duration of 4,1342 years, but one year later, the same bond has the following duration:

Table 3: Duration of a 4 year 9% par bond

Coupon payment	Term in years until cash flow	PV of cash flows at 9%	Weight of each PV	Term X weight
R4,50	0,5	4,3062	0,0431	0,0215
4,50	1	4,1208	0,0412	0,0412
4,50	1,5	3,9433	0,0394	0,0591
4,50	2	3,7735	0,0377	0,0754
4,50	2,5	3,6110	0,0361	0,0902
4,50	3	3,4555	0,0346	0,1038
4,50	3,5	3,3067	0,0331	0,1158
4,50	4	3,1643	0,0316	0,1264
100,00*	4	70,3186	0,7032	2,8128
		99,9998	1,0000	3,4462

*Redemption

Duration = 3,4462 years.

After one year of chronological time, the duration of this bond has fallen from 4,1342 years to 3,4462 years, a drop of only 0,688 years. The consequences of this drift, as time elapses, is that a gap will appear between the duration of the portfolio and the period over which the investor wishes to achieve his target return. At the outset, the duration of the 5 year 9% par bond was 4,1342 years, indicating that it was suitable for a target date that lay 4,1342 years into the future. One year later, the target date was 3,1342 years away, but the duration of the bond had only fallen to 3,4462 years. As the gap between the duration of the portfolio and the length in chronological time until the target date widens, the portfolio loses its immunity, and again gradually becomes exposed to the risk of changing interest rates. In order to maintain immunity, the maturity structure of the portfolio must be rebalanced periodically so that the duration of the portfolio is always approximately equal to the chronological time remaining until the target date.

The rebalancing that is required to maintain the immunity of a bond portfolio obviously implies transaction costs. The benefits of immunisation must exceed these transaction costs or the exercise will not be worthwhile. Therefore, a careful estimate of the probable costs and benefits must be made, together with an evaluation of the risks involved in not immunising the portfolio.

The durations of the more heavily traded gilt and semi-gilt issues on 31 August 1983 are given in Table 4 below, which is taken from Blench (1983). They indicate that the maximum time period over which a bond portfolio could be immunised on that date was just over 7 years.

Table 4: Duration of heavily-traded issues on 31 August 1983

Issue		YTM	Term to maturity	Duration
RSA				
11%	15/11/1997	13,35	14 years	6,716 years
11%	15/4/1998	13,43	15 years	6,888 years
12,5%	1/9/2003	13,10	20 years	7,079 years
14,5%	1/6/1987	13,43	3,75 years	2,933 years
14%	15/5/1993	13,50	10 years	5,431 years
14%	15/7/1992	13,70	9 years	5,363 years
Escom				
10%	1/11/2007	13,75	24 years	7,381 years
8%	1/3/1986	13,80	2,5 years	2,204 years
12%	1/9/2008	13,80	25 years	7,051 years
12,95%	1/4/2006	13,85	23 years	6,978 years
13,2%	1/11/2007	13,85	24 years	7,093 years
15,15%	1/11/1987	13,65	4,16 years	3,119 years

Immunising a bond portfolio in South Africa

Immunisation has been used as a technique of bond portfolio management in America and Europe since the late 1970s, but it has not yet been used in South Africa. The gilts market in South Africa does not lend itself easily to the implementation of this technique. Firstly, there are few highly-traded stocks, with the result that investors may not be able to find bonds with the durations they require. Secondly, trading is very thin in many issues, which makes buying or selling small lots difficult. Investors may encounter problems reinvesting their coupon income in the same stock that they hold at the time. Moreover, a large proportion of RSA stock with less than 3 years to maturity is held by banks to fulfil their liquid asset requirements.

However, the gilts market in South Africa is growing and developing rapidly. If the number of highly traded issues does increase, it will become progressively easier to immunise bond portfolios in South Africa. Moreover, the problems mentioned above can be overcome to a large extent by averaging the durations of different stocks. If a duration of four years is required, and no such stock exists or is available, two different stocks with durations of, say, 3 years and 5 years could be purchased in such proportions that their weighted average duration is equivalent to the duration required. Rebalancing exercises could then consist of changes in the proportion of the two or more stocks held.

Table 5 demonstrates how, in theory, a bond portfolio could be immunised in South Africa. A five year time period is selected, from 31 December 1977 to 31 December 1982. At the outset, the objective is established of achieving the sum of R1 000 000 by the end of the period. On 31 December 1977, a bond with a duration of 5 years is selected, the Cape Town 5,625% 1984. The YTM of this issue on 31 December 1977 was 11,15; hence the objective of this immunisation exercise is to achieve a fully compound return of 11,15% over this target period. The initial sum for this portfolio is, therefore, the present value on 31 December 1977 of R1 000 000 on 31 December 1982, discounted six monthly at 11,15%, or R581 285. The portfolio is rebalanced every six months in

Table 5: Strategy of immunised portfolio. 31 December 1977 – 31 December 1982

Date	Total market value of portfolio R	Issue bought	Issue sold	Price R	YTM %	Number of bonds purchased	Number of bonds sold	Coupon income R	Time to target date	Duration of portfolio	Term of portfolio
31/12/77	581 285	Cape Town 5,625% 15/2/84	–	78,04	11,15%	7 449	–		5 years	4,973 years	6,125 years
15/2/78	599 612	Cape Town 5,625% 15/2/84	–	77,68	10,80%	270	–	20 950	–	–	–
30/6/78	628 172	–	Cape Town 5,625% 15/2/84	81,38	10,60	–	7 719	–	4,5 years	–	–
30/6/78	628 172	Johannes-burg 6,75% 31/12/83	–	84,23	10,60%	7 458	–	–	4,5 years	4,59 years	5,5 years
31/12/78	706 012	–	Johannesburg 6,75% 31/12/83	91,29	8,95%	–	7 458	25 171	4 years	–	–
31/12/78	706 012	Vanderbijl Park 11,775% 31/12/83	–	110,57	9,10%	6 385	–	–	4 years	3,98 years	5 years
30/6/79	764 205	–	Vanderbijl Park 11,775% 31/12/83	113,80	8,05%	–	6 385	37 592	3,5 years	–	–
30/6/79	764 205	Benoni 5,75% 30/6/83	–	92,27	8,05%	8 282	–	. .	3,5 years	3,55 years	4 years
31/12/79	813 168	–	Benoni 5,75% 30/6/83	95,31	7,30%	–	8 282	23 811	3 years	–	–
31/12/79	813 168	Escom 5% 30/4/83	–	94,57	7,15%	8 599	–	–	3 years	3,07 years	3,33 years

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The Buy and Sell Agreement

-an essential element of every small business

It would be most unwise for any partnership or small proprietary company not to have a buy and sell agreement funded by life insurance.

The agreement should provide that, on the death of one of the partners, the surviving partners are obliged to take over the deceased partner's share of the business. The estate is obliged to sell such interest to the survivors. In a proprietary company the agreement contains similar provisions relevant to the major shareholders. (See also Sole Proprietor below).

The agreement should also stipulate the price to be paid or specify the formula to be used in arriving at the value of a deceased partner's interest. Provision should be made for the price or the formula to be revised from time to time to take account of changing circumstances.

The advantages of a buy and sell agreement funded by life insurance are that

- *It provides a guaranteed market and a guaranteed price for each partner's interest at his death.*

- *It eliminates uncertainty as far as the heirs are concerned by giving them a fair value for the deceased's interest. The full value is paid to them in cash and without delay.*

- *It gives the surviving partner(s) complete and unfettered ownership of the business plus the cash to pay out the deceased partner's interest in full at the agreed price.*

- *It provides guaranteed cash reserves through the increasing cash values of the insurance policies on the lives of the partners. These reserves may also be used in other emergencies or to exploit other opportunities that may arise.*

- *It ensures the goodwill of employees and creditors by ensuring the stability of the business.*

- *Appropriate life insurance policies will furnish adequate capital to fund the rearrangement of ownership on dissolution when a partner dies.*

The Sole Proprietor

The sole proprietor is faced with problems which are perhaps more serious than problems facing partnerships and working shareholders of proprietary companies. There is only one solution and that is to enter into a buy and sell agreement, funded by life insurance, with a selected successor.

The sole proprietor may wish to ensure that on his death his widow will continue to run the business without any encumbrances. Or he may have a child who shows some interest in the business and who may want to acquire it on the proprietor's death. As an alternative to his wife or child, there may be a trusted employee who knows and has helped to build up the business and to whom the sole proprietor might wish to sell the business on his death.

In the absence of a suitable family member or employee to buy the business as a going concern, it might be advisable for the sole proprietor to look around for a suitable person who would be willing to purchase the business on his death.

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Table 5: Strategy of immunised portfolio. 31 December 1977 – 31 December 1982

Date	Total market value of portfolio R	Issue bought	Issue sold	Price R	YTM %	Number of bonds purchased	Number of bonds sold	Coupon income R	Time to target date	Dura-tion of portfolio	Term of portfolio
30/4/80	835 646	Escom 5% 30/4/83	–	94,68	7,00%	227		21 497	–	–	–
30/6/80	841 647	–	Escom 5% 30/4/83	95,36	7,17%	–	8 826	–	2,5 years	–	–
30/6/80	841 647	AD Board Midlands 11,75% 31/3/83	–	113,51	7,42%	7 415	–	–	2,5 years	2,39 years	2,75 years
30/9/80	843 670	AD Board Midlands 11,75% 31/3/83	–	107,90	8,20%	404	–	43 563	–	–	–
31/12/80	820 213	–	AD Board Midlands 11,75% 31/3/83	104,90	10,75%	–	7 819	–	2 years	–	–
31/12/80	820 213	Cape Town 5,125% 15/2/83	–	92,25	10,30%	8 891	–	–	2 years	1,98 years	2,12 years
15/2/81	803 461	Cape Town 5,125% 15/2/83	–	87,81	12,30%	259		22 783	–	–	–
30/6/81	834 206	–	Cape Town 5,125% 15/2/83	91,17	12,60%	–	9 150	–	1,5 years	–	–
30/6/81	834 206	Empangeni 9% 31/1/83	–	98,04	13,05%	8 509	–	–	1,5 years	1,45 years	1,58 years
31/7/81	843 705	Empangeni 9% 31/1/83	–	94,66	13,00%	404	–	38 290	–	–	–
31/12/81	873 028	–	Empangeni 9% 31/1/83	97,95	14,95%	–	8 913	–	1 year	–	–
31/12/81	873 028	Johannesburg 11,80% 28/2/83	–	101,06	14,60%	8 639	–	–	1 year	1,081 years	1,1667 years
28/2/82	877 394	Johannesburg 11,80% 28/2/83	. .	95,66	16,70%	553	–	50 970	–	–	–
30/6/82	923 254	–	Johannesburg 11,80% 28/2/83	100,66	17,15%	–	9 172	–	0,5 years	–	–
30/6/82	923 254	RWB 5% 1/1/83	–	94,30	17,15%	9 791	–	–	0,5 year	0,5 year	0,5 year
1/1/83	1 003 577	–	Redeem RWB 5% 1/1/83	100,00	–	–	Redeem 9 791 bonds	24 477	–	–	–

On 1 January 1983, redeem 9 791 bonds for R979 100 and collect R24 477 in coupon income, for a total of R1 003 577. Total compound return: 11,22%.

order to keep the duration of the portfolio roughly equal to the time remaining until the target date. Coupon income is reinvested at the time it is received in the stock held in the portfolio at that time. At the end of the period, the portfolio achieved a figure of R1 003 577 for a total compound return of 11,22%. This return is not exactly the initial YTM of 11,15% because the duration of the portfolio sometimes drifted away from the time to the target date. More frequent rebalancing would enable the portfolio to approach the target return more closely, but the benefits of doing so would have to be offset against the transaction costs incurred.

This strategy of immunisation may be compared with an alternative strategy for achieving the same target figure of R1 000 000 on the same target date. In the alternative strategy, portrayed in Table 6, a bond that matures on 31 December 1982, the Cape Town 12,4% 1982, is selected. The YTM of this issue on 31 December 1977 was 10,50%. This yield is taken to calculate the present value, on the starting date, of R1 000 000 five years later, a sum of R599 486. This amount is invested in the bond, and coupon payments are reinvested in the same bond. This portfolio achieves a figure of R975 186 on the target date, for a total compound yield of 9,96%.

It should be noted that a third alternative exists, namely to buy a 5 year bond with a redemption value of R1 000 000. However, this would require an initial outlay of R1 072 500 in the case of the Cape Town stock, as opposed to the R581 285 for the immunised strategy. It is hard to imagine a situation in which the benefit of the absolute certainty of the R1 000 000 on maturity would outweigh the considerably greater initial outlay. In any

case, to ignore interest on interest is nonsensical, and, hence, this approach is not considered further.

A comparison of the differential transaction cost between these two strategies is important. The total cost of the immunisation strategy, including all purchases and sales over the 5-year period, amounts to approximately R6 000 at current JSE commission rates on gilt transactions. The cost of the simple reinvestment strategy is approximately R1 000. At a time when interest rates are volatile, it could well be worthwhile paying the extra transaction costs in order to achieve the security provided by immunisation. On the other hand, at a time when interest rates are stable, and can be expected to remain stable, these extra costs might not be warranted.

Table 6: Strategy of non-immunised portfolio. 31 December 1977 – 31 December 1982. Issue: Cape Town 12,4% 31/12/82

Date	Total market value of portfolio R	YTM	Price R	Coupon income from bonds bought on 31/12/77 R	Number of new bonds bought with coupon income	Cumulative total number of new bonds bought with coupons	Interest on interest R	Number of bonds bought with interest on interest	Total number of bonds held
31/12/77	599 486	10,50%	107,25	–	–	–	–	–	5 590
30/6/78	629 758	10,55%	106,45	34 658	326	326	–	–	5 916
31/12/78	698 891	8,80%	111,93	34 658	310	630	2 021	18	6 244
30/6/79	752 274	7,65%	114,31	34 658	303	933	3 906	34	6 581
31/12/79	791 328	7,10%	114,09	34 658	304	1 237	5 785	51	6 936
30/6/80	812 260	7,12%	111,01	34 658	312	1 549	7 669	69	7 317
31/12/80	802 511	10,35%	103,63	34 658	334	1 883	9 604	93	7 744
30/6/81	817 863	12,65%	99,63	34 658	348	2 231	11 675	117	8 209
31/12/81	853 166	14,60%	98,02	34 658	354	2 585	13 832	141	8 704
30/6/82	901 548	17,15%	97,75	34 658	355	2 940	16 027	164	9 223
31/12/82	975 186	–	100,00	34 658	–	2 940	18 228	–	9 223

On 31 December 1982, 9 223 bonds are redeemed, yielding R922 300, and coupon income of R52 886 is received, totalling R975 186.
Total compound return: 9,96%.

Uses of immunisation

Immunisation has been used overseas, and particularly in America, for three major purposes. Firstly, it has been used by insurance companies that manage corporate pension funds. By using this technique, insurance companies have been able to guarantee to corporate pension funds, a minimum return over specific periods. This has helped insurance companies attract the business of managing pension funds.

Secondly, it has been used by financial institutions to minimise the present outlay required to meet fixed cash obligations in the future. If a financial institution has a commitment to pay a substantial sum in, say, three years time, and does not want to rely on meeting it out of current income at the time, immunisation offers the cheapest way of assuring that such a sum is available when required.

Thirdly, immunisation lends a degree of stability to a bond portfolio in times of turbulent interest rates. Although few managers would wish or need to immunise their entire portfolios, this strategy can be applied to a part of the portfolio in order to achieve predictable returns for a portion of the portfolio. Moreover, this can be done without locking funds up in fixed term deposits.

Conclusion

The uses to which immunisation is put overseas are relevant in South Africa.

In South Africa, insurance companies do manage corporate pension funds, and this is a growing area of activity with insurers competing for such business. The possibility of a guaranteed level of return may appeal to some corporate pension fund managers.

Although South Africa has seen several years of relatively abundant cash flows, the same situation may not continue in the future. Under more stringent conditions, financial institutions may not wish to rely on uncertain future cash flows to meet future commitments, and may employ immunisation to minimise the present cost of meeting these commitments.

As the gilts market grows and develops in South Africa, it will facilitate the implementation of this technique, and immunisation may come to be used as widely in South Africa as it has been overseas.

University of Cape Town, Graduate School of Business. February 1984.

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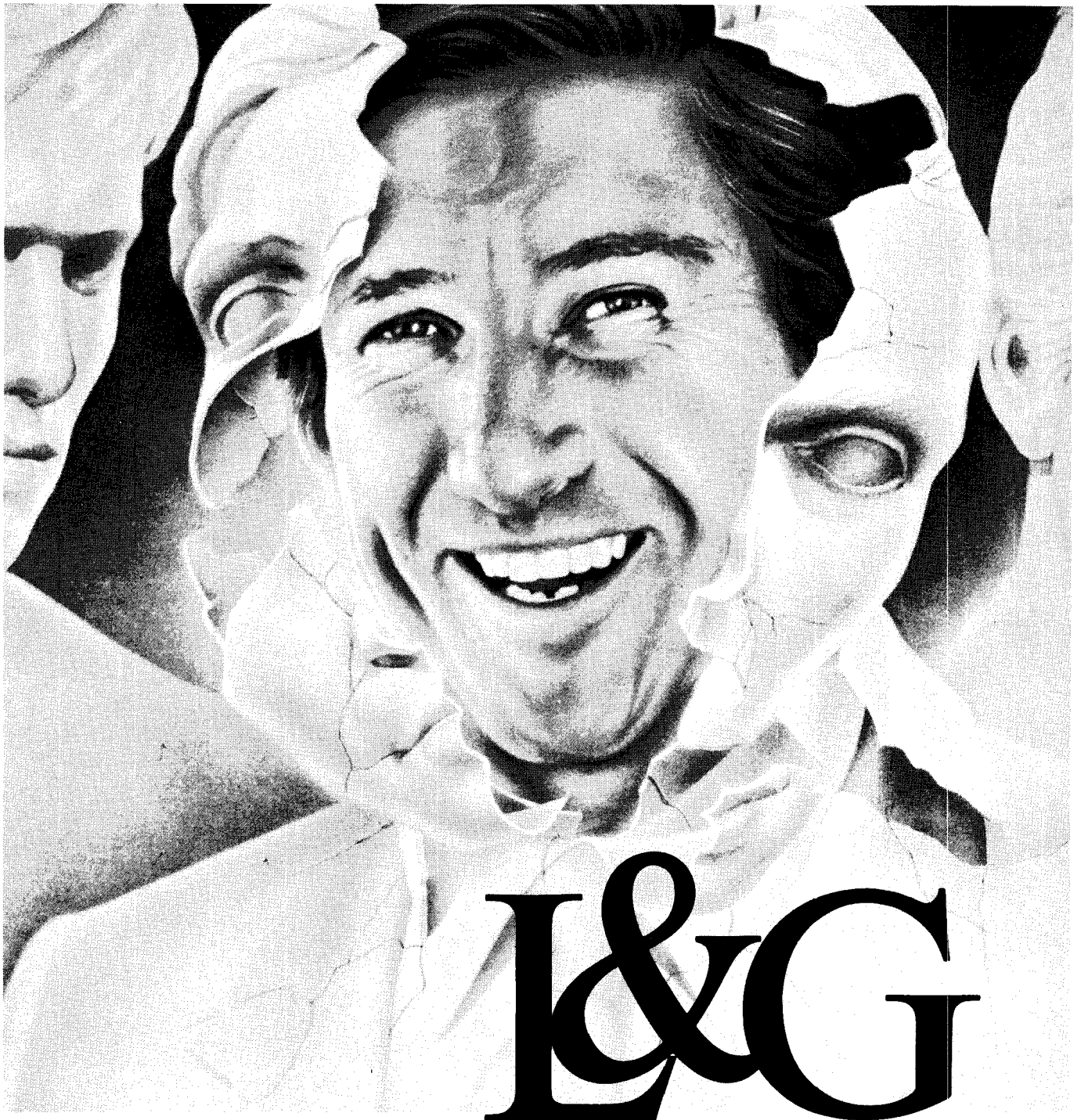

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B. P. Gilbertson

Investment basics XV

The role of share risk measurements in the management of investment portfolios

Introduction

Modern finance theory has provided new tools to assist portfolio managers in their investment decisions. The purpose of this article is to show how these tools might be used in the practical situation to quantify:

(a) the prospects of any particular portfolio;

(b) the trade-off between expected return and risk that has to be made when the composition of the portfolio is determined or changed.

These applications are illustrated using shares listed on The Johannesburg Stock Exchange.

Theory

Investment analysts and portfolio managers are concerned with the probable future performance of their investments. Since the future cannot be known with certainty, the possible future returns must be expressed in probabilistic terms. Following Markowitz (1, 2), it is now widely accepted that:

- the *expected return* on any given investment is the expected value of the probability distribution of possible outcomes, and
- the investment *risk* is the probability that a particular investment will yield less than the expected value.

Provided that the distributions of possible future returns are approximately Gaussian, it follows that investment risk can be identified with the standard deviation of the distribution of returns. (This parameter is usually denoted by the symbol σ.)

This *total investment risk* of a particular share may be split into two components, namely the *systematic risk* and the *unsystematic risk.* The former is closely related to the beta factor which specifies how a share responds to general market movements. Specifically, for share j:

$$(Systematic\ risk)_j = \beta_j.\sigma_m \qquad (1)$$

where β_j = "beta coefficient" of share j

σ_m = standard deviation of the distribution of returns on the overall market.

If over a given period the market generates an actual return of 10%, one would *expect* a share with a beta greater than one to achieve an even greater return – say 13% – and vice versa. This *expected* return can be precisely quantified via the Capital Asset Pricing Model. (See equation 5 below.)

In practice, however, share prices do not behave exactly in accordance with the beta factor; hence one would not be too suprised if, in the above example, the actual share return over the period was not 13% but 15% or 10% or perhaps even negative. This residual variation is independent of the overall market behaviour and arises from factors unique to the company in question, such as labour difficulties, the introduction of a new product, a change in the management structure and so on. This component of investment risk is called the *unsystematic risk.*

Consider now what happens when individual shares are combined into a portfolio. The expected return on the portfolio is then equal to the weighted average of the expected returns of the component securities, thus:

$$E(R_p) = \sum_i x_i.E(R_i) \qquad (2)$$

where E = expectations operator

R_p = return on the portfolio

x_i = proportion of portfolio invested in security i and

R_i = return associated with security i.

The beta coefficient of the portfolio is also determined quite simply as the weighted average of the component beta's, thus:

$$\beta_p = \sum_j x_j.\beta_j \qquad (3)$$

The *total risk* of such a portfolio is somewhat more complicated; while the prices of some shares in the portfolio will be rising, others might be falling; such "opposing movements" can materially reduce the standard deviation of the portfolio returns. (This is hardly new to professional portfolio managers who have long been aware of the benefits of diversification.) The variance of the portfolio's rate of return is then given by the expression:

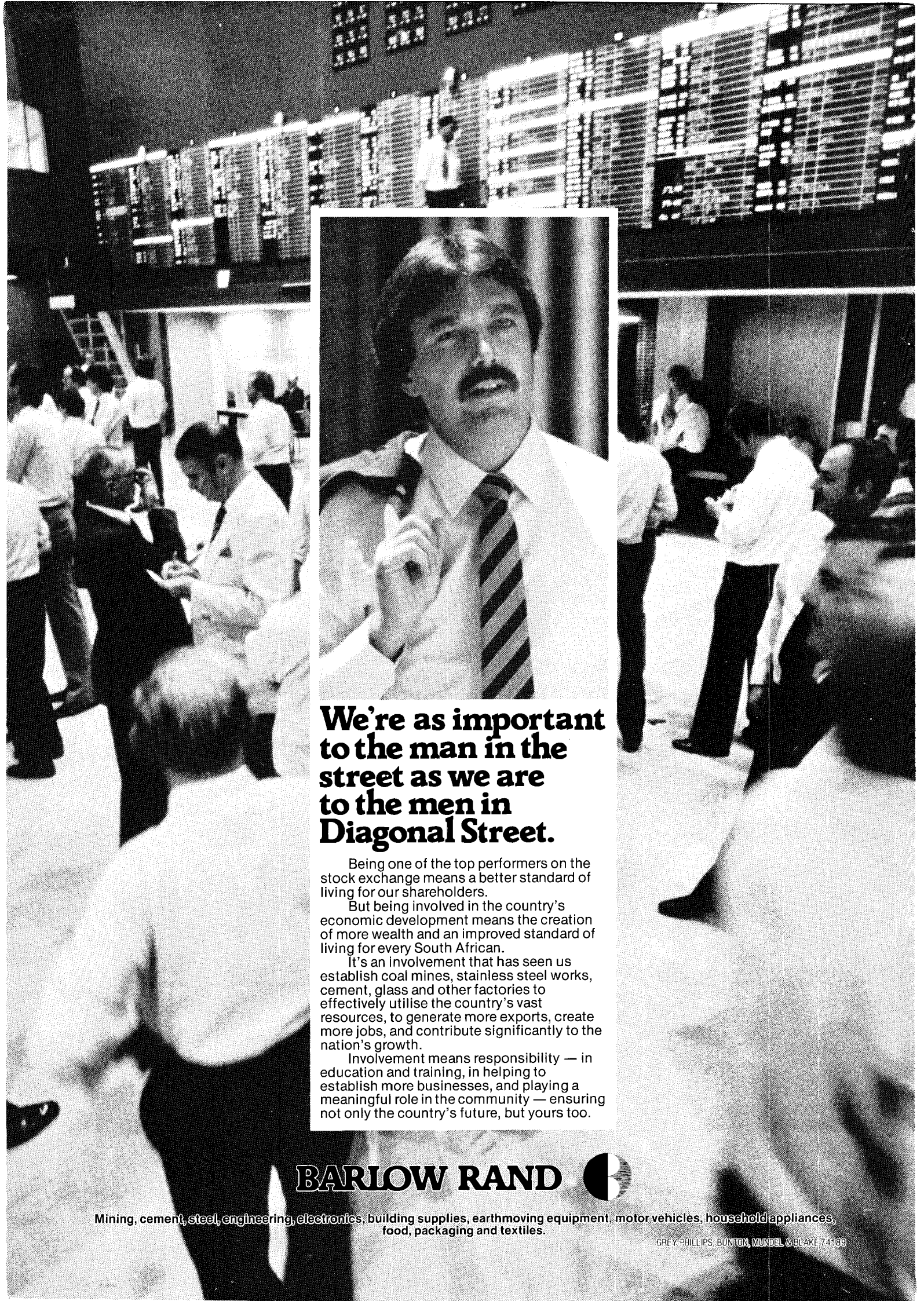
$$\sigma^2 P = \sum_i \sum_j x_i.x_j.\rho ij.\sigma_i.\sigma_j \qquad (4)$$

where ρij = correlation coefficient between the returns of securities i and j and

σ_i = standard deviation of the distribution of returns of security i.

The *total risk* of the portfolio – ie the standard deviation of the portfolio returns – is then simply the square root of the variance σ_p^2. Equation (4) shows that this risk depends on the interrelationship between the security returns via the correlation coefficient ρ_{ij}. Of course, this total risk can still be decomposed into *systematic* (market related) and *unsystematic* components.

Unsystematic risk can be virtually eliminated by holding a well-diversified portfolio and modern investment theory holds that investors should therefore not *expect* to earn additional returns for bearing such risk. Hence only the *systematic* component of investment risk is taken into account in the pricing of capital assets. This



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principle is formalised in the well-known Capital Asset Pricing Model ("CAPM") which states that:

$$E(R_j) = R_F + \beta_j \left[E(R_m) - R_F\right] \quad (5)$$

Where $E(R_j)$ = Expected return on any share j
R_F = Return on a "risk-free" asset
$E(R_m)$ = Expected return on the "overall market"
β_j = "Beta coefficient" of the share j.

With some manipulation it is possible to re-write equation (5) in the form:

$$E(R_j/R_m) = R_F + \beta_j\left[R_m - R_F\right] \quad (6)$$

where $E(R_j/R_m)$ = the expected return on the share j conditional upon an actual market return R_m having been realised.

This expression allows the return actually realised on a security to be compared with the return that might have been expected given a particular return on the market.

We have now stated all of the relationships needed by portfolio managers to quantify the prospects of their portfolios. (A more extensive discussion with examples drawn from the JSE is given in reference 3.) In order to utilise these relationships, one needs only the risk-estimates for the individual shares; these are available from professional share risk measurement services for virtually every stock market in the world.

An illustrative example

We shall now illustrate the above concepts by means of simple examples. To do so we shall utilise the share risk measurements summarised in table 1 below; these parameters were taken from a 1979 issue of the *Risk-inform* service of the Graduate School of Business Administration of the University of the Witwatersrand. The shares were deliberately chosen to emphasise differences between two theoretical portfolios.

Table 1: Summary of share risk parameters and other data. (Measured against RDM-100 index)

Share	Code	Total Risk (% p.a.)	Specific Risk (% p.a.)	Beta	Price in cents on 790105	Price in cents on 790629
Placor	PLT	54,2	52,2	1,14	60	65
Utico	UTI	44,3	41,2	1,44	105	130
Amrel	AMR	44,5	36,4	1,97	160	260
Chloride	CLO	16,0	14,1	0,52	380	500
ICS	ICS	26,2	18,9	1,48	255	212
Asseng	ASE	19,7	17,1	0,65	345	270
RDM-100		12,50			274,7	309,1

Consider the properties of a portfolio *(portfolio 1)* comprised of an equal investment in each of the first three shares. The following parameters may be estimated for *portfolio 1*:

By equation (3)

$$\text{Portfolio } \beta_{P1} = (\tfrac{1}{3} \times 1{,}14) + (\tfrac{1}{3} \times 1{,}44) + (\tfrac{1}{3} \times 1{,}97) = 1{,}52 \quad (7)$$

If the choice of shares is not restricted excessively to a limited number of market sectors (ie if we are considering generally well diversified portfolios) then the correlation coefficients between the "residual share returns" (ie the return remaining after removal of the *systematic* component) will generally be low. If we assume these coefficients to equal zero, then equation 4 reduces to:

$$\sigma^2(\rho) = \sum_1 x_i^2.\sigma_i^2. \quad (8)$$

Hence for *portfolio 1* we can write:

$$(\textit{Unsystematic risk})_{P1} = \left[\left(\frac{52{,}2}{3}\right)^2 + \left(\frac{41{,}2}{3}\right)^2 + \left(\frac{36{,}4}{3}\right)^2\right]^{1/2} = 25{,}3\% \text{ p.a.} \quad (9)$$

By equation (1) and (7) we have:

$$(\textit{Systematic risk})_{P1} = \beta_{P1} \times \sigma_m = 1{,}52 \times 12{,}5 = 19{,}0\% \text{ p.a.}$$

It follows now that the total risk of *portfolio 1* is equal to the sum of the *systematic* and *unsystematic* components, thus:

$$(\textit{Total risk})_{P1} = \left[(25{,}3)^2 + (19{,}0)^2\right]^{1/2} = 31{,}6\% \text{ p.a.} \quad (10)$$

A perfectly diversified portfolio would have no remaining *unsystematic risk*, ie all of the risk associated with the portfolio would be *systematic.* Hence we may estimate the degree of diversification of the portfolio as the ratio of the *systematic risk* to the *total risk,* thus:

$$\text{Degree of diversification} = (19{,}0)^2/(31{,}6)^2 = 36\%. \quad (11)$$

Since *unsystematic risk* contributes 100%−36%=64% of the *total risk,* the portfolio is not very well diversified. (This is of course to be expected from a portfolio containing only 3 shares.) Whether such poor diversification is "good" or "bad" depends entirely on how well the portfolio manager is able to pick "underpriced" securities. If his record is not good or he believes the market to be efficient, then he should seek to increase the degree of diversification (probably to well above 95%).

His past performance may be instructive in making such decisions. Over the previous 6-month period he has in fact achieved the following capital gain:

Performance of *portfolio 1* (12)

$$1 = \left[\tfrac{1}{3} \times \left(\frac{65}{60} - 1\right)\right] + \left[\tfrac{1}{3} \times \left(\frac{130}{105} - 1\right)\right] + \left[\tfrac{1}{3} \times \left(\frac{260}{160} - 1\right)\right]$$

$$= 31{,}5\%$$

Over the same period, the market has achieved the following gain:

$$\text{Performance of Index} = (309{,}1)/(274{,}7) - 1 = 12{,}5\% \quad (13)$$

We know from equation 6 that, given the market return of

(13), one would have expected from *portfolio 1* the following return:

$$\text{Benchmark return for } \textit{portfolio 1} = \frac{11\%^*}{2} + 1{,}52 \times \left[12{,}5\% - \frac{11\%^*}{2}\right]$$

$$= 16\% \qquad (14)$$

Thus the return of nearly 32% actually realised by *portfolio 1* is greatly in excess of the 16% that was expected. This would indicate that the portfolio manager might be good at picking securities and hence that his chosen degree of (low) diversification is justified. (Efficient market theorists would contend conversely that he had been lucky and shouldn't expect to achieve the same superior performance in the future.)

Provided that the portfolio manager can quantify his expectations about the likely performance of the market over the next one-year period, he will also be able to specify the *expected* return on *portfolio 1* via the CAPM of equation 5. Assume that he expects the market to rise by 20% overall. Then:

Expected return on *portfolio 1*
over next year = 11%+1,52 (20%−11%)
= 24,7%.

However, although he may *expect* this performance, he cannot be sure of achieving it. Therefore he will want to quantify the likelihood of not achieving this return, ie his "downside potential". Given that the portfolio returns have an approximately Gaussian distribution, there is a probability of nearly 16%† (ie about one chance in six) that the realised returns will be lower by one standard deviation than the expected value. Hence the portfolio manager should expect that in about 1 year out of 6 his portfolio:

- will "underperform" the expected value by the *total risk* parameter and further, with the same frequency,
- will "underperform" the market by the value of the *unsystematic risk* parameter.

Hence we may write the following estimates:

Total downside potential = 31,6% p.a.
Potential below index = 25,3% p.a.

(Similar computations may be made for the "upside potential". When computational precision is required it is preferable to promote Gaussian distributions by working with continuously compounded returns when estimating the share risk statistics.)

Share risk measurements thus allow the portfolio manager to estimate via simple calculations the probable performance of his portfolio, as well as the likelihood of him underperforming or overperforming his target. Such quantification is of assistance when risk-return trade-offs have to be made between alternative portfolio compositions. To illustrate this further, consider an alternative investment set, *portfolio 2*, which is comprised of investments in the last 3 shares of table 1 in the proportions ¼ to ½ to ¼ respectively. Table 2 below compares the various parameters for *portfolio 1* and *2.*

Table 2: Comparison of alternative portfolios

Parameter	Portfolio 1	Portfolio 2
Beta coefficient	1,52	1,03
Unsystematic risk	25,3% p.a.	10,9% p.a.
Systematic risk	19,0% p.a.	12,9% p.a.
Total risk	31,6% p.a.	16,9% p.a.
Degree of diversification	36%	58%
Past performance	31,5%	−6%
Benchmark return	16,1%	12,7%
Expected return next year	24,7%	20,3%
Total downside potential	31,6%	16,9%
Potential below index	25,3%	12,9%

The choice facing the portfolio manager has been clearly quantified: He can choose *portfolio 1* with an expected return that is a full 4,4% p.a. greater than that of *portfolio 2.* However, in so-doing his downside potential will be greatly increased, in fact, virtually doubled. His choice will depend on his attitude to risk, i.e. on how he makes the risk-return trade-off. Share risk measurements do not provide guidelines in this regard – they merely enable the decision to be made on a quantitative basis.

Conclusions

This note has outlined a simple methodology for quantifying portfolio alternatives in a risk-return framework. Examples drawn from JSE-listed shares were used to illustrate the technique. The final investment decision by the portfolio manager must ultimately depend on his personal attitude to risk, but the likely consequences of his decision can now be expressed in quite specific terms.

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* In this equation we have used the yield on the debentures of AAA-rated companies as a measure of the risk-free rate. Division by a factor of 2 allows for the fact that we are considering a 6-month period only.

† Actually 15,8%; see any set of tables of the standardised Gaussian distribution.