INFLATION, ASSET STRUCTURE AND THE DISCREPANCY BETWEEN ACCOUNTING AND TRUE RETURN

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ABSTRACT

This thesis studies the effect of inflation on the difference between the rate of profit reported in a firm's accounts and the true profitability of the firm. It specifically investigates how the type of assets employed by a firm affects this discrepancy.

The researcher constructed theoretical firms consisting of projects with the same internal rate of return. He then calculated the firm's accounting rate of return and compared it to its true return.

The analysis established there is a discrepancy between the accounting rate of return and the true rate of return. The discrepancy exists for accounting returns calculated on either the book value or the true value of the firm. The difference depends upon the type of assets employed by the firm.

The model further shows that inflation influences a firm's price-earnings ratio. The model predicts a decline in price-earnings ratios with increasing inflation (for all but the all non-depreciable asset firm). It further predicts that the price-earnings ratios of firms will vary under inflation depending on the type of assets they employ. The empirical part of the thesis investigates these two relationships.

The study investigated price-earnings ratios and inflation rates in the UK between 1965 and 1986. It found that inflation had a statistically significant effect on price-earnings ratios. This relationship does not seem to exist in South Africa between 1969 and 1986. This could be the result of sporadic political developments in South Africa over this period.

The researcher constructed theoretical price-earnings ratios for 218 industrial firms quoted on the Johannesburg Stock Exchange. The theoretical ratios account for the asset structure of the firms. The research did not find a statistically significant relationship between the theoretical ratios and the actual price-earnings ratios of the firms. The market seems to be inefficient. It fails to reflect the effect of asset structure in the pricing of industrial shares.

DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

J U DE VILLIERS

29th day of June, 1988.

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PREFACE

The basic idea of this thesis came to me in 1978. This happened in the Management Accounting class of Prof W.D. Hamman when I was an MBA student at the Graduate School of Business of the University of Stellenbosch.

In Management Accounting we were introduced to the inflation accounting models based on the Hicksian concept of maximum consumption while retaining "welloffness". The models required the evaluation of welloffness at the beginning and end of the accounting period to determine profitability. In capital budgeting profitability was determined using discounted cash flow methods. These methods follow a project to its conclusion and therefore do not require the evaluation of end states. I thought that one could use the discounted cash flow concept of profitability to analyse the effect of inflation on accounting returns and cash flows. In doing so one would overcome the problems of end state evaluation posed by the current inflation accounting models.

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From my undergraduate studies in chemical engineering I was familiar with techniques used in the design of distillation columns. Although I did not really have the opportunity to explore the idea, the inflation problem and the distillation problem appeared to me to be very similar. The outputs from one of the plates in a distillation column forms the input to the next plate. Similarly, the final balances at the end of an accounting period constitutes the opening balances of the next period. The composition of the fluid and gas mixtures at a distillation plate is determined by the characteristics of the distillation mixture and a mass balance over the total distillation column. It appeared to me as if parameters describing a firm's activities and accounting balances would be related in a similar way. I expected that these relationships would be determined by the firm's characteristics, its underlying profitability and the cash flow balance and other balances over the accounting period. Given these similarities, I thought one could adapt the techniques used in the design of distillation columns to analyse the effect of inflation on accounting and true profitability.

Only after joining the staff in the Department of Business Economics at the University of the Witwatersrand in 1985 did I have time to pursue this idea seriously. It was only a vague idea and I did experience difficulties in selling this as a thesis topic. I received encouragement from my former colleague Dr Hugh High. He was the first person that expressed the opinion that the idea had merit and he was prepared to supervise the research. At a later stage I also received encouragement from my colleague Michael Cohen. Without the support of these two colleagues I do not think I would have undertaken the research. I can only hope that

the final product does justice to the confidence they expressed in the merits of the topic.

While undertaking the research I received assistance from many people. My thesis supervisor, Prof W.D. Reekie, spent much time reviewing earlier drafts of the thesis. These drafts were always returned very promptly with his comments. In this he must, from what I gather about the experience of other students, be a rare exception.

Many of my colleagues helped me to learn how to use my personal computer. My thanks to Michael Cohen, Donald Graham, Michael Polonsky, Don Scott, Roy Snaddon, David Solomon and Frank Vorhies in this regard. I also required assistance in managing data files and running programmes on the Wits mainframe. For this I have to thank Michael Cohen as well as Mrs I. Turton and Miss W. Kihn of the Wits Computer Center. Michael Polonsky helped me to use the SAS package on the Wits mainframe.

I also want to thank the personnel of the Bureau of Financial Analysis who assisted me in accessing their data base. My thanks to the director, Prof A.P. Zevenbergen and Mr le Roux and Miss Botes from his staff.

I received a bursary from the Institute for Research Development of the Human Sciences Research Council and hereby acknowledge its financial assistance towards this research. Opinions expressed in the thesis and the con-

clusions arrived at are my own and are not necessarily to be attributed to the Institute for Research Development or the Human Sciences Research Council.

An article that covers part of the literature review presented in chapter 2 of the thesis and the development of the theory presented in chapter 3 has been accepted for publication in the Journal of Business Finance and Accounting. The article is entitled "Inflation, Asset Structure and the Discrepancy between Accounting and True Return" and will be published in 1989.

In conclusion I would like to thank my wife Maureen for her support and understanding during the study.

CHAPTER 1

INTRODUCTION

1.1 RESEARCH OBJECTIVE

The objective of the research of this thesis is to study the effect of inflation on the difference between the rate of profit reported in a firm's accounts and the true profitability of that firm. More specifically, the research aims to investigate how the type of assets employed by the firm affects this discrepancy.

Contrary to what this may at first glance suggest, the study is not about inflation accounting. In all the analyses of this thesis it will be assumed that accounts are drawn to historical cost conventions. The purpose of this study is therefore not to try to modify accounting procedures but to determine how well the profit figure in the conventional accounts of firms approximates the true profitability of the firm or how it could be used as an indication of this true return.

This immediately raises the question what the true return really is. Had it been possible to calculate this true return this would have been done and it would not have made sense to calculate anything else or waste time looking at accounting returns that may or may not equal to the true return. It is shown from the literature reviewed in this thesis that the internal rate of return (IRR) of a project (when the cash flows of the project is such that it yields a single internal rate of return) is accepted as an unambiguous definition of true return. This is only defined for projects and cannot be measured for an on-going firm.

Although the true yield of a real firm can therefore not be measured, it is possible to construct a theoretical firm that consists of projects of known IRR. The accounting rate of return (ARR) of this theoretical firm can then be calculated and compared to the known IRR. This will be the basic method employed in this thesis to study the discrepancy between ARR and IRR. By determining the extent of the discrepancy for firms employing different types of assets the thesis shows that the discrepancy is influenced by asset structure.

1.2 RESEARCH FOCUS

The research of this thesis can be grouped into three parts. These are a literature review, the development of the theory and empirical analyses. Each will be discussed in turn below.

1.2.1 Literature review

The literature review of this thesis has two goals.

The first is to demonstrate that the basic method to be employed in the theoretical sections of this thesis is well established in the financial literature. The review shows that it is generally accepted that a firm's true yield is the IRR of its projects It also confirms the validity of the procedure used in this thesis to determine the discrepancy between IRR and ARR.

The second goal of the literature review is to show that previous studies have not investigated the effect that asset structure has on the discrepancy between IRR and ARR under inflation. This will be the topic of the theoretical investigations of this thesis.

1.2.2 Theoretical

The theoretical investigations form the most important part of the thesis. The goal of the theoretical analyses is to determine the effect of inflation and asset structure on the discrepancy between ARR and IRR.

The basic method to be employed in the study is as follows: A theoretical firm is constructed consisting entirely of a number of parallel projects. These projects all have the same IRR. By summing the discounted annual cash flows of a project the project characteristics that will yield that IRR are determined. With the project characteristics known, the characteristics of the firm can be determined by summing across the current projects of the firm. From the firm's characteristics its ARR can be determined and compared to its IRR.

The discrepancy between ARR and IRR is first determined assuming that the theoretical firm does not experience real growth and pays no tax. The basic pattern of the discrepancy is established. The analyses are then repeated for firms that experience real growth and do pay tax to determine how this changes the pattern of the discrepancy between ARR and IRR.

1.2.3 Empirical

The empirical part of the thesis investigates two aspects of the effect of inflation on price-earnings ratios.

The first is the effect of inflation on the general level of price-earnings ratios. This is a question that has received some attention in the literature. From casual observation it has appeared to previous workers in the field that price-earnings ratios are negatively influenced by inflation. Being unable to explain this, they have ascribed the effect to the market suffering from an inflation induced illusion. If the theory developed in this thesis is applied to this problem a negative relationship between inflation and price earnings ratios is predicted. In the empirical section statistical tests are done on the time series of price-across the current projects of the firm. From the firm's characteristics its ARR can be determined and compared to its IRR.

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The second topic investigated in the empirical section of the thesis is the effect of inflation and asset structure on inter-firm price-earnings differences. The theory developed in this thesis predicts that price-earnings will vary according to the type of assets employed by a firm. In this section the price-earnings ratios of 218 industrial firms listed on the Johannesburg Stock Exchange are studied over a period of ten years to determine whether the market does exhibit this relationship.

1.3 CONTRIBUTION OF THE RESEARCH

The contribution of the present research to the field of study can be summarised into three main points:

- The research provides a better understanding of the relationship between a firm's true profitability and its rate of profit determined from conventional accounts. It therefore presents an improved method of evaluating accounting earnings under inflation.

- The research presents an alternative method of evaluating inflation accounting procedures. Their present evaluation is based on Hick's definition of income, which is the maximum that can be consumed by a person over a period without impairing his "welloffness" as it existed at the beginning of the period. The present research is not based on this definition of <u>income</u>, but focuses on <u>profitability</u>. The <u>method</u> developed in this thesis can then be used to determine whether profit figures produced by inflation accounting methods provide good estimates of a firm's true profitability.

- The research provides an explanation for the negative correlation between inflation and price-earnings ratios. This had been observed but could not be explained by previous workers.

1.4 THESIS LAYOUT

The thesis is presented in seven chapters.

Chapter 1 of the thesis (this chapter) contains the introduction to the study. This is followed in chapter 2 by a literature review discussing previous studies into the discrepancy between ARR and IRR.

The theoretical part of the thesis is presented in chapters 3 and 4. The chapters discuss the development of a theory to determine the influence of asset structure on the discrepancy between ARR and IRR under inflation. In chapter 3 the theory is developed for a firm that pays no tax and experiences no real growth. This theory is expanded in chapter 4 to allow for the effect of tax and real growth.

Chapters 5 and 6 present the empirical part of the thesis. Chapter 5 studies the *effect of inflation on* the general level of price-earnings ratios. In chapter 6 the effect of asset structure on inter-firm price-earnings differences is investigated.

The conclusions of the thesis and recommendations for further study are presented in chapter 7.

CHAPTER 2

LITERATURE REVIEW: THE DISCREPANCY BETWEEN THE ACCOUNTING AND THE TRUE RATES OF RETURN

2.1 *INTRODUCTION*

This chapter describes the literature on the discrepancy between the accounting rate of return and the true rate of return of firms as it has developed over two decades. Over this period numerous studies have been undertaken to determine whether: "...the answer obtained by using the accountant's measure of the rate of profit correspond with what is known ... to be the right answer ..."(Harcourt,1965,p.66).

In this chapter the contribution of these studies will be discussed. In section 2.2 the accounting rate of return and the true rate of return will be defined. The methods used to determine the discrepancy between these two rates of return will be outlined in section 2.3. The assumptions and results of studies undertaken to establish the extent of this discrepancy are discussed in section 2.4. This is followed in section 2.5 by a discussion of studies to determine the influence of inflation on this discrepancy and in section 2.6 by a discussion of the extent to which the asset structure (that is, the ratios of current, depreciable and non-depreciable assets employed by the firm) has been taken into account when determining the discrepancy. Section 2.6 presents empirical tests done. The conclusions of the chapter are presented in section 2.7.

2.2 THE ACCOUNTING RATE OF RETURN AND THE TRUE RATE OF RETURN: DEFINITION

Before the accounting rate of return and the true rate of return could be compared it is necessary to explain what is understood by each of these terms. The way in which these have been defined in the literature is presented in this section.

2.2.1 Accounting rate of return (ARR)

Many variants exist for the accounting rate of return (ARR), also referred to as the "accountant's measure of the rate of profit" (Harcourt, 1965,p.69) or "book yield" (Solomon and Laya, 1967, p.153) but all of these are based on the ratio of the conventional book income to the net book value of assets (Solomon and Laya, 1967, p.152). There are therefore two aspects to be considered: the definition of accounting income and the definition of book value of assets. These will be discussed in turn below.

2.2.1.1 Accounting profit

The accounting profit of the firm depends upon the accounting convention followed. In the literature differences in accounting methods usually result from different depreciation methods employed. Differences are not only found between the methods used by different authors but more often than not the individual authors would allow for the use of more than one depreciation method.

Harcourt (1965,p.67) already accommodates more than one method in that he first assumes straight-line depreciation and then repeats his calculations for reducing-balance depreciation. Solomon and Laya (1967, p.169) calculate the effect of accelerated depreciation procedures, while Livingstone and Salamon (1970, p.203) employ only straight-line depreciation. Van Breda (1981, p.26) allows for various depreciation schedules and for both historical and current cost depreciation. Kay (1976, p.499) as well as Kay and Mayer (1986, p.200) allow for different time shapes of depreciation schedules.

The first real controversy in the literature about the choice of depreciation method is found in the Long and Ravenscraft (1984) comment on the Fisher and McGowan (1983) paper. Fisher and Mcgowan (1983, p.86) report results for straight-line, declining balance and sum-of-years' digits depreciation. Long and Ravenscraft note that the use of accelerated *depreciation creates exaggerated differences* between the accounting and economic rates of return. They believe that straight-line depreciation is used by approximately 80 percent of firms in the United States as against only 9 percent using sum-of-years' digits, and that the former would be the more appropriate method to use. (1984, p.497) Fisher (1984, p.510) replied that any depreciation schedule other than the particular method pointed out by Hotelling (1925) will result in a difference between accounting and economic return. This particular evaluation method is not practical, because it would sometimes require taking negative depreciation. In order to apply the Hotelling method of depreciation a firm needs to know its economic rate of return, which makes the calculation of the accounting rate of return pointless.

The selection of the accounting method influences the accounting profit and also the accounting rate of return. Discrepancies between the ARR and the true rate of return could therefore be eliminated or at least reduced by appropriate changes in the accounting conventions. Anthony (1986) argues this point and recommends that the accounting method be changed by charging annuity depreciation and recognising interest on capital as a cost. This would then, according to Anthony (*1986, p.244*) eliminate the discrepancy.

From this discussion it is evident that many variants of the ARR exist. The appropriate ARR depends upon the objectives of the research. If the researcher attempts to design an appropriate accounting method various variants of the ARR could be evaluated. If, on the other hand, a researcher attempts to interpret conventionally produced accounting data it would be appropriate to use the same accounting method in his definition of ARR. In any event it is important to realise that the accounting method should be stipulated for the ARR to be properly defined.

2.2.1.2 Book value of assets

All the variants of the accounting rate of return (ARR) are based on the ratio of the conventional book income to the net book value of assets. The second aspect to be considered is therefore the definition of the net value of book assets.

The book value of assets is influenced by the accounting method employed. Because the book value is usually taken to be the difference between the original cost and the accumulated depreciation of the asset, the method of depreciation is significant. It is therefore important for the accounting method to be stipulated for the ARR to be properly defined, not only because of its effect on the nominator of this ratio (as discussed in section 2.2.1.1) but also as a result of its influence on the denominator (the book value of assets).

There is another aspect influencing the book value of assets; whether beginning-of-year, end-of-year or yearly average assets should be considered.

When employing a continuous time (rather than a discrete time) analysis as Kay (1976) or *Kay and Mayer (1986)* do, the ARR (which Kay calls the "accountant's rate of profit" or "ARP") is defined at a point in time. The question of beginning-of-year or end-of-year assets does not become an issue. It is only when employing a discrete analysis or when interpreting the theoretical results of continuous analyses for discrete accounting data that this becomes a problem.

Harcourt (1965, p.69) uses "...the average of the opening and the closing book values of the assets in the business concerned", which procedure he claims to "...accord... with the accounting practice of averaging the opening and closing values of assets when calculating annual rates of profit." (Harcourt, 1965, p.70). On the other hand Solomon and Laya (1967, p.159), Livingstone and Salamon (1970, pp.203,205) and Van Breda (1981, p.26) all use beginning-of-year asset figures.

Fisher and McGowan (1983, pp.93-97) derive their theoretical results using a continuous time analysis but also report returns calculated on both beginning-of-year and end-of-year assets (Fisher and McGowan, 1983, pp.85-87,89). They also point out that some of the theoretical results obtained from the continuous analysis only hold for accounting rates of return calculated on beginning-of-year, and not end-of-year or yearly average assets (*Fisher and McGowan*, 1983, p.84). They believe that using accounting rates of return on end-of-

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Long and Ravenscraft (1984, p.494) criticise the use of beginning-of-year assets by Fisher and McGowan and argue that the use of end-of-year assets is the standard practice. Fisher and McGowan found that the results from their continuous time analyses held in discrete time for accounting profit rates defined on beginning-of-year assets. Long and Ravenscraft ascribe this to the fact that Fisher and McGowan define the internal rate of return and the growth rate in beginning-of-year terms. Long and Ravenscraft argue that the relationship would also have held for accounting profit rates defined with end-of-year assets if the growth rate and internal rate of return is defined in end-of-year terms. There is therefore no a priori reason to prefer beginning-of-year assets (Long and Ravenscraft, 1984, p.495).

Fisher (1984, pp.511-512) replied that the internal rate of return based on end-of-year assets would result in some serious anomalies if used in project evaluation and is undefined for assets whose payoff comes entirely in one year. This therefore "...no longer (has) the property that the usual internal rate of return does of being something in which the analysis is interested." (Fisner, 1984, p.512).

Whether beginning-of-year or end-of-year assets are to be used would again depend upon the objectives of the research. From Fisher's (1984) argument beginning-of-year assets would appear to be more sound. If the researcher however plans to evaluate or interpret specific accounting data it would be appropriate to use the same method as the one employed in compiling the data. In any event it is important to realise that the asset base should be stipulated for the ARR to be properly defined.

2.2.2 True rate of return (IRR)

This section presents the definition of true rate of return as encountered in the literature.

Solomon and Laya (1967, p.154) discuss the nature of the true rate of return in some detail and conclude:

> "This ... is known by many names. In the financial world where it is now unanimously used for the purpose of measuring bond yields, it is called 'the effective yield to maturity.' Economists have referred to it as 'marginal productivity of capital,' 'marginal efficiency of capital,' or 'internal rate of return.' In the industrial world where it has been used with increasing frequency as a measure of rate of return on single investment projects, it has been referred to as 'discounted cash flow rate of return,' 'investor's rate of return,' 'scientific rate of return,' 'compound interest rate of return,' and so on. We shall call it 'true yield.'
>
> "True yield is an old and well-known concept. It is defined as the discount rate which equates the present value of all cash inflows to the present value of investment outlays."

The definition of the true rate of return as being the internal rate of return (IRR) is well established in the literature and the latter will be used to denote true return in this text.

There are two problems associated with the use of IRR in analyses. The first of these is that IRR is not always uniquely defined. For a unique IRR, all the negative terms in the net revenue stream resulting from an investment should occur before the positive terms occur. Failing this, profitability cannot be accurately summarised by any rate of return (Fisher and McGowan, 1983, p.82).

The second problem associated with the use of IRR is that the IRR of a project can be determined but that the information to calculate the IRR of a firm is not available (Solomon and Laya, 1967, p.157). The methods to overcome this problem and compare the ARR and IRR of firms form the essence of this research and will be discussed in section 2.3.

2.3 METHOD TO DETERMINE THE DISCREPANCY BETWEEN ARR AND IRR

The IRR of a firm cannot be calculated and an observer depends upon the ARR of the firm as some readily observable approximation of the IRR. This leaves the observer with the problem of to what extent the observed ARR approximates the IRR.

Solomon and Laya (1967, p.158) explain this dilemma as follows:

> "We are somewhat in the position of Plato's man in a cave who can see the shadows on the ground outside, but who cannot directly see the objects which cast the shadows. Is the length of an observable shadow always a correct indication of the height of the actual object or are there systematic biases due to some other factors? Like Plato's man, we can see at least a partial answer by trying a controlled experiment. Send out a son or an animal of known height at the end of a string and observe its shadow under various conditions, and thereby get more understanding of how well or poorly the observable shadow measures the size of the human object under different circumstances."

Solomon and Laya (1967, p.158) then proceed to conduct a similar experiment by observing simulated models of firms with a known built-in IRR, and determining how the ARR of this theoretical firm would behave under different conditions. The other analyses reported in the literature proceed along similar lines, the major difference between them being the characteristics of the theoretical firms constructed.

The analyses have one important aspect in common, and that is that they are all based on stationary state or steady-state growth scenarios. (One exception being the simulation exercises of Livingstone and Salamon (1970), but then these are based on a constant reinvestment rate, to which the same criticism would apply.) Van Breda (1984, p.507) makes the very important observation that because these scenarios are rarely encountered in practice, the assumption of a stationary state or steady-state growth seriously limits the general validity of the conclusions from these analyses. This limitation has to be kept in mind when considering the results of the analyses, which are presented in section 2.4.

2.4 THE DISCREPANCY BETWEEN ARR AND IRR

Various investigations of the kind outlined in section 2.3 have been undertaken. In this section the results of these studies are presented and some published comments on the significance of these analyses discussed.

Harcourt (1965) studies a theoretical firm consisting of a number of machines of known IRR. He considers firms with "a balanced stock of identical machines" (stationary state) as well as firms whose "gross investment in machines ... grows at a constant rate per year." (steady-state growth) (Harcourt, 1965, p.67). He also considers firms employing machines with four different time patterns of quasi-rents; constant over the life of the machine, steadily increasing, steadily decreasing, and steadily increasing and then decreasing (Harcourt, 1965, p.86).

Harcourt (1965, p 77) finds the ARR to be influenced by irrelevant factors such as the pattern of machine quasi-rents, method of depreciation, growth in the stock of capital and by what assets are included in the stock of capital. No rules to allow for the adjustment of these factors are suggested from his analysis.

In a similar analysis, Solomon and Laya (1967) find that the ARR of firms is not comparable to the IRR of the projects underlying the theoretical firm. A precise basis for making adjustments to the ARR to equate this with IRR does not arise from their analysis, although it provides the method to test the appropriateness of proposed adjustments (Solomon and Laya, 1967, p.179).

Livingstone and Salamon (1970, p.201) review the literature on the difference between ARR and IRR and find a general agreement that ARR is not an accurate measure of IRR, and that the error in ARR is neither constant nor consistent. Livingstone and Salamon also conduct a number of simulation exercises in which they vary the pattern of cash flows generated by projects, the length of projects, the proportion of annual cash flows reinvested, and the IRR for firms <u>not</u> in steady-state growth. In all the examples they have found that the ARR cycles symmetrically about a constant. The cycle dampens out over time as the firm approaches steady-state growth (Livingstone and Salamon, 1970, p.206).

Stauffer (in his 1971 thesis, published in 1980) studies the relationship between ARR and IRR, and finds that a discrepancy will exist unless the firm charges what Stauffer calls "exact depreciation" (Stauffer, 1980, p.II-13). This is a depreciation rate that is equal to the rate at which the value of the machine changes (where the value of the machine at any point equals the present value of the remaining cash flows associated with the machine). This depreciation function was shown by Samuelson (1964) to be the only form for which the present value of the stream of quasi-rents is invariant of the tax rate. The correct depreciation schedule therefore depends upon the cash flow profile, and an exact match between these two will only be encountered in very special instances. Stauffer (1980, p.II-14) concludes that it would be purely fortuitous for the ARR and IRR to be identical in actual cases.

Stauffer then proceeds to identify some special structural characteristics that could influence the extent of the discrepancy between ARR and IRR. He discusses the theoretical effect of working capital (which he calls "non-depreciable capital", p.III-3), time lags and investment in quasi-capital outlays such as research and development expenditure, exploration costs and advertising. From this he selects examples of firms and industries to illustrate the identified biases. For these "illustrative atrocities" (Stauffer, 1980, p.V-1) he estimates the IRR using methods he develops, and compares this to the ARR.

Stauffer (1980, p.V-9) does find large differences between the ARR and IRR within his sample but ascribes this to some of the special structural characteristics of the firms and industries in his sample. He concludes that there is little reason to expect significant discrepancies between ARR and IRR for most firms. He nevertheless warns that each case has to be analysed individually, and that a high ARR not be interpreted as an indication of a degree of excessive market power or imperfect market structure. This could at least partly be the result of ARR being an inaccurate approximation of IRR (Stauffer, 1980, p.V-11).

More recently Fisher and McGowan (1983, p.82) argue that ARR, even when properly measured, provide almost no information about IRR. In their analysis, Fisher and Mcgowan emphasise the effect of an uncertain time shape of investment benefits, which they call the "Q-profile" (Fisher and McGowan, 1983, p.85). The use of ARR as a proxy for IRR to draw conclusions about industry concentration or monopoly profits can therefore be totally misleading (Fisher and McGowan, 1983, p.91).

Kay (1976, p.459) explores the relationship between ARR and IRR and concludes that distortions in one year will in due course be offset by opposite distortions. A simple average ARR will therefore be a good estimator of IRR (Kay, 1976, p.448). Methods to estimate the IRR from accounting data are developed and the author concludes that the ARR is likely to overstate rather than understate the IRR (Kay, 1976, p.495).

Wright (1978) commented on the article by Kay (1976) and remarked that it could lead the reader to underestimate the difficulty of applying these results to actual accounting data. Wright (1978, p.466) points out that although the nature of double-entry book-keeping ensures that profits cannot be misstated in the long run, it does not correct for distortions in book value. Profitability (profit divided by book assets) can be understated or overstated for an indefinitely long period. Wright (1978, p.467) also states that for the average ARR to be an acceptable indicator of IRR as Kay (1976, p.495) alleges, it may be necessary to calculate this over a period approaching the life of the project.

In his reply Kay (1978, p.469) states that there is no disagreement between himself and Wright (1978) over the relationship between ARR and IRR, but while he emphasises the possibility of exploiting the relationship Wright emphasises the difficulties that it presents. Kay (1978, p.470) concludes that although care is needed when using accounting data in economics, the task is not hopeless.

Kay and Mayer (1986) pursue the idea of changing the method of compiling accounting data so as to provide the returns required for economic analysis. To accomplish this accounts should be drawn up using replacement rather than historic cost conventions, should employ current cost accounting and should include holding period gains (Kay and Mayer, 1986, p.206). Anthony (1986, p.244) is of similar opinion and concludes that reconciliation between ARR and IRR is possible if accountants charge annuity depreciation and recognise interest on both debt and equity capital as a cost.

Various comments on the article by Fisher and McGowan (1983) were published in the June 1984 issue of the American

Economic Review. The authors were criticised for assuming that "... the economic rate of return is the only measure of the profit rate for the purposes of economic analysis." (Fisher and McGowan, 1983, p.82). The Lerner index (which can be approximated by the ratio of profits to sales) is preferred as a profit measure by Martin (1984, p.501) and Long and Ravenscraft (1984, p.495).

Further criticism comes from Horowitz (1984) who is of the opinion that economists are forced to rely upon accounting information despite its imperfections and that these, like all data imperfections, do not rule out its use in analysing monopoly profits. Long and Ravenscraft (1984, p.499) comment upon the usefulness of accounting information as is evidenced by the vast resources spent in the private sector analysing it. Had accounting data been valueless as Fisher and McGowan (1983) suggest, it would imply substantial market failure.

Van Breda (1984, p.507) stresses the importance of the time shape of benefits and states that if this is known it is possible to construct graphs linking the ARR and IRR. The analysis is only possible under a stationary state or steady-state growth, which limits the general validity of the results.

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In his reply Fisher (1984, p.516) indicates that he considers the Lerner index to be useful only insofar as it yields information about the IRR. (Whether the Lerner index actually has this property he considers to be an open question.) Fisher therefore maintains that the IRR is the true measure a d that the point at issue is how well other indicators approximate it.

Fisher (1984, p.514) also rejects the argument that accounting returns must be of value considering the large amounts sp nt gathering it, *saying that the criticism in his and* McGowan's article was direct inst the use of ARR in economic analyses and not against the use of accounting profit figures for other purposes.

There seems to be a general agreement in the literature that a discrepancy exists between ARR and IRR. There is disagreement over the extent of the discrepancy and the consequences that this holds for the use of ARR in economic analyses. The first school of thought, represented b Harcourt (1965), Solomon and Laya (1967), Livingstone and Salamon (1970), Wright (1978), Fisher and McGowan (1983) and Fisher (1984) considers the difference to be of such a serious nature that it precludes the use of ARR as an indication of IRR. Another school, represented by Horowitz (1984) and Long and Ravenscraft (1984) suggests that differences represent data imperfections which must be accommodated like all other data imperfections and which does not rule out the use of ARR in economic analysis. Finally, there is a group, represented by Stauffer (1980), Kay (1976), Kay and Mayer (1978) and Van Breda (1984) that tries to reconcile the differences, either through changing accounting methods or by developing a method to link accounting returns and IRR

2.5 THE EFFECT OF INFLATION ON THE DISCREPANCY BETWEEN ARR AND IRR

The effect of inflation on the discrepancy between ARR and IRR has been studied by Solomon and Laya (1967, p.175). They show that inflation causes an escalation [illegible] to the inflation rate) in the investment outlays [illegible] project underlying the firm. In addition, the [illegible] in inf [illegible] stream rises at the inflation rate. By [illegible] simulation Solomon and Laya (1967, p.177) show th [illegible] the inflation rate causes an increase in ARR (IRR [illegible] eld constant). This effect is found to be more marked [illegible] ng projects than for short projects.

Kay (1976, p.495) studies the relationship between conventional straight-line depreciation and economic depreciation and finds that depreciation is conventionally overstated in the early years of a project and understated in later years. Inflation increases this difference. A rise in the inflation rate will initially cause depreciation to be overstated and profits to be understated. Over time, the discrepancy in the reported inflation rate will fall and a new steady-state will be reached where the profit rate is systematically overestimated (Kay, 1976, p.460).

The most specific study of the effect of inflation on the discrepancy between ARR and IRR has been undertaken by Van Breda (1981). Van Breda (1981, p.18) finds that inflation biases all accounting rates upwards. He then discusses the effect of depreciation based on current cost or market value. Straight-line depreciation based on the replacement cost would remove the inflation-induced portion of the discrepancy, and would provide a return figure comparable to the IRR (Van Breda, 1981, p.19). The entire problem of biases can be resolved if the market price of assets is used in the calculations and the depreciation taken as the change in market value over the period (Van Breda, 1981, p.20). This is, as the author points out, probably infeasible because so few physical assets are traded.

An alternative to adjusting accounting rates is to understand their behaviour. Van Breda (1981, p.22) studies the effect of inflation on the discrepancy between ARR and IRR. The existence of inflation does not change the sign of the discrepancy. The general result that ARR will be larger than IRR for firms growing at a rate smaller than their IRR, that ARR will equal IRR for firms growing at a rate equal to their IRR and that ARR will be smaller than IRR for firms growing at a rate larger than their IRR, still holds for all inflation rates (as well as all accounting methods and all project lives). Inflation increases the extent of this discrepancy (as does an increase in project life).

Kay and Mayer (1986) study changes to accounting methods that could eliminate the discrepancy between ARR and IRR. To accomplish this accounts should be drawn up using replacement rather than historic cost conventions, should employ current cost accounting and should include holding period gains (Kay and Mayer, 1986, p.206). If accounts are drawn up in this way, inflation does not produce any new difficulties and the ARR will equal the IRR (Kay and Mayer, 1986, p.207).

There seems to be an agreement in the literature that inflation increases the extent to which the ARR, based on historical cost conventions, overstate the IRR of the firm. This effect is more marked for long-term than short-term projects. The discrepancy can be removed if accounts are compiled using replacement rather than historic cost conventions, employ current cost accounting and include holding period gains (Solomon and Laya, 1967, Kay, 1976, Van Breda, 1981 and Kay and Mayer, 1986).

2.6 THE EFFECT OF ASSET STRUCTURE ON THE DISCREPANCY BETWEEN ARR AND IRR

With the exception of the study by Stauffer (1980), all the invertigations on the discrepancy between ARR and IRR were based on the assumption that the firms consisted of depreciable assets only .

Harcourt (1965. p.67) assumes that the machines used by the theoretical firm are all "one-hoss shays" which are depreciated either by the straight-line or reducing balance method. For their simulation exercise Solomon and Laya (1967, p.158) assume that "all investment outlays are made in one payment and consist entirely of purchases of fixed assets with no scrap values".

Similarly, Livingstone and Salamon (1970, p.203) assume that all cash outlays by the firm relate to specific investment projects and that these projects all have a zero salvage value. Kay (1976, p.499) assumes that "all expenditures are written off sooner or later". Fisher and McGowan (1983, p.91) assume that the value of the project eventually becomes zero and that all assets are therefore depreciable. Kay and Mayer (1986, p.200) set the value of projects at time infinity equal to zero, implying zero scrap value.

Stauffer (1980, p.III-3) does consider the effect of working capital on the discrepancy between ARR and IRR. He refers to this as "non-depreciable capital" and perceives this as being an additional amount of capital tied up in inventories, accounts receivables and trade investments. This amount stays constant over the life of the project and is recovered when the project is terminated.

Stauffer (1980, p.III-10) concludes that the effect of the inclusion of working capital in the project assets would, in most instances, reduce the discrepancy between ARR and IRR.

Stauffer's assumption that working capital remains constant over the life of a project is important because the model fails to incorporate the effect of having to finance increases in working capital resulting from increases in and consist entirely of purchases of fixed assets with no scrap values".

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Stauffer's assumption that working capital remains constant over the life of a project is important because the model fails to incorporate the effect of having to finance increases in working capital resulting from increases in turnover or the effects of inflation. This is an important factor to be considered when studying the interaction between inflation and asset structure in their impact on the discrepancy between ARR and IRR (see chapter 3).

With the exception of Stauffer (1980), who takes the effect of working capital into account, all the authors assume that their theoretical firms consist of depreciable assets only. Stauffer does not study the effect of inflation on the discrepancy between ARR and IRR. The effect of the interaction between inflation and asset structure in their impact on the discrepancy between ARR and IRR is therefore not investigated in the literature.

2.7 EMPIRICAL

The publications referred to report the results of theoretical studies and the empirical testing of theories is not reported. This could be attributed to the fact that the IRR of a firm is not visible (Solomon and Laya, 1967, p.157). It is therefore not possible to test directly whether ARR deviate from IRR in the manner predicted by the theory because IRR cannot be determined easily.

Two instances are reported where researchers estimated the IRR of firms or industries and compared this to ARR. Kay (1976, p.453) did so for the manufacturing industry in the UK over the period 1960 to 1969. He estimates this to have been 17,12 percent as against an undiscounted average ARR of 17,11 percent. Wright (1978, p.465) comments that this estimate of IRR "seems to imply a remarkable degree of precision", but points out that the calculations depend critically on accepting the accounting value of the capital stock at the beginning and end of the period. (Kay did show this in his article as well.)

Stauffer (1930) studied nine firms or industries in the US and estimated their IRR. The firms and industries were specifically selected to illustrate each of the sources of bias that he has identified. His results are summarised below (Stauffer, 1980, p.V-9):

Automotive industry	ARR 17%	IRR 11%
Business equipment	ARR 9%	IRR 11%
Electric utilities	ARR 7%	IRR 7%
Frasch Sulphur	ARR 25%	IRR 25%
Gillette	ARR 35%	IRR 21%
Liquor (Hiram Walker)	ARR 12%	IRR 10%
Non-ferrous metals	ARR 17%	IRR 13%
Pharmaceuticals	ARR 31%	IRR 18%
Polaroid	ARR 22%	IRR 24%

The IRR figures are estimates that depend upon Stauffer's theoretical analysis and the differences between ARR and IRR could therefore not be viewed as support for the theory. It nevertheless illustrates the extent of the theoretical discrepancy between ARR and IRR.

The discussion above shows that although illustrative figures have been produced in the literature to show the theoretical extent of the discrepancy between ARR and IRR, no empirical testing of the theories have appeared in the literature cited.

2.8 CONCLUSIONS

The main conclusions to be drawn from the discussion of the literature presented in this chapter are:

(i) The practice to equate IRR to the true return of a firm is well accepted in the literature.

(ii) The accepted method to determine the theoretical discrepancy between ARR and IRR is to construct a theoretical firm consisting of a number of parallel projects of known IRR, calculate the ARR of this theoretical project and compare the ARR with the known IRR.

(iii) There is a general agreement in the literature that a discrepancy exists between ARR and IRR, but authors disagree over the extent and significance of the discrepancy.

(iv) Inflation increases the extent of the discrepancy between ARR and IRR.

(v) The effect of the interaction between inflation and asset structure in their impact on the discrepancy between ARR and IRR is not investigated in the literature.

(vi) No empirical studies to test the theoretical relationships are described in the literature cited.

The aim of this thesis is to study the interaction between inflation and asset structure in their impact on the discrepancy between ARR and IRR. This aspect of the discrepancy between ARR and IRR has not been considered in the literature, as could be seen from the discussion above.

Using the well-established methods identified in this chapter, a theoretical firm of known IRR will be constructed to determine the theoretical influence of inflation and asset structure on ARR. The results of this investigation will be presented in chapter 3 of the thesis.

CHAPTER 3

THE INFLUENCE OF ASSET STRUCTURE ON THE DISCREPANCY BETWEEN ARR AND IRR UNDER INFLATION

3.1 *INTRODUCTION*

The aim of this chapter is to develop a theory to determine the influence of asset structure on the discrepancy between ARR and IRR under inflation. In the review presented in chapter 2 it was shown that this aspect of the discrepancy between ARR and IRR has not been considered in the literature.

In the development of the theory a method similar to those reported in the literature will be employed. A theoretical firm of known IRR will be constructed and the ARR of this firm compared to the known IRR. The theory will go beyond those reported in the literature in that this theoretical firm will employ current assets (debtors plus inventory minus creditors), depreciable fixed assets (plant and machinery) and non-depreciable fixed assets (land and the salvageable portion of depreciable assets). In contrast, the firms used in the literature employed depreciable assets only.

For the purposes of this study current assets are assumed to consist of debtors plus inventory minus creditors. This implies a zero cash balance. It would have made no difference to the analysis if the maintenance of a cash balance, constant in real terms had been assumed and this balance been included in the current assets.

Depreciated assets are assumed to be plant and machinery with a limited life, after which they become valueless. This implies a zero scrap value, and the salvageable portion of the depreciable assets should therefore be included in non-depreciable assets as this will not depreciate in the normal sense but will appreciate under inflation.

Non-depreciable assets are assets like land, which do not deteriorate in the normal course of events and are not depreciated. Buildings may eventually depreciate but because of their long life may in practice approach the nature of land.

In section 3.2 the assumptions of the theory will be discussed, while the development of the theory will be presented in section 3.3. The mathematical development of the model is presented in appendix 1, and only a description of the method that is followed is included in section 3.3.

In section 3.4 the results of calculations based on the relationships determined in section 3.3 are presented. This shows the extent to which asset structure influences the discrepancy between ARR and IRR under inflation.

The conclusions of this chapter are presented in section 3.5.

3.2 ASSUMPTIONS OF THE MODEL

In this section the assumptions of the model to determine the influence of asset structure on the discrepancy between ARR and IRR under inflation will be discussed.

The model is based on a theoretical firm consisting of a number of parallel projects, and is in this respect similar to the models used in the published analyses discussed in chapter 2. The most important extension of the present model is that the firm employs current assets, depreciable fixed assets and non-depreciable fixed assets. In the studies discussed in chapter 2 the authors assumed that their firms consisted of depreciable assets only.

The assumptions of the model are as follows:

- The theoretical firm consists of a number of parallel projects.

- Each of the projects of the firm has an internal rate of return of r.

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The assumptions of the model are as follows:

- The theoretical firm consists of a number of parallel projects.

- Each of the projects of the firm has an internal rate of return of r.

- An investment in depreciable and non-depreciable assets is made in year 0 of the project. No further investment in these assets is made over the life of the project.

- Current assets consist of debtors plus inventory minus creditors. (This implies a zero cash balance. It would have made no difference if the maintenance of a cash balance, constant in real terms, had been assumed.)

- An investment in current assets is made during year 0 of the project. Current assets are consumed during the project and have to be continually replaced. As a result of inflation the investment in current assets increases at the inflation rate which means that additional investments in current assets have to be made over the life of the project.

- The length of each project is determined by the life of the depreciable assets employed by the firm (d years). This is assumed to be the same for all the depreciable assets employed by the firm.

- At the termination of the project current and non-depreciable assets are converted into cash.

- Depreciable assets have a zero salvage value.

- Turnover, cost of sales and cash expenses stay constant in real terms from year 1 to year d of the project, consequently rising by (1+i) per year in monetary terms (where i equals the rate of inflation).

- The annual cash expenses incurred by the company include such amounts as are necessary to maintain the depreciable and non-depreciable fixed assets of the firm.

- The age of the current projects of the firm is assumed to be uniformly distributed.

- Steady-state is assumed, under which one project is wound up and another initiated annually.

- A zero real growth rate is assumed, and the projects are therefore all of the same size in real terms. Each project is (1+i) times larger in monetary terms than the project started a year earlier, where i equals the rate of inflation.

- Accounts are drawn up according to historical cost conventions. Inventory is valued on a first in first out basis. Depreciable assets are depreciated on a straight-line basis over their useful life and are shown at cost minus accumulated depreciation. Non-depreciable assets are shown at cost.

- The firm is fully equity financed. Profits are not accumulated in ` all excess cash is distributed to s

- The firm pays no income tax.

- A discrete time analysis is employed in which all trading takes place at the end of each year.

- All the calculations are done in monetary (as opposed to real) terms.

The assumptions of the model are of two types. Some of these are characteristics of the model and can therefore not be relaxed. Others are simplifying assumptions that could conceivably be relaxed although this will of course make the analysis more complex. Two of the simplifying assumptions will be relaxed in the next chapter. These are the assumptions of a zero real growth and tax rates. Other simplifying assumptions that will not be relaxed in this thesis but could be candidates for such treatment in later studies are the assumption of a rectangular profile of project activity, the firm being all equity financed and accounts being drawn to historical cost conventions. These will again be discussed under recommendations for further study presented in chapter 7.

For the moment the above assumptions are sufficient to calculate the conventional ARR. This can then be compared to the known IRR of the projects underlying the firm. In the development of the theory another variant of the ARR, the accounting profit as a percentage of the true value of the firm (rather than the book value as in the conventional ARR), will also be considered. The use of this ratio makes it possible to distinguish between the respective contributions to the discrepancy between ARR and IRR of an understatement (or overstatement) of profits and an understatement of asset values. The true value of the firm is calculated by discounting its future cash flows, and an assumption about an appropriate discount rate is therefore required. In this analysis the IRR will be used as the discount rate, which means that the firm is assumed to consist of projects with an IRR equal to its cost of capital. This assumes a marginal firm, one not making any excess profits.

An analysis similar to that used in the literature (chapter 2) will be employed to determine the discrepancy between ARR and IRR for the theoretical firm. The development of this theoretical model is discussed in the next section.

3.3 DEVELOPMENT OF THE MODEL

In this section the development of a model to determine the discrepancy between ARR and IRR is discussed. The model is based on the assumptions outlined in section 3.2 of the thesis. It differs from the models reported in the literature (chapter 2) in that it considers the effect of current and non-depreciable assets in addition to the effect of depreciable assets which is reported in the literature. The analysis also differs from reported studies in that it also considers the accounting profit as a percentage of the true value of a firm in addition to the conventional ARR based on book values.

The mathematical development of the model is presented in appendix 1, and this section describes the procedure that is followed.

3.3.1 Project cash flows

The theoretical firm consists of a number of parallel projects, and the first step in the development of the model is to determine the annual cash flow associated with an individual project. This is done for the year in which the project is initiated (year 0), the year in which the project is terminated (year d) and a representative year (year j) in between.

In year 0 no trading takes place and the only cash flows are the investments in current, depreciable and non-depreciable assets undertaken in that year.

In year j of the project no investment in depreciable or non-depreciable assets takes place and the cash flow is shown (appendix 1) to consist of the trading surplus (sales minus cash expenses minus inventory processed) minus an additional investment in current assets. Because of the known project trading pattern (a rectangular pattern is assumed in which the relevant variables remain constant in real terms for the duration of the project) it is possible to express the annual project trading surplus in terms of the project trading surplus in year 1 of the project, and the annual additional investment in currant assets in terms of the original investment in current assets.

In the last year of the project (year d), the wound-up value of current and non-depreciable assets has to be taken into account in addition to the trading cash flow. These can also be expressed in terms of the investment made in current and non-depreciable assets.

It is therefore possible to express the cash flows in all the years of a project in terms of the initial investment in current, depreciable and non-depreciable assets as well as the trading surplus in the first operating year of the project (plus, of course, the inflation rate and the length of projects). The expressions are summarised in table A.1.1 in appendix 1.

3.3.2 Trading surplus required

One of the assumptions of the model is that the individual projects all have a known IRR. The net present value of the annual cash flows (section 3.3.2), discounted at the IRR, therefore has to be equal to zero. By discounting and summing the individual annual cash flows, putting the sum equal to zero and solving for the trading surplus it is possible to derive an expression for the trading surplus.

It is therefore possible to describe all the characteristics of a project in terms of the initial investment in current, depreciable and non-depreciable assets, the length of project, the IRR and the inflation rate. These relationships are now used to determine the characteristics of the firm of which the project forms a part.

3.3.3 Accounting profit of the firm

The accounting profit of the firm is made up from the contributions of its individual projects. It is therefore necessary to determine the contributions of the individual projects and to sum across the firm's current projects to determine its accounting profit.

The accounting profit of an individual project is equal to sales minus cost of sales (inventory processed), cash expenses and depreciation. Because a zero real growth rate is assumed for the theoretical firm, all projects are of equal size in real terms. It is therefore possible to express the variables of any project in terms of the variables of an earlier or later project. To determine the accounting profit of the firm the contributions of the current projects are all expressed in terms of the variables of one project, and it is then possible to sum across the contributions of the individual projects to determine the accounting profit for the total firm.

This yields an expression for accounting profit in terms of the trading surplus achieved in the first year of operation of a particular project and the initial investment in depreciable assets required for that project. An expression for the trading surplus in terms of the initial investment required for the project has been derived in section 3.3.2, and it is therefore possible to express the accounting profit of the firm in terms of the initial investment in current, depreciable and non-depreciable assets (in this case for the project started a year earlier). Other variables in this expression are the duration of projects making up the firm, their IRR and the inflation rate.

To determine the conventional accounting rate of return the accounting profit is divided by the book value of assets. The procedure to determine the latter is discussed in the next section.

3.3.4 Book value of the firm

The book value of the firm is determined by a similar method as that used to calculate the accounting profit.

The book value of the firm is made up from the contributions of the individual projects. The latter are expressed in terms of the characteristics of one particular project (in this case, the project started in the year for which book value is calculated). It is then possible to sum across all the current projects of the firm to determine its book value. This yields an expression for book value in terms of the initial investment in current, depreciable and non-depreciable assets (in this case for the project started in the year for which assets are calculated). Other variables in this expression are the duration of the projects making up the firm and the inflation rate.

If the accounting rate of return (section 3.3.3) is divided by the book value (this section) it yields the conventional accounting rate of return which could be compared to the IRR of the projects. Because the ARR is the quotient of a profit figure and an asset figure, a discrepancy between IRR and ARR could result from deficiencies in either of these. To separate a possible prof deficiency from a possible asset deficiency, the true ue of the firm is also calculated. The ARR based on this asset figure (profit on true value or POV) will then reflect only the deficiency in the accounting profit figure and can be compared to the IRR to determine the extent of this deficiency. The calcu ion of the true value of the firm is discussed in the next section.

3.3.5 True value of the firm

The true value of a firm is the present value of its future cash flows. To determine the true value of the firm it is necessary to determine both the future cash flows and an appropriate discount rate.

The future cash flows of the theoretical firm can be calculated from the cash flows of its projects. Expressions for these have been derived in sections 3.3.1 and 3.3.2.

An appropriate discount rate has to be assumed and in this case the IRR of the projects making up the firm will be used. This means that the firm is assumed to consist of projects with an IRR equal to its cost of capital. It is a marginal firm, one not making any excess profits.

For the marginal firm the net present value of all projects is zero. (This is when considering the full project and taking all its cash flows into account.) As a result, future projects do not contribute to the firm's value, and its true value is simply the present value of the remaining cash flows of its current projects. (These remaining cash flows, being incomplete, need not necessarily have a zero present value.)

The method used consists of firstly determining the present value of the remaining cash flows of an individual project. The values of different projects are then expressed in terms of the characteristics of one particular project (in this case, the project started in the year for which firm value is calculated). It is then possible to sum across all the current projects of the firm to determine its value. This yields an expression for true value in terms of the initial investment in current, depreciable and non-depreciable assets (in this case for the project started in the year for which assets are calculated). Other variables in this expression are the duration of the projects making up the firm, their IRR and the inflation rate.

The profit and asset figures calculated above can then be combined to determine the ARR of the firm. The calculation of the ARR will be discussed in the next section.

3.3.6 The ARR of the firm

The conventional accounting rate of return (return on investment or ROI) of the firm is the quotient of the accounting profit and the book value of the firm. With both these figures known from sections 3.3.3 and 3.3.4 the ROI can be calculated. An issue still to be addressed is whether beginning-of-year or end-of-year assets are to be used in this calculation. The arguments for and against each of these as presented in the literature have been discussed in section 2.2.1.2. In the present analysis beginning-of-year assets will be used for the following reasons:

- Theoretical results obtained from continuous analysis hold for ARR based on beginning-of-year assets but not for ARR based on end-of-year or yearly average assets as Fisher and McGowan (1983, p.84) point out. It is therefore more correct to use beginning-of-year assets if the results are to be compared with theoretical results based on continuous analysis.

- The IRR as conventionally used is based on beginning-of-year assets (Fisher, 1984,p.511-512) and it is considered appropriate to use a similar definition for ARR if these are to be compared.

- Beginning-of-year assets seem to be used more frequently in the literature. It is used by Solomon and Laya (1970, p.159), Livingstone and Salamon (1970,pp.203,205), Van Breda (1981, p.26) and Fisher and McGowan (1983, p.85-87,89). (The latter also reports results based on end-of-year assets.)

The use of beginning-of-year assets, though theoretically sound, does present a problem in that it does not appear to be the standard accounting practice (Long and Ravenscraft, 1984, p.494). If theoretical results are to be compared with actual accounting data it is important to verify how the actual ARR has been calculated. If required, theoretical results can be converted to an alternative asset base. This does not present a problem since the assets at the beginning of the year can be determined from the assets at the end of the year (and vice versa) by allowing for the inflation rate and the real growth rate of the firm.

The *conventional* ARR (the return on investment or ROI) can then be calculated by *dividing* the accounting profit over a year by the asset value at the beginning of the year.

An alternative measure of accounting return, the profit on true value or POV is likewise calculated by dividing the accounting profit over a year by the true value at the beginning of the year.

3.3.7 Summary of *relationships*

The relationships determined by means of the method outlined above and discussed in more detail in appendix 1 are presented below.

The conventional accounting rate of return of the theoretical firm is given by:

$$ROI = \frac{E_{k+1}}{A_k}$$

An alternative measure of accounting rate of return for the theoretical marginal firm is given by:

$$POV = \frac{E_{k+1}}{}$$

V_k

where:

$$E_{k+1} = d.r.CA_{0,k}$$

$$+ \ d.DA^A_{0,k}\left(\frac{r - i}{1 - \left(\frac{1+i}{1+r}\right)^d} + \left(\frac{1+i}{d.i}\right)\left(1 - \left(\frac{1}{1+i}\right)^d\right)\right)$$

$$+ \ d.(r-i).NA^A_{0,k}$$

and:

$$A_k = dCA_{0,k}$$

$$+ \ DA^A_{0,k}\left(\left(\frac{1+i}{i}\right) - \left(\frac{1+i}{d.i^2}\right) + \frac{1}{d.i^2.(1+i)^{d-1}}\right)$$

$$+ \ NA^A_{0,k}\left(\frac{1+i}{i}\right).\left(1 - \left(\frac{1}{1+i}\right)^d\right)$$

and:

$$V_k = dCA_{0,k}$$

$$+ \ DA^A_{0,k}\left(\frac{d}{1 - \left(\frac{1+i}{1+r}\right)^d} - \frac{1+i}{r-i}\right)$$

$$+ \ dNA^A_{0,k}$$

and where:

A_k = book value of assets at the end of year k

$CA_{0,k}$ = initial investment in current assets for the project initiated in year k

d = duration (in years) of the projects making up the firm

$DA^{A}_{0,k}$ = initial investment in depreciable assets for the project initiated in year k

E_{k+1} = accounting profit in year (k+1)

i = inflation rate

$NA^{A}_{0.k}$ = initial investment in non-depreciable assets for the project initiated in year k

POV = accounting profit as a ratio (percentage) of true value

r = IRR of projects (and firm)

ROI = return on investment (conventional ARR)

V_k = true value of the firm

In the next section the relationships presented above will be investigated and their significance discussed.

3.4 DISCUSSION OF RESULTS

The aim of this section is to explore the relationship between IRR and ARR, and specifically how the pattern of the relationship is influenced by the firm's asset structure. For this purpose a computer program is employed to calculate the ARR under various conditions, and the results are presented in a three-cornered diagram on which asset structure can be depicted.

The "Basic" computer program used to generate the results presented in this section is included in appendix 2, together with a sample of the output from this program.

To use this program, the IRR (discount rate), inflation rate and project length have to be supplied. The program generates positive-value project asset structures in increments of 10 percent and uses the equations presented in section 3.3.7 to calculate the accounting profit, book value and true value for each of the structures. The program then calculates and prints the ROI, A/V (book value divided by true value) and POV for each of these structures.

An alternative method to generate the results presented in this section is shown in appendix 3. This consists of the numerical calculation of ROI, A/V, and POV for a firm with a specific asset structure, project duration, IRR and under a specific inflation rate.

The calculation follows the same lines as the mathematical derivation presented in section 3.3 and can therefore serve as both an aid to the understanding of the mathematical derivation and as a procedure to validate its results.

The example presented in appendix 3 was produced on a "Lotus" spread-sheet and it is therefore possible to repeat the calculation for different asset structures, IRR's and inflation rates. The procedure has been set up specifically for firms with four-year projects and has to be repeated for each asset structure. It is therefore not a very convenient method to use for this purpose, especially when firms with varying project lives are being considered.

To depict the results of the calculations a three-cornered diagram as in figure 3.1 is used. The proportion of the initial investment in current, depreciable and non-depreciable assets required by the projects making up the firm are shown on the three sides of the triangle. Each point within the triangle therefore represents a specific asset structure.

The distance that a point is away from the left side of the triangle represents the proportion of current assets, the distance from the right side the proportion of non-depreciable assets and the distance from the base of the triangle the proportion of depreciable assets. The point marked on

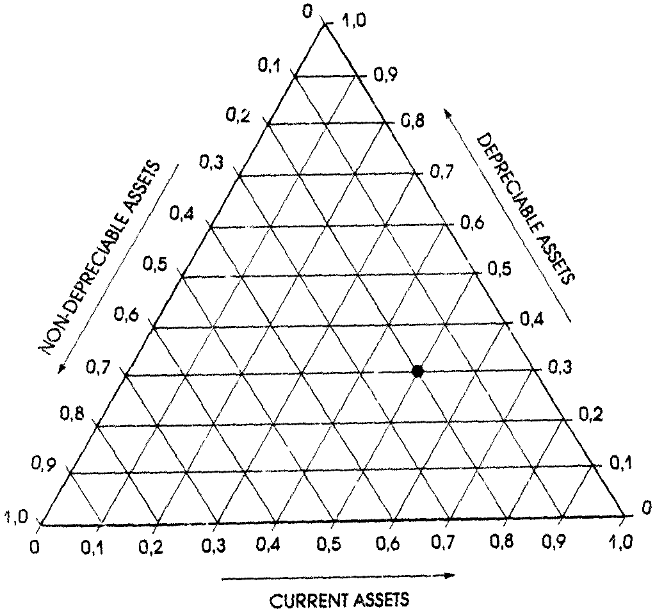

Figure 3.1 Asset structure diagram

the diagram therefore represents a project asset structure consisting of 50 percent current, 30 percent depreciable and 20 percent non-depreciable assets. The bottom left corner corresponds to a firm with nothing but non-depreciable assets, the bottom right corner to 100 percent current assets, and the top corner to 100 percent depreciable assets.

This diagram will be used to show the effect of asset structure on the ROI, A/V and POV below.

3.4.1 The conventional accounting rate of return (ROI)

The conventional ARR is the accounting profit expressed as a percentage of the book value of the firm (also called return on investment or ROI). This has been calculated for firms with varying asset structure, an IRR of 20 percent per year, operating under inflation of 10 percent per year and with a project duration of four years. The results are presented in figure 3.2.

Each point within the triangle in figure 3.2 represents a specific asset structure. Each firm has an IRR of 20 percent per year. The sloping lines on the diagram show the firms that have an IRR as indicated. For example, the ROI for the asset structure consisting of 50 percent current, 30 percent depreciable and 20 percent non-depreciable assets is between 18 and 19 percent per year.

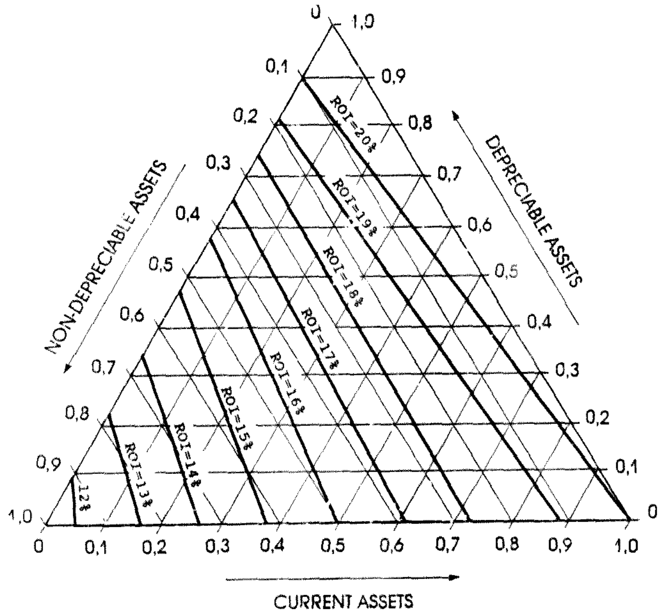

Figure 3.2 ROI of a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 4 years.

The actual ROI *for* this asset structure (18,53043 percent) can be read from appendix 3, *since* this is the point to which the numerical example presented in that appendix applies. The actual ROI for this and other points (increments of 10 percent) in the diagram can also be read from appendix 2, because the sample output presented in that appendix refers to the conditions of figure 3.2.

Figure 3.2 shows that ROI equals IRR only for an exceptional set of asset structures, and that ROI is therefore not a good indicator of IRR. *Figure* 3.2 further shows that the discrepancy between ROI and IRR is *influenced* by the asset structure of the firm. From figure 3.2 it would appear as if ROI equals IRR for a firm consisting of only current assets, that the (reported) ROI would be less than the (actual) IRR for firms consisting of non-depreciable assets and that the ROI would be greater than IRR for firms with depreciable assets.

This same pattern applies to figure 3.3, where the same data are presented but this time for firms with a project life of 10 years (as against four years in figure 3.2). *In figure* 3.3 there is also a set of asset structures (including the all current asset structure) for which ROI equals IRR. The IRR is now overstated to a greater extent for the all depreciable asset firm and understated to a lesser extent for the all non-depreciable asset firm.

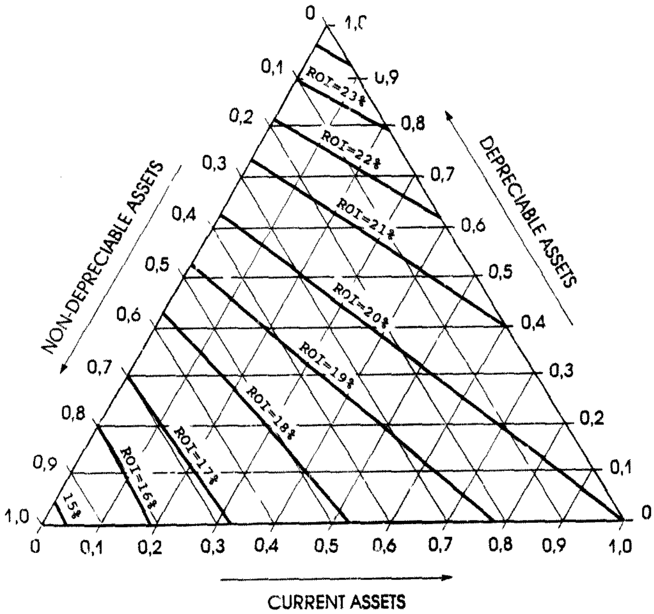

Figure 3.3 ROI of a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 10 years.

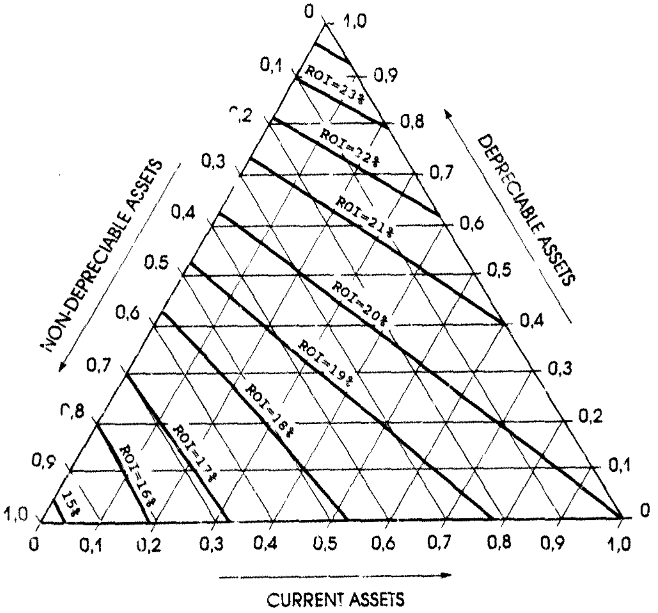

Figure 3.3 ROI of a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 10 years.

This pattern of the discrepancy between ROI and IRR does not apply in general, as can best be illustrated by referring to figure 3.4, where the ROI was determined for firms with a project life of 20 years (as against four years and 10 years in figures 3.2 and 3.3 respectively). Figure 3.4 again shows that ROI is not a good indicator for IRR. In fact, the discrepancy is even worse this time because ROI equals *IRR only for the firm* consisting of 100 percent current assets, where previously a set of asset structures existed where ROI equalled IRR. Furthermore, the pattern of the discrepancy has changed. *ROI is now greater than IRR* for all but the 100 percent current asset firm already referred to.

This changing pattern can be ascribed to the following: The ROI is the quotient of the accounting profit and the book value of the firm. Deficiencies in both the profit and the asset figures are at the same time observed through ROI, which makes the interpretation of the changing patterns difficult.

It is therefore necessary to isolate the effect of a deficiency in the profit figure from that of a deficiency in the asset value figure. This *will be done in the next* section.

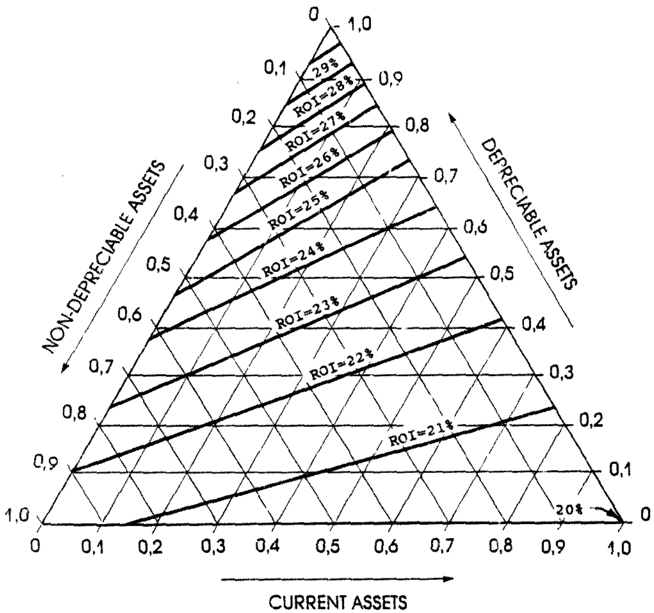

Figure 3.4 ROI of a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 20 years.

3.4.2 Book value as a percentage of true value (A/V)

To determine the extent of the deficiency in the asset value figure, the book value of the theoretical firm is compared to the true value of the firm in this section.

To calculate the true value of the firm its future cash flows have to be discounted at an appropriate rate. In this analysis, the IRR of the projects making up the firm is used. This assumes a marginal firm, one not making any excess profits. All the analyses referring to the true value of the firm (including the POV calculations in the next section) apply only to marginal firms (as against the ROI calculations in section 3.4.2 which apply to both marginal and non-marginal firms).

In figure 3.5 the book value of a firm is shown as a percentage of its true value. Figure 3.5 applies to a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of four years. (This is the conditions to which the output sample in appendix 2 applies while the numerical example in appendix 3 refers to one of the points in the diagram.)

Figure 3.5 shows that the book value of the firm consistently understates its true value (with the one exception of the 100 percent current asset firm). This understatement would be expected in accounts drawn to historical cost conventions, and the pattern of the understatement is fairly

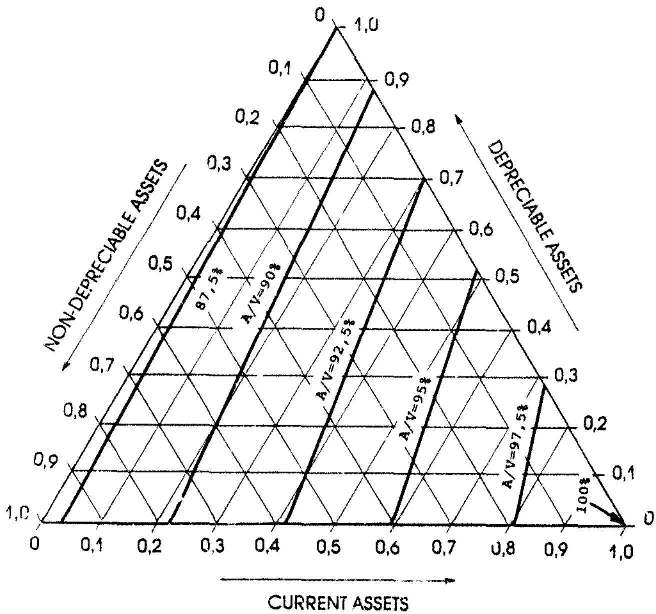

Figure 3.5 Book value as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 4 years.

consistent, as can be seen from figures 3.6 and 3.7, where the book value as a percentage of true value is presented for firms with project lives of 10 years and 20 years respectively. From a comparison of the three figures it is clear that the pattern of the value understatement remains the same but that the extent of the understatement increases with an increase in the project duration.

The results presented in this section have shown a consistent understatement of the asset figure in accounts drawn to historical cost conventions. The next section will focus on the deficiencies of the profit figure produced according to this convention.

3.4.3. The accounting rate of return based on the true value of the firm (POV)

In this section the accounting profit as a percentage of the true value of the firm will be calculated. By considering the POV rather than the conventional ROI (section 3.4.1) the effect of an understatement of asset value (section 3.4.2) is eliminated. A discrepancy between POV and IRR can therefore be ascribed to a deficiency in the accounting profit figure only.

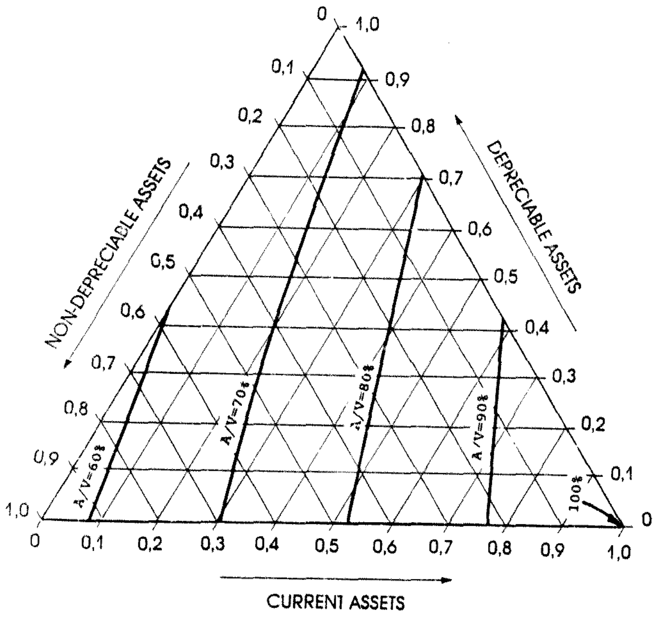

Figure 3.6 Book value as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 10 years.

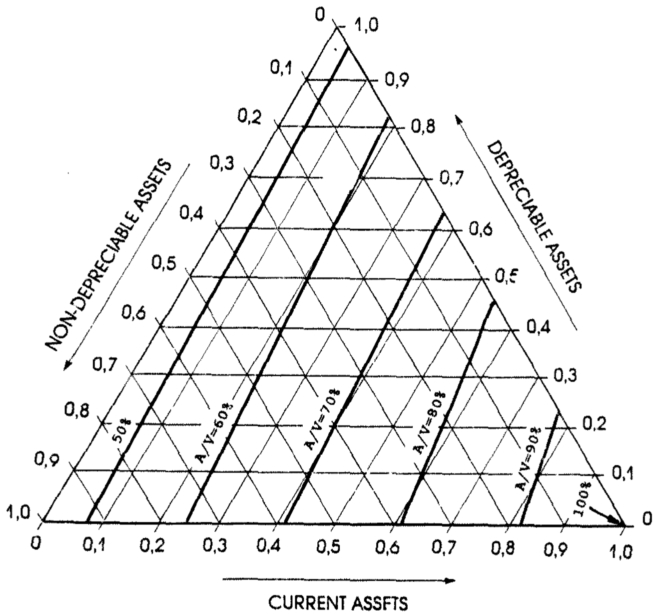

Figure 3.7 Book value as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 20 years.

In figure 3.8 the POV is presented for firms with varying asset structure, an IRR of 20 percent per year, operating under inflation of 10 percent per year and with a project duration of ten years.

Figure 3.8 shows that POV is also not a good indicator for IRR and that POV equals IRR only for the 100 percent current assets firm. It further shows that the discrepancy between POV and IRR is influenced by the asset structure of the firm.

Although POV is not a good indicator for IRR, a pattern in the discrepancy between POV and IRR does emerge from figure 3.8. For the 100 percent current asset firm (the bottom right corner of the diagram) POV equals IRR and for the 100 percent non-depreciable asset firm (the bottom left corner of the diagram) POV equals the difference between POV and the inflation rate. The POV of the 100 percent depreciable asset firm lies somewhere in between these two extremes (16,8 percent in figure 3.8).

This pattern holds for all project durations, internal rates of return and inflation rates. This will be illustrated in the sections below, where the effect of changes in the conditions on the discrepancy between POV and IRR are investigated.

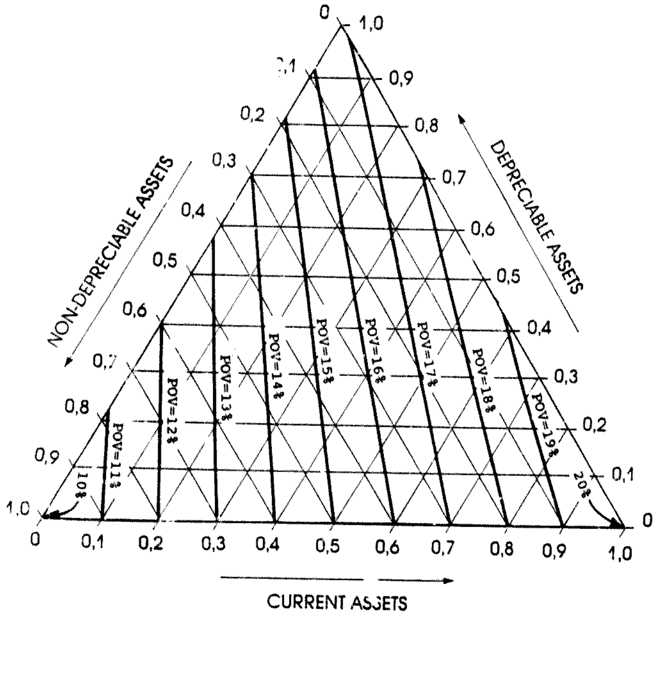

Figure 3.8 Accounting profit as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 10 years.

3.4.3.1 The effect of a change in the project duration on the discrepancy between POV and IRR

The effect of a change in the duration of projects making up the firm is illustrated in figures 3.9 and 3.10, where the POV is calculated for firms with asset lives of four years and twenty years respectively (for the rest conditions being the same as those in figure 3.8).

The pattern observed in figure 3.8 is also evident from figures 3.9 and 3.10. The POV of the 100 percent current asset firm equals the IRR, that of the 100 percent non-depreciable asset firm equals the difference between IRR and the inflation rate and that of the depreciable asset firm is somewhere in between.

A decrease in the project life (figure 3.9) increases the POV of depreciable assets, rotating the lines in the diagram to the left so that the depreciable assets become more like current assets. An increase in project life (figure 3.10) has the opposite effect so that depreciable assets become more like non-depreciable assets.

In the next section the effect of a change in the inflation rate will be investigated.

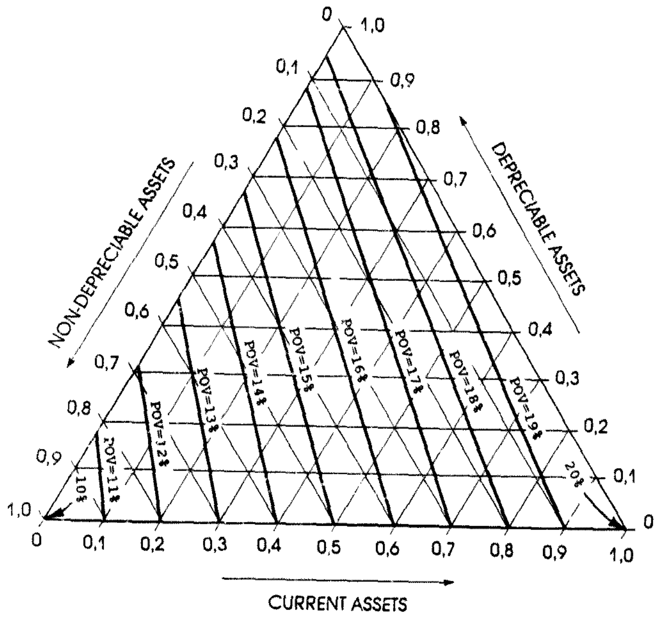

Figure 3.9 Accounting profit as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 4 years.

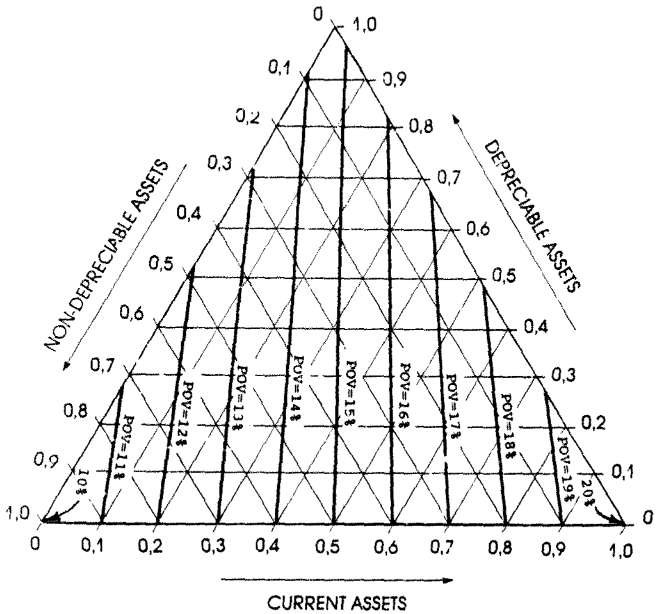

Figure 3.10 Accounting profit as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 10 percent per year and with a project life of 20 years.

3.4.3.2 The effect of a change in the inflation rate on the discrepa" between IRR and POV

The effect of a change in the inflation rate is illustrated in figures 3.11 and 3.12, where the POV is calculated for firms operating under inflation rates of 15 percent per year and 5 percent per year respectively (for the rest conditions being the same as those in figure 3.8).

The pattern observed in figure 3.8 is also evident from figures 3.11 and 3.12. The POV of the 100 percent current asset firm equals the IRR, that of the 100 percent non-depreciable asset firm equals the difference between IRR and the inflation rate and that of the depreciable asset firm is somewhere in between.

An increase in the inflation rate (figure 3.11) causes a compression and simultaneous shift to the right of the POV lines in the diagram so that the 100 percent current asset POV stays constant. This causes a decrease in the POV for all other asset structures (and a corresponding increase in the discrepancy between POV and IRR). A decrease in the inflation rate (figure 3.12) has the opposite effect and the POV lines expand towards the left of the diagram. This increase the POV, bringing it nearer to the IRR (20 percent per year) and decreasing the discrepancy between the two.

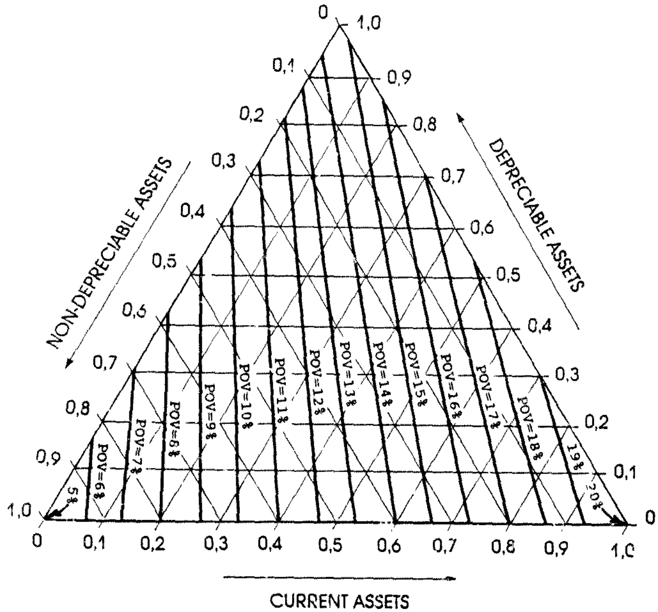

Figure 3.11 Accounting profit as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 15 percent per year and with a project life of 10 years.

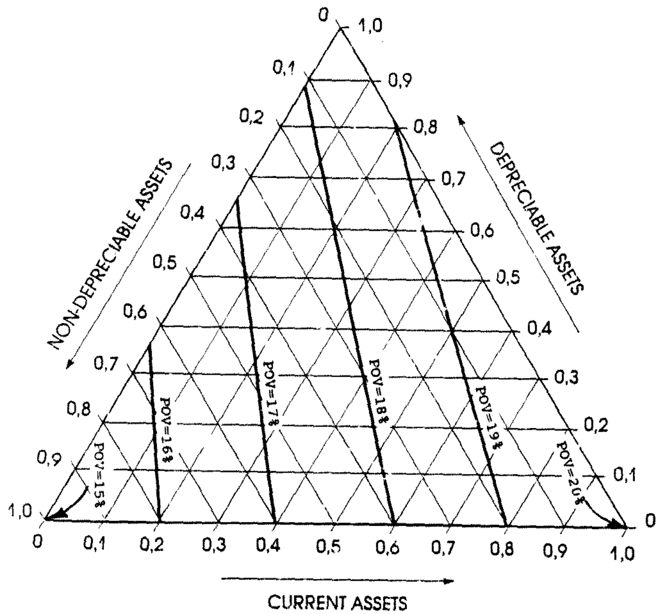

Figure 3.12 Accounting profit as a percentage of true value for a firm with an IRR of 20 percent per year under inflation of 5 percent per year and with a project life of 10 years.

Up to this point all the firms considered had an IRR of 20 percent per year. The effect of a change in the IRR will be discussed in the next section.

3.4.3.2 The effect of a change in the IRR on the discrepancy between IRR and POV

The effect of a change in the IRR is illustrated in figures 3.13 and 3.14, where the POV is calculated for firms with an IRR of 25 percent per year and an IRR of 15 percent per year respectively (for the rest conditions being the same as those in figure 3.8).

In figures 3.13 and 3.14 the pattern of POV observed throughout is also evident. The POV of the 100 percent current asset firm equals the IRR, that of the 100 percent non-depreciable asset firm equals the difference between IRR and the inflation rate and that of the depreciable asset firm is somewhere in between.

An increase in the IRR (figure 3.13) causes the POV lines to shift to the left, increasing the POV of all asset structures while keeping the discrepancy between POV and IRR more or less the same as previously (figure 3.8). A decrease in the IRR (figure 3.14) has the opposite effect, shifting the POV lines to the POV lines to the left of the diagram, decreasing the POV and keeping the discrepancy between POV and IRR more or less constant.

Up to this point all the firms considered had an IRR of 20 percent per year. The effect of a change in the IRR will be discussed in the next section.

3.4.3.2 The effect of a change in the IRR on the discrepancy between IRR and POV

The effect of a change in the IRR is illustrated in figures 3.13 and 3.14, where the POV is calculated for firms with an IRR of 25 percent per year and an IRR of 15 percent per year respectively (for the rest conditions being the same as those in figure 3.8).

In figures 3.13 and 3.14 the pattern of POV observed throughout is also evident. The POV of the 100 percent current asset firm equals the IRR, that of the 100 percent non-depreciable asset firm equals the difference between IRR and the inflation rate and that of the depreciable asset firm is somewhere in between.

An increase in the IRR (figure 3.13) causes the POV lines to shift to the left, increasing the POV of all sset structures while keeping the discrepancy between POV and IRR more or less the same as previously (figure 3.8). A decrease in the IRR (figure 3.14) has the opposite effect, shifting the POV lines to the POV lines to the left of the diagram, decreasing the POV and keeping the discrepancy between POV and IRR more or less constant.

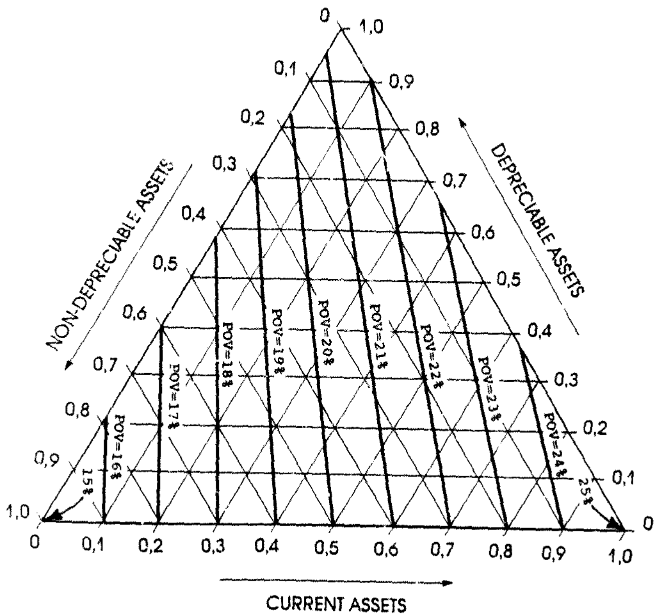

Figure 3.13 Accounting profit as a percentage of true value for a firm with an IRR of 25 percent per year under inflation of 10 percent per year and with a project life of 10 years.

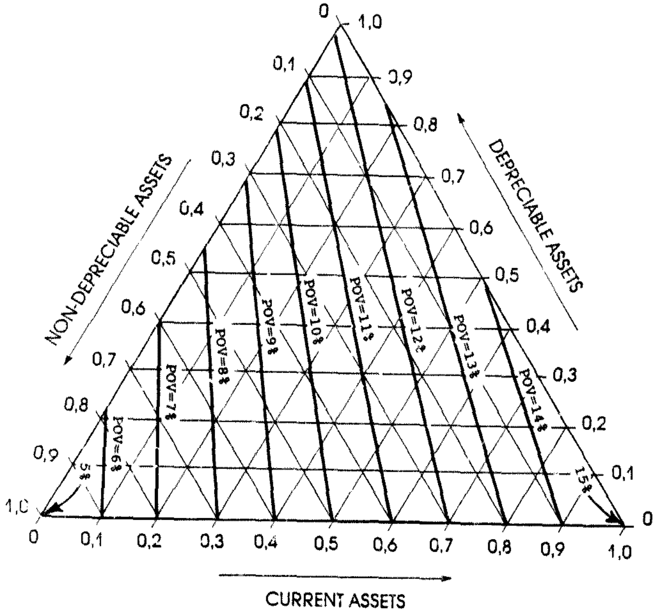

Figure 3.14 Accounting profit as a percentage of true value for a firm with an IRR of 15 percent per year under inflation of 10 percent per year and with a project life of 10 years.

3.5 CONCLUSIONS

The main conclusions to be drawn from the analyses presented in this chapter are:

(i) The conventional accounting rate of return (ROI) is not a good indicator of the true return (IRR) of the theoretical firm analysed.

(ii) The discrepancy between ROI and IRR is influenced by the asset structure of the firm, but the pattern of the discrepancy does not appear consistent.

(iii) The reason for the seemingly inconsistent pattern is that ROI at the same time reflects deficiencies in both the profit and the asset figures from which it is calculated. This makes the interpretation of the changing patterns difficult.

(iv) To isolate the effect of a deficiency in the asset figure, the book value of the firm is compared to its true value. A consistent understatement of asset value in accounts drawn to historical cost conventions is found.

(v) To isolate the effect of a deficiency in the profit figure the accounting profit divided by the true value of the firm (POV) is compared to the true return (IRR). Although POV is also found not to be a good indicator of IRR, the discrepancy between the two shows a more consistent pattern.

(vi) POV equals IRR for the all current asset firm and POV equals the difference between IRR and the inflation rate for the all non-depreciable asset firm. The POV of the all depreciable asset firm lies somewhere in between. This pattern holds for all project durations, IRR's and inflation rates, and within this pattern changes in these parameters influence the extent of the discrepancy between POV and IRR.

In this chapter the discrepancy between ARR (both its variants, ROI and POV) and IRR was investigated under certain perhaps restrictive assumptions. To make the analysis more useful, the effects of relaxing at least two of these assumptions have to be investigated. These are the assumption of a zero real growth rate and the assumption that the theoretical firm pays no tax.

The effect of relaxing these two assumptions will be considered in the next chapter.

CHAPTER 4

THE EFFECT OF TAXES AND GROWTH ON THE DISCREPANCY BETWEEN ARR AND IRR UNDER INFLATION

4.1 INTRODUCTION

The aim of this chapter is to investigate the effect of taxes and growth on the discrepancy between ARR and IRR. The theory presented in chapter 3 of the thesis assumed that the theoretical firm is not paying income tax and that the firm is not experiencing any real growth. This theory will be developed further in this chapter by relaxing these two assumptions in turn.

4.1.1 Method

This chapter follows the same method as chapter 3. A theoretical firm is constructed consisting of a number of parallel projects of known IRR. The project characteristics are determined and the accounting profit and book value calculated by summing across the current projects of the firm. The true value of a project is determined by summing the discounted values of the remaining cash flow streams of the project and the true value of the firm is calculated by summing across the current projects of the firm. The accounting rate of return can then be calculated and compared to the known IRR.

As in chapter 3, two variants of the accounting rate of return are considered. The accounting rate of return is calculated on an after tax basis so that it can be compared to the internal rate of return which has also been defined on an after tax basis. To calculate the conventional accounting rate of return, the accounting profit after tax is divided by the book value of assets, or:

$$ROI = \frac{E^T_{k+1}}{A_k}$$

where:

E^T = accounting profits after tax

The alternative measure of accounting rate of return based on the true value of the firm is also calculated on an after tax basis. To calculate the POV the accounting profit after tax is divided by the true value of the firm, or:

$$POV = \frac{E^T_{k+1}}{V_k}$$

The notation used in this chapter and its appendices is the same as that used in chapter 3. Symbols have been defined when they were first introduced and a list of the symbols is included in appendix 1.

The assumptions of the model that is used to calculate the theoretical firm's accounting earnings and value were outlined in section 3.2 of the thesis and will not be repeated here. In sections 4.2.1 and 4.3.1. only the assumptions that are to be relaxed will be discussed.

4.1.2 Presentation of results

If the results of the derivations presented in this chapter are plotted on the three-cornered asset structure diagrams used in chapter 3, patterns similar to those presented in chapter 3 are obtained. In many instances it is difficult to detect the difference between the diagrams, and the three-cornered diagrams are not a convenient way to show the additional effects of taxes or growth.

The presentations in this chapter will therefore focus on the corners of the three-cornered diagram, or the single asset type firms. Figure 4.1 presents the POV with changing project duration for single-asset type firms not paying tax and in a stationary state. This refers to the model of chapter 3, and the IRR and inflation rate are the same as those of figures 3.8, 3.9 and 3.10. Figure 4.1 presents the characteristics of single asset type firms, or the corners of the diagrams in chapter 3. The POV for points inside the three-cornered diagrams (firms employing more than one type of asset) is the weighted average of the corner points.

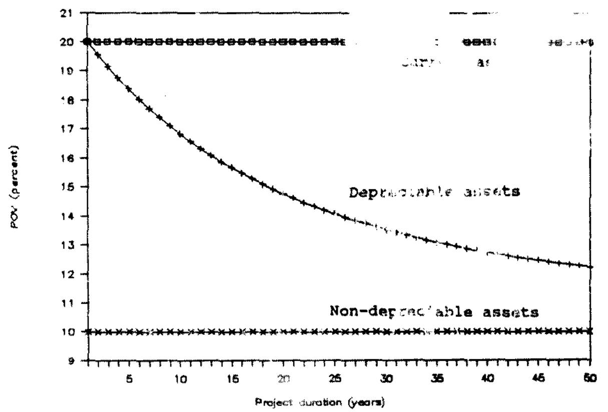

Figure 4.1 The influence of the life of depreciable assets on accounting profit as a percentage of true value (POV) of single asset type firms. (IRR 20 percent per year and inflation rate 10 percent per year.)

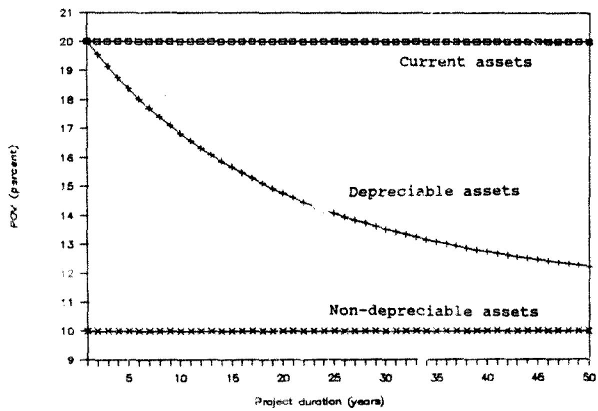

Figure 4.1 The influence of the life of depreciable assets on accounting profit as a percentage of true value (POV) of single asset type firms. (IRR 20 percent per year and inflation rate 10 percent per year.)

From figure 4.1 the relationships determined in chapter 3 are evident. The POV for current asset firms equals the IRR for all project durations. For non-depreciable assets the POV equals the difference between the IRR and the inflation rate. The POV of depreciable asset firms varies between these two extremes depending on the project duration. Short lived depreciable assets take on the character of current assets while depreciable assets with a longer life approach the nature of non-depreciable assets. (It has been shown in chapter 3 that the POV of depreciable asset firms approaches that of non-depreciable assets as the project duration approaches infinity.)

The pattern shown in figure 4.1 is a general one and also holds for other IRR's and inflation rates. The remainder of this chapter investigates the influence of tax and growth on the relationships. The results will be shown in diagrams similar to figure 4.1.

The effect of income tax is discussed in section 4.2 and that of growth in section 4.3 below. Conclusions are summarised in section 4.4.

4.2 THE EFFECT OF INCOME TAX

This section investigates the effect of income tax on the discrepancy between accounting return (POV) and true return (IRR) under inflation. The assumptions of the model are outlined in section 4.2.1 and the derivation of relationships discussed in section 4.2.2. The results are presented in section 4.2.3 and the conclusions summarised in section 4.2.4.

4.2.1 Assumptions

In chapter 3 it was assumed that the theoretical firm does not pay any taxes. In this chapter this assumption is relaxed by including the effect of company income tax. The assumptions outlined in section 3.2 still hold (except of course for the assumption about tax) and will not be repeated here. In addition it is assumed that:

- The firm pays income tax based on its accounting income.

- Taxable income is calculated according to historical cost conventions (the same methods used to calculate the accounting profit).

- The tax is payable immediately.

As in chapter 3, the model does not assume marginality when the accounting return and book value are calculated but it does so to determine the true value of the firm. The derivation of the relationships based on these assumptions is discussed in the next section.

4.2.2 Derivation of relationships

The derivation of the relationships follow the same pattern as that of the model presented in chapter 3. The characteristics of the individual projects are determined first. This includes calculating the trading surplus required to attain the specified IRR. The IRR is defined as the return after tax and the tax payable is taken into account when determining the project annual cash flows and required annual trading surplus.

The accounting profit and book value of the firm are then determined by summing across the contributions of its current projects. The true value of the firm is determined by summing the present values of the remaining cash flows of the current projects.

The derivation of the relationships is shown in appendix 4. It is shown that:

$$E_{k+1} = d.r.CA_{0,k}$$

$$+ \left(d.(r-i).\left(\frac{1 - \left(\frac{t}{d.r}\right)\left(1 - \left(\frac{1}{1+r}\right)^{d}\right)}{1 - \left(\frac{1+i}{1+r}\right)^{d}}\right)\right.$$

$$\left. - (1-t)\left(\frac{1+i}{d.i}\right)\left(1 - \left(\frac{1}{1+i}\right)^{d}\right)\right)DA^{A}_{0,k}$$

$$+ \quad d.(r-i).NA^{A}_{0,k}$$

$$A_k = dCA_{0,k}$$

$$+ DA^A_{0,k} \left(\left(\frac{1+i}{i}\right) - \left(\frac{1+i}{d.i^2}\right) + \frac{1}{d.i^2.(1+i)^{d-1}} \right)$$

$$+ NA^A_{0,k}\left(\frac{1+i}{i}\right).\left(1 - \left(\frac{1}{1+i}\right)^d\right)$$

and:

$$V_k = d.CA_{0,k}$$

$$+ DA^A_{0,k} \left(\left(\frac{t}{d.r}\right)\left(\left(\frac{1+i}{i}\right)\left(1 - \left(\frac{1}{1+i}\right)^d\right) - \left(\frac{1+i}{r-i}\right)\left(\left(\frac{1}{1+i}\right)^d - \left(\frac{1}{1+r}\right)^d\right)\right)\right.$$

$$\left. + \left(1 - \left(\frac{t}{d.r}\right)\left(1 - \left(\frac{1}{1+r}\right)^d\right)\right)\left(\frac{d}{1 - \left(\frac{1+i}{1+r}\right)^d} - \frac{1+i}{r-i}\right)\right)$$

$$+ \alpha.NA^A_{0,k}$$

where:

E^T = Accounting earnings after tax

t = Rate of taxation

and other symbols as previously defined (see appendix 1).

The results of this derivation will be discussed in section 4.2.3 below.

4.2.3 Results

The POV of firms employing only one type of asset has been calculated for varying project durations and income tax rates of 80 percent 40 percent and 0 percent. The results are presented in figure 4.2.

From figure 4.2 it is clear that the basic structure that was determined for the non tax paying firm (chapter 3 and figure 4.1) also holds if the firm pays income tax. The POV of current asset firms still equals the IRR and this can be shown to be a general result (see appendix 4). [illegible] of non-depreciable asset firms equals the diff[illegible] the IRR and the inflation rate and this can [illegible] shown to be a general result (appendix 4).

Changes in the tax rate does influence the POV of depreciable asset firms but the effect is limited, particularly if one keeps in mind that the tax rates considered in figure 4.2 span the area between 0 percent and 80 percent. At the extremes of the project duration range the relationships determined from chapter 3 still hold. Depreciable assets with a life of 1 year have a POV equal to that of current assets (a general result, see appendix 4). Their POV approaches that of non-depreciable assets (the difference between the IRR and the inflation rate) as the life of depreciable assets approaches infinity (a general result, see appendix 4).

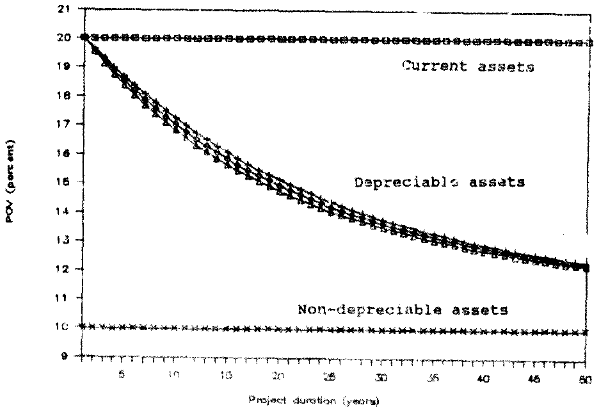

Figure 4.2 The influence of company income tax and the life of depreciable assets on accounting profit as a percentage of true value (POV) of single asset type firms. (IRR 20 percent per year, inflation rate 10 percent per year and tax rates 80 percent, 40 percent and 0 percent respectively.)

4.2.4 Conclusion

Income tax does not alter the basic pattern of the discrepancy between POV and IRR under inflation.

In the next section the additional effect of growth on the discrepancy will be investigated.

4.3 THE EFFECT OF GROWTH

This section investigates the effect of growth on the discrepancy between accounting return (POV) and true return (IRR) under inflation. The assumptions of the model are outlined in section 4.3.1 and the derivation of relationships discussed in section 4.3.2. The results are presented in section 4.3.3 and the conclusions summarised in section 4.3.4.

4.3.1 Assumptions

All the assumptions outlined in section 3.2 (except of course the assumption of no growth) as well as those from section 4.3.2 also apply to the present model. The effect of income tax is therefore retained in the present derivation but it could of course be eliminated easily by setting the tax rate equal to zero.

In addition it is assumed that:

- The firm grows in steady state at a constant real growth rate.

In practice this means that the firm employs larger and larger projects, each one larger by the growth rate than the one initiated a year before.

As in chapter 3, the model does not assume marginality when the accounting return and book value are calculated but it does so to determine the true value of the firm. The derivation of the relationships based on these assumptions is discussed in the next section.

4.3.2 Derivation of relationships

The derivation of the relationships follow the same pattern as that of the models presented in chapter 3 and in section 4.2. This derivation is presented in appendix 4 where it is shown that:

$$
\begin{aligned}
E^{T}_{k+1} \; = \; & \left(\frac{(1+g).r}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^{d}\right) CA_{0,k} \\
& + \left(\left(\frac{(1+g)(r-i)}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^{d}\right)\left(\frac{1 - \left(\frac{t}{d.r}\right)\left(1 - \left(\frac{1}{1+r}\right)^{d}\right)}{1 - \left(\frac{1+i}{1+r}\right)^{d}}\right)\right. \\
& \qquad \left. - \left(\frac{1-t}{d}\right)\left(\frac{1 - \left(\frac{1}{((1+g)(1+i))^{d}}\right)}{1 - \left(\frac{1}{(1+g)(1+i)}\right)}\right)\right) DA^{A}_{0,k} \\
& + \left(\frac{(1+g)(r-i)}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^{d}\right) NA^{A}_{0,k}
\end{aligned}
$$

And:

$$A_k = CA_{0,k}\left(\frac{1+g}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^d\right)$$

$$+ DA^A_{0,k}\left(\left(\frac{1}{1 - \left(\frac{1}{(1+g)(1+i)}\right)}\right.\right.$$

$$\left.\left. - \left(\frac{1}{d}\right) \cdot \left(\frac{\left(\frac{1}{(1+g)(1+i)}\right) - \left(\frac{1}{((1+g)(1+i))^{d+1}}\right)}{\left(1 - \left(\frac{1}{(1+g)(1+i)}\right)\right)^2}\right)\right)$$

$$+ NA^A_{0,k}\left(\frac{1 - \left(\frac{1}{((1+g)(1+i))^d}\right)}{1 - \left(\frac{1}{(1+g)(1+i)}\right)}\right)$$

And:

$$V_k = \left(\frac{1+g}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^d\right)CA_{0,k}$$

$$+ \left(\left(\frac{t}{d.r}\right)\left(\left(\frac{1 - \left(\frac{1}{(1+g)(1+i)}\right)^d}{1 - \left(\frac{1}{(1+g)(1+i)}\right)}\right)\right.\right.$$

$$\left.\left. - \left(\frac{1}{1+r}\right)^d\left(\frac{1 - \left(\frac{(1+r)}{(1+g)(1+i)}\right)^d}{1 - \left(\frac{(1+r)}{(1+g)(1+i)}\right)}\right)\right)$$

$$+ \left(\frac{1 - \left(\frac{t}{d.r}\right)\left(1 - \left(\frac{1}{1+r}\right)^d\right)}{1 - \left(\frac{1+i}{1+r}\right)^d}\right)\left(\left(\frac{1+g}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^d\right)\right.$$

$$\left. - \left(\frac{1+i}{1+r}\right)^d\left(\frac{1 - \left(\frac{(1+r)}{(1+g)(1+i)}\right)^d}{1 - \left(\frac{(1+r)}{(1+g)(1+i)}\right)}\right)\right)\right)DA^A_{0,k}$$

$$+ \left(\frac{1+g}{g}\right)\left(1 - \left(\frac{1}{1+g}\right)^d\right)NA^A_{0,k}$$

where:

g = growth rate

The results of this derivation will be discussed in section 4.3.3 below.

4.3.3 Results

The POV of firms employing only one type of asset has been calculated for varying project durations, an income tax rate of 40 percent and growth rates of 1 percent, 5 percent and 15 percent. The results are presented in figure 4.3.

Figure 4.3 shows that growth distorts the pattern of the relationship to a much greater extent than taxes (figure 4.2). Some aspects of the basic pattern is however still clear from the diagram. The POV of current asset firms still equals the IRR and this can be shown to be a general result (see appendix 5). The POV of non-depreciable asset firms equals the difference between the IRR and the inflation rate and this can similarly be shown to be a general result (appendix 5).

Changes in the growth rate influences the POV of depreciable asset firms to a great extent, a higher growth rate resulting in a decreased POV. What is however significant is that the relationships determined from chapter 3 and section 4.2 still hold at the extremes of the project duration range. Depreciable assets with a life of 1 year have a POV equal to that of current assets (a general result, see appendix 5). What is not apparent from figure 4.3 is that the POV of depreciable assets approaches that of non-depreciable assets

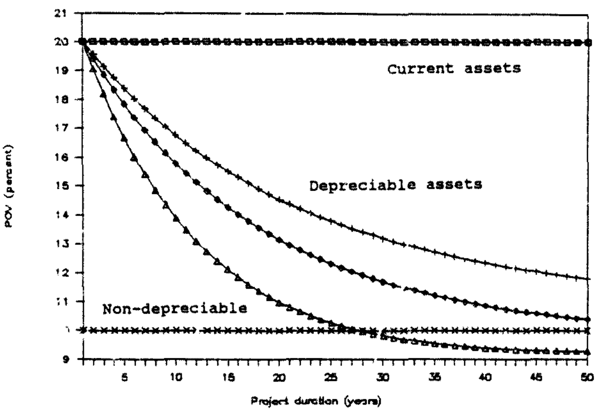

Figure 4.3 The influence of real growth and the life of depreciable assets on accounting profit as a percentage of true value (POV) of single asset type firms. (IRR 20 percent per year, inflation rate 10 percent per year and real growth rates 1 percent, 5 percent and 15 percent respectively.)

(the difference between the IRR and the inflation rate) as the life of depreciable assets approaches infinity. This is shown to be a general result in app[illegible] but in figure 4.3 it appears as if the POV of the [illegible] growth firm would stabilise at a lower level.

The reason for this apparent contradiction is clear from figure 4.4, where the calculations of figure 4.3 have been repeated for longer project durations. Figure 4.4 shows that although the POV for both the 5 percent and the 15 percent growth firms decreases below the non-depreciable assets line, it eventually increases and approaches the line as the project duration approaches infinity.

What is however apparent from both figures 4.3 and 4.4 is that growth biases the reported profits of depreciable asset firms downwards. This stems from the charging of straight-line depreciation as will be discussed below.

Under inflation, the monetary value of an asset appreciates. This also applies to the undepreciated portion of depreciable assets. At the end of the accounting period, the economic value of the depreciable assets is therefore higher than its accounting value based on historical costs. This has an effect on the economic depreciation in both the period before and the period after the valuation. In the period before the valuation, economic depreciation is lower than the book depreciation. The higher economic valuation

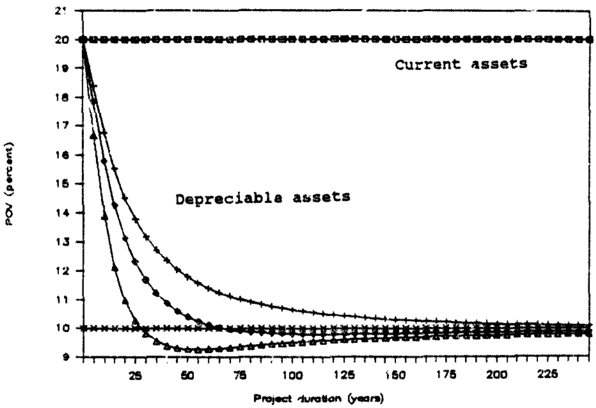

Figure 4.4 The influence of real growth and the life of depreciable assets on accounting profit as a percentage of true value (POV) of single asset type firms. (For extremely long projects, IRR 20 percent per year, inflation rate 10 percent per year and real growth rates 1 percent, 5 percent and 15 percent respectively.)

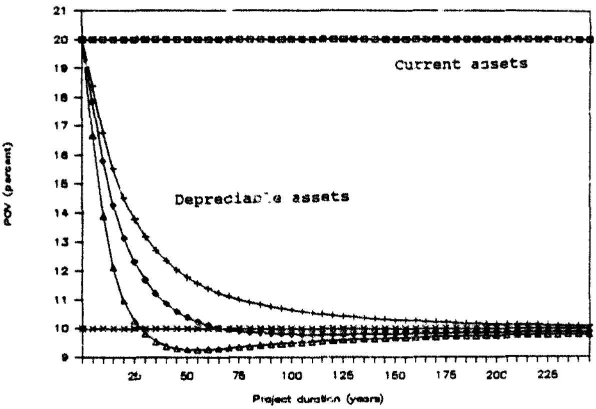

Figure . The influence of real growth and the life of depreciable assets on accounting profit as a percentage of true value (POV) of single asset type firms. (For extremely long projects, IRR 20 percent per year, inflation rate 10 percent per year and real growth rates 1 percent, 5 percent and 15 percent respectively.)

however means that economic depreciation in later periods has to be higher.

The effect of this is that book returns are lower than economic returns during the early part of a project (because book depreciation is higher than economic depreciation). During the later years of the project the relationship is reversed, with book returns higher than economic returns.

When a company grows, its projects become larger every year. This means that younger projects gain in importance over the older (smaller) projects. Because younger projects with their understated returns are weighted more heavily in the firm average, the return of the firm is distorted downwards. This explains why the POV for all project durations are lower for high growth firms than for low growth firms.

4.3.4 Conclusions

Growth does not alter the basic pattern of the discrepancy between POV and IRR under inflation. It does however bias the POV for depreciable asset firms downwards.

4.4 CONCLUSIONS

The main conclusions to be drawn from the analyses presented in this chapter are:

(i) When the effect of taxes and growth is taken into account, the basic pattern in the discrepancy between POV and IRR that was established in chapter 3 still holds.

(ii) POV equals IRR for the all current asset firm and POV equals the difference between IRR and the inflation rate for the all non-depreciable asset firm. The POV of the all depreciable asset firm equals IRR for firms with a project duration of one year, and approaches the difference between IRR and the inflation rate as the project duration approaches infinity. This pattern holds for all project durations, IRR's, inflation rates, tax rates and growth rates.

(iii) The POV of the all depreciable firm is influenced to a very minor extent by taxes.

(iv) The POV of the all depreciable asset firm is biased downwards by growth. As a result the POV may even be lower than the difference between IRR and the inflation rate.

This chapter as well as the preceding chapter studied the effect of inflation and asset structure on the discrepancy between the accounting return and true return of a theoretical firm. In the next chapter this theory will be used to investigate the effect of inflation on the general level of the price-earnings ratios of shares.

CHAPTER 5

THE EFFECT OF INFLATION ON THE GENERAL LEVEL OF PRICE-EARNINGS RATIOS

5.1 INTRODUCTION

The aim of this chapter is to investigate the effect of inflation on price-earnings ratios, using the theory developed in the previous chapters of the thesis.

The chapter starts (section 5.2) with a discussion of the results of some previous theoretical investigations into the relationship between inflation and price-earnings ratios.

This is followed in section 5.3 by the development of a model that uses the theory presented in previous chapters to predict the relationship between inflation and price-earnings ratios. The assumptions of the model are discussed in section 5.3.1, and the development of the model presented in section 5.3.2. The results of the model are simplified to facilitate their interpretation and this is discussed in section 5.3.3. In section 5.3.4 the effect of inflation on real returns are discussed, concluding that the present analysis will assume that it does not affect the real return. In section 5.3.5 this is integrated into the model in section 5.3.5 and the results of the model presented and discussed. The theoretical conclusions are presented in section 5.3.6.

Section 5.4 contains an empirical study to determine whether an increase in the inflation rate is in fact associated with a decrease in price-earnings as the model predicts. The results of an investigation using data from the UK are presented in section 5.4.1 and the results of the South African investigation presented in section 5.4.2.

The conclusions of the chapter are summarised in section 5.5.

5.2 THE RELATIONSHIP BETWEEN INFLATION AND PRICE-EARNINGS RATIOS: PREVIOUS STUDIES

The effect of inflation on price-earnings ratios has received some attention in the literature.

Modigliani and Cohn (1979) studied the effect of inflation on the market valuation of firms. They assumed that inflation would cause an increase in nominal profits as well as a similar increase in the nominal discount rate. Under these assumptions, inflation will have no effect on the pricing of shares and the price-earnings ratios of firms should not be influenced by inflation. Contrary to their theory, the authors observed a decline in price-earnings ratios in the United States from the late 1960's to the end of 1977. They model in section 5.3.5 and the results of the model presented and discussed. The theoretical conclusions are presented in section 5.3.6.

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Feldstein (1980) studied the effect of United States tax laws on price-earnings ratios under inflation. He concluded that the use of historic depreciation and the taxation of nominal capital gains raise the effective tax rate on corporate source income under inflation. This causes a permanent reduction in price-earnings ratios. Feldstein believed this effect, rather than the theory of systematic error advanced by Modigliani and Cohn (1979), to be responsible for the drop in price-earnings ratios in the United States over the period 1967 to 1976.

Modigliani (1982, p.257) studied the impact of inflation on share prices and price-earnings ratios and concluded that inflation should increase the value of financial leverage to the firm and thus also the price-earnings ratio. He found this implication of his model to be inconsistent with the empirical evidence, because price-earnings ratios in the United States have declined considerably during a period of rising inflation instead of rising as the model predicts (Modigliani, 1982, p.265). Modigliani believes that this failure can be attributed to the market suffering from an inflation induced illusion of the type hypothesised by Modigliani and Cohn (1979).

In the next section of the thesis the theory developed in previous chapters will be used to study the theoretical effect of inflation on price-earnings ratios. The analysis differs from that employed by Modigliani and Cohn (1979). They took the value of the firm to be equal to its discounted future profits. The present analysis uses discounted future cash flow as the value of the firm. The analysis also differs from that of Feldstein (1980). He focussed on the effect of United States tax laws. In the present analysis it will be shown that a decline in price-earnings ratios should be expected in the absence of tax. The decline should therefore not solely be ascribed to the effects of a particular tax system.

5.3 THE THEORETICAL RELATIONSHIP BETWEEN INFLATION AND PRICE-EARNINGS RATIOS

This section describes the development of a model that uses the theoretical relationships from previous chapters to study the effect of inflation on price-earnings ratios. Some important assumptions and their significance for the interpretation of the results of the model will be discussed first.

5.3.1 Important assumptions

All the assumptions made during the development of the theory in previous chapters (see section 3.2) also apply to the current analysis, which uses the results of the theory. All the assumptions will not be repeated here, but two are of particular importance. These are the assumption of a theoretical firm in steady state and the assumption of marginality. Their significance will be discussed in turn below.

In the development of the theory a theoretical firm in steady state was assumed. Under this assumption the firm terminates and initiates one project annually, and these as well as the current projects of the firm all have the same IRR. The firm's reported profits therefore reflects not only its past performance but also its prospects. This need not be the case in practice. Because of an ever-changing environment firms may face investment opportunities that are very much better or worse than in the past. If the new conditions persist a new steady state will be reached. In the interim transition effects distort the relationship between price (based on prospects) and earnings (based on historical performance). These transition effects need not only apply to individual firms (in which case they could have cancelled out when a large number of firms are considered). The prospects for the economy as a whole could change as a result of the business cycle or political developments. The transition effects will therefore also influence the average price-earnings ratio of large numbers of firms.

A further consequence of the steady-state assumption is that it implies a constant inflation rate. If the inflation rate changes transition effects may influence the relationship between price and earnings until a new steady state position is reached.

The second important assumption is that of marginality, under which the IRR of the firm's projects is equal to the market discount rate. In practice there will be firms with investment opportunities yielding a return superior to the market discount rate. In an efficient market for the firm's products this will attract competition and the returns will decrease until an equilibrium is reached where no firm makes superior profits. In the interim the price of the firm's shares will reflect the superior returns and the price-earnings ratio will be higher than predicted by the theory. (In the event of market distortions such as government-sanctioned monopolies it is even conceivable that the superior returns and price-earnings distortions could last indefinitely.)

It is important that these two assumptions be kept in mind when interpreting the results of the analysis. Because of the transition effects an observer should not expect price-earnings ratios to vary exactly as predicted by the theory. The model nevertheless provides a useful benchmark from which price-earnings ratios under inflation could be interpreted.

5.3.2 Development of the theoretical relationship between inflation and price-earnings ratios

This section uses the theoretical relationships developed in chapter 3 to determine the theoretical relationship between inflation and the price-earnings ratio of a firm.

According to this theory the accounting earnings of a firm is given by:

$$E_{k+1} = d.r.CA_{0,k}$$

$$+ d.DA^{A}_{0,k}.k\left(\frac{r - i}{1 - \left(\frac{1+i}{1+r}\right)^{d}} + \left(\frac{1+i}{d.i}\right)\left(1 - \left(\frac{1}{1+i}\right)^{d}\right)\right)$$

$$+ d.(r-i).NA^{A}_{0,k}$$

where:

$CA_{0,k}$	=	initial investment in current assets for the project initiated in year k
d	=	duration (in years) of the projects making up the firm
$DA^{A}_{0,k}$	=	initial investment in depreciable assets for the project initiated in year k
E_{k+1}	=	accounting profit in year (k+1)
i	=	inflation rate
$NA^{A}_{0,k}$	=	initial investment in non-depreciable assets for the project initiated in year k
r	=	IRR of projects (and firm)

The price of the total firm will in an efficient market equal the value of the firm. This is given by:

$$V_k = dCA_{0,k} + DA^A_{0,k}\left(\frac{d}{1-\left(\frac{1+i}{1+r}\right)^d} - \frac{1+i}{r-i}\right) + dNA^A_{0,k}$$

where:

V_k = true value of the firm

The earnings yield of this theoretical firm is then given by:

$$EY = (E_{k+1})/(V_k)$$

The price-earnings ratio is the reciprocal of the earnings yield, or:

$$P/E = 1/(EY) = (V_k)/(E_{k+1})$$

This defines the price-earnings ratio as the price (year k) divided by the expected profit (year k+1). This is the equivalent of using beginning-of-year assets when calculating rates of return. (The arguments for and against the use of beginning-of-year assets have been presented in section 2.2.1.2.) This definition is therefore consistent with the analyses presented in chapters ~ and 4 of the thesis. It is also consistent with the conventional textbook interpretation of price-earnings ratios (Brealey and Myers, 1984, p.54).

5.3.3 Simplifying the results

This section presents procedures to simplify the results of the model in order to facilitate their interpretation. For this purpose three further variables are defined. These are the proportions that current assets, depreciable assets and non-depreciable assets make up of the true value of the firm.

It can then be shown that (appendix 7):

$$EY = r.s_{CA} + f_{DA}.s_{DA} + (r-i).s_{NA}$$

where s_{CA}, s_{DA} and s_{NA} represent the proportions that current assets, depreciable assets and non-depreciable assets contribute respectively to the value of the firm as a whole, and where:

$$f_{DA} = \left(\frac{\dfrac{d.(r-i)}{1 - \left(\dfrac{1+i}{1+r}\right)^d} - \left(\dfrac{1+i}{d.i}\right).\left(1 - \left(\dfrac{1}{1+i}\right)^d\right)}{\dfrac{d}{1 - \left(\dfrac{1+i}{1+r}\right)^d} - \dfrac{1+i}{r-i}} \right)$$

So that the price-earnings ratio is given by:

$$P/E = \frac{1}{r.s_{CA} + f_{DA}.s_{DA} + (r-i).s_{NA}}$$

The price-earnings ratio is most easily interpreted by looking at its reciprocal, the earnings yield. The earnings yield depends on the mix of assets employed by the firm, and is the weighted average of r, (r-i) and f_{DA}. The factor f_{DA} depends upon the life of the depreciable assets employed by the firm. It is shown in appendix 7 that f_{DA} equals r for depreciable assets with a life of only one year (the shortest life allowed under the assumptions of the model) and that the limit of f_{DA} as the life of depreciable assets approach infinity is equal to (r-i).

The earnings yield of the firm (the reciprocal of the price-earnings ratio) therefore varies between r and (r-i) depending upon the type of assets employed by the firm and the life of the depreciable assets employed by the firm.

5.3.4 Inflation and real returns

To determine the theoretical effect of inflation on price earnings ratios one further assumption is required. This concerns the effect of the inflation rate i on the market capitalisation rate r.

Fama (1981) and Benderly and Zwick (1985) have found a negative relationship between the rate of inflation and the real yield of shares on the New York Stock Exchange. Fama believed this to be a spurious relationship because it contradicts rational expectations, according to which real variables should not be influenced by purely nominal variables such as the inflation rate. Benderly and Zwick attempted to explain this relationship in terms of real balances.

The debate on the effect of inflation on real returns falls outside of the scope of this thesis, although a relationship of this nature may of course have an additional effect on price-earnings ratios. For the purposes of the present analysis the rational expectations position will be accepted according to which real returns are not affected by the rate of inflation. This will be combined with the relationships presented in section 5.3.3 and the results presented in the next section.

5.3.5 Discussion of results

The influence of inflation on price-earnings ratios can now be determined. Assuming a constant real marginal productivity of the firm (see section 5.3.4) of r_R (which is also the real market capitalisation rate, see section 5.3.1):

$$(1+r) = (1+r_R).(1+i)$$

If r_R and i are both small, (r-i) is approximately equal to r_R and r is approximately equal to (r_R+i). The earnings yield of marginal firms will therefore vary between the real productivity of capital (for firms consisting of only non-depreciable assets and approached by firms with extremely long-lived depreciable assets) and the sum of the real productivity and the inflation rate (for firms consisting entirely of current assets and approached by firms with short-lived depreciable assets). The price-earnings ratios of all firms (with the exception of firms consisting entirely of non-depreciable assets) are therefore lowered as a result of higher inflation rates. This is illustrated in figure 5.1, where the effect of inflation on price-earnings ratios is shown for firms having a real return of 4 percent per year.

The price-earnings ratio of the firm is the weighted average of the ratios for the various types of assets shown in figure 5.1. All firms show a decline in price-earnings, but the effect is much more marked for firms composed of

5.3.5 Discussion of results

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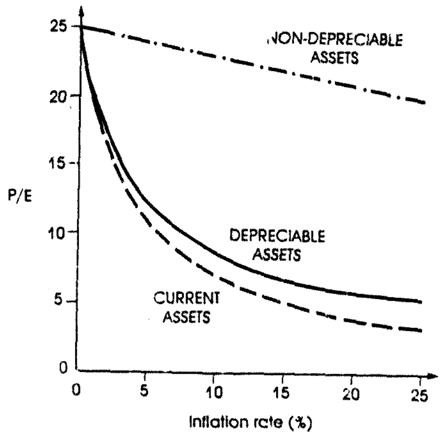

Figure 5.1 The effect of inflation on the price-earnings ratios of 100 percent *non*-depreciable, 100 percent depreciable (d = 10 years) and 100 percent current asset firms. (Real return 4 percent per year.)

exclusively current or depreciable assets. (The decline for the non-depreciable asset firm can be attributed to the fact that the price-earnings ratio is defined as earnings at the end of the year divided by price at the beginning of the year and would not have existed if end-of-year prices were taken.)

What is significant about figure 5.1 is the fact that depreciable assets (here with a life of 10 years) is much closer to current assets than to non-depreciable assets. This can also be seen from figure 5.2, where the price-earnings ratio of a depreciable asset firm is compared with that of current and non-depreciable asset firms for varying asset life and a constant inflation rate of 10 percent per year.

Figure 5.2 shows that although depreciable assets with a long life eventually take on the character of non-depreciable assets (see appendix 7), depreciable assets with asset lives encountered in practice are much closer to current than to non-depreciable assets (in their influence on price-earnings ratios). In practical terms this means that even long-lived assets such as buildings with a life of 30 years do not fail to contribute to the decrease in the price-earnings predicted by this theory.

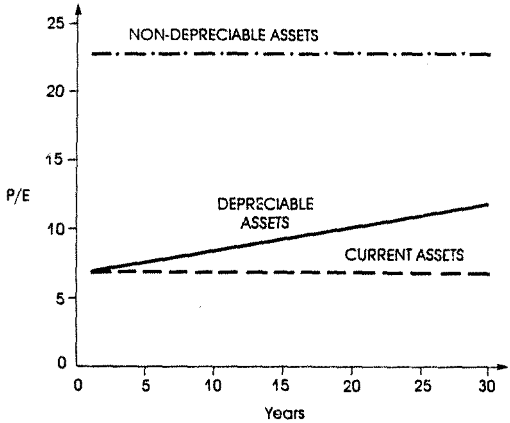

Figure 5.2 The influence of the life of depreciable assets on the price-earnings ratios of 100 percent non-depreciable, 100 percent depreciable and 100 percent current asset firms. (Real return 4 percent per year and inflation rate 10 percent per year.)

5.3.6 Conclusions

The model provides a benchmark from which price-earnings ratios under inflation could be interpreted. The model predicts a decline in price-earnings ratios with increasing inflation. It is therefore unnecessary to attribute this decrease to the existence of an inflation induced illusion when it is encountered in practice (Modigliani and Cohn, 1979 and Modigliani, 1982). The analysis also shows that this decrease exists in the absence of corporate taxes and provides an alternative explanation to the tax-induced decrease postulated by Feldstein (1982).

The model predicts a decline in price-earnings ratios with increasing inflation. The next section will study the behaviour of price-earnings ratios in the UK and South Africa to determine whether the predicted decline does in fact take place.

5.4 EMPIRICAL: INFLATION AND PRICE-EARNINGS RATIOS

In this section actual price-earnings ratios will be studied to determine whether they do in fact decline with increasing inflation (and vice versa) as predicted by the model.

Four different series of earnings yields will be investigated. These are the average earnings yield of shares comprising the FT-500 Actuaries Index (UK), and three South

African earnings yield indices referring to financial, industrial and commercial shares respectively.

In each of the four instances the earnings yield will be regressed against the relevant inflation rate. The model predicts that the price-earnings ratio will decrease and the earnings yield increase with an increasing inflation rate. If this is the case, the coefficient of the inflation rate in the regression of the earnings yield will be greater than zero. This hypothesis will in each instance be tested against the null hypothesis that the earnings yield is not influenced by inflation and that the coefficient of the inflation rate in the regression is equal to zero. The hypotheses are therefore:

H_0: The coefficient of the inflation rate in the regression of the earnings yield is equal to zero.

H_a: The coefficient of the inflation rate in the regression of the earnings yield is greater than zero.

The investigations using British and South African data are discussed in turn below.

5.4.1 UK

This section studies the effect of inflation on the earnings yield of shares traded in the UK.

5.4.1.1 Data

The earnings yield data for this analysis was obtained from the UK FT-500 earnings yield index published in the Bank of England Quarterly Bulletin (various issues). This gives the average earnings yield of shares included in the FT Actuaries Index at the end of each month. The inflation rates were obtained from the International Monetary Fund publication International Financial Statistics (various issues). This publication reports the annual change in the consumer price index (CPI) for various countries on a monthly basis. The monthly figures refer to the change in the CPI over the index twelve months earlier and they therefore measure the inflation rate over the twelve month period prior to the date quoted. In the present analysis this was taken as a proxy for the inflation rate in the middle of the twelve month period, or six months before the date quoted in International Financial Statistics.

The UK analysis spans the period from August 1965 (when the basis for the calculation of the reported earnings yield changed, see Bank of England Quarterly Bulletin vol.5 (1965) p.292 and vol.6 (1966) p.395) to July 1986 (the last month for which the UK inflation data were available). This is a total of 252 monthly data points.

The results of the analysis are presented in the next section.

5.4.1.2 Results

The earnings yield and inflation rate data have been plotted in figure 5.3. From an inspection of the graph in figure 5.3 it does seem as if the inflation rate influences the earnings yield and as if the two series move in tandem. To verify this the earnings yield was regressed (ordinary least squares) against the inflation rate. The result of the regression (appendix 8) shows a Durbin-Watson statistic of 0,12. This supports a hypothesis of positive autocorrelation. The generalised difference method was used to correct for the autocorrelation. The coefficient of autocorrelation was estimated to be 0,9365375 using the procedure suggested by Katz (1982). The result of the regression of the transformed data is also shown in appendix 8. The Durbin-Watson statistic of 1,65 supports the null hypothesis of no autocorrelation (at the 0,01 level). The coefficient of the inflation rate is positive and significantly different from zero (at the 0,01 level). The alternative hypothesis that the coefficient of the inflation rate in the regression of the earnings yield is greater than zero is therefore accepted.

5.4.1.3 Conclusion

In the UK the inflation rate has a statistically significant effect on earnings yields and price-earnings ratios. This agrees with the prediction of the model.

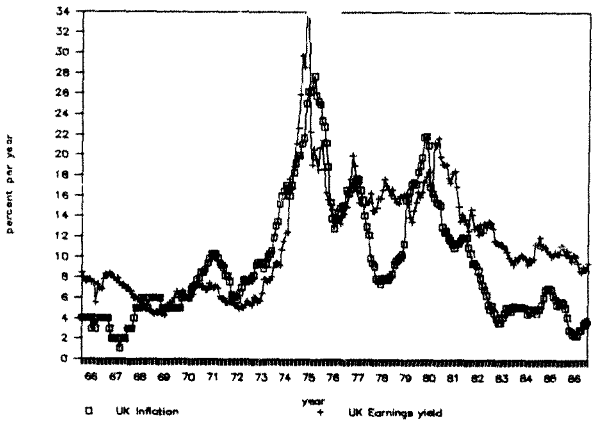

Figure 5.3 Graph of the UK earnings yield (FT-500 Actuaries Index) and the UK inflation rate: 1966-1986.

5.4.2 RSA

This section studies the effect of inflation on the earnings yield of shares traded on the Johannesburg Stock Exchange. Three earnings yield indices are included in the study. These refer to financial, industrial and commercial shares respectively.

5.4.2.1 Data

The earnings yield data for this analysis were obtained from the indices published in the South African Reserve Bank Quarterly Bulletin (various issues). The inflation rates were obtained from the International Monetary Fund publication International Financial Statistics (various issues). For reasons explained in section 5.4.1.1 the monthly inflation figures were taken as a proxy for the inflation rate six months before the date quoted in International Financial Statistics.

The South African analysis spans the period from January 1969 (when the Reserve Bank started reporting earnings yield data) to September 1986 (the last month for which RSA inflation data were available). This is a total of 213 monthly data points.

The results of the analysis are presented in the next section.

5.4.2.2 Results

The RSA inflation rate and the earnings yields for financial, industrial, and commercial shares have been plotted in figures 5.4, 5.5 and 5.5 respectively. From the graphs it would appear as if the inflation rate does not influence the earnings yields in South Africa to the same extent as in the UK (figure 5.3).

The three earnings yields were in turn regressed against the RSA inflation rate (using ordinary least squares). The results are shown in appendix 8. Durbin-Watson statistics of 0,05 0,03 and 0,04 were obtained. These support hypotheses of positive autocorrelation in each instance. As in section 5.4.1.2, the generalised difference method was used to correct for the autocorrelation. The coefficients of autocorrelation were estimated to be 0,974232 0,983127 and 0,9800445 respectively using the procedure suggested by Katz (1982). The results of the regression of the transformed data are also included in appendix 8. In all three instances the coefficients of the inflation rate is not significantly different from zero (at either the 0,01 or the 0,05 level). The null hypothesis is therefore accepted in each instance.

5.4.2.2 Results

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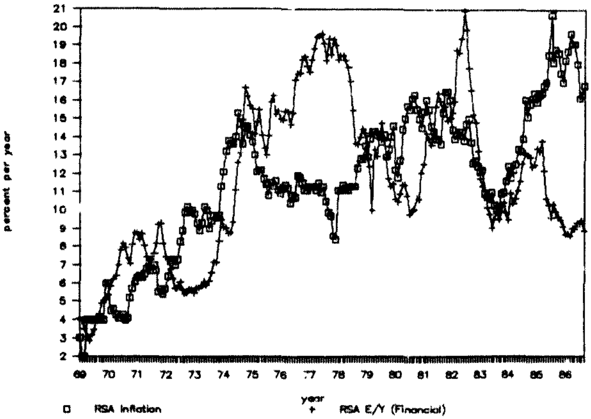

Figure 5.4 Graph of the South African earnings yield (financial shares) and the South African inflation rate: 1969-1986.

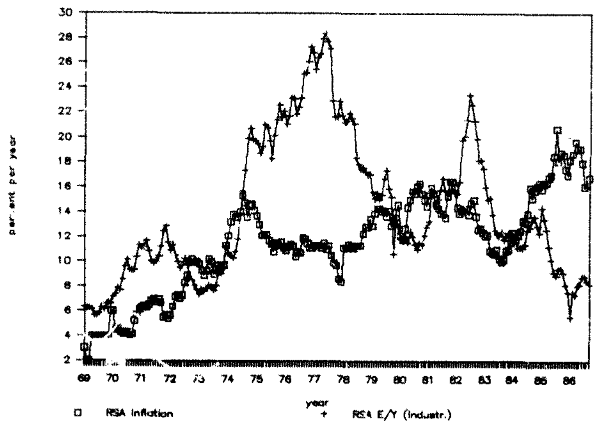

Figure 5.5 Graph of the South African earnings yield (industrial shares) and the South African inflation rate: 1969-1986.

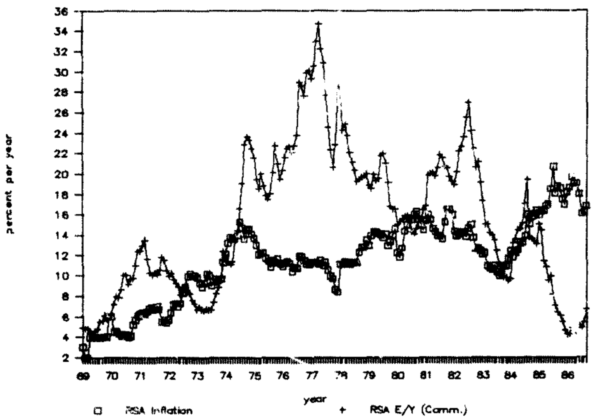

Figure 5.6 Graph of the South African earnings yield (commercial shares) and the South African inflation rate: 1969-1986.

5.4.1.3 Conclusion

In South Africa the inflation rate does not have a significant effect on earnings yields and price-earnings ratios. This contradicts the model.

Two reasons could be advanced why a statistically significant relationship is found in the UK but not in South Africa. These are:

(i) In the UK there have been large changes in the inflation rate during the period covered by the analysis (figure 5.3). By comparison, the inflation rate in South Africa has shown a steady upward drift over the period, with relatively small changes in the rate. (Compare figure 5.6, which is drawn to approximately the same scale as figure 5.3.) It is therefore more likely that the possible effect of a change in the inflation rate on the earnings yield will be overshadowed by other changes in South Africa than is the case in the UK.

(ii) The prospects for the South African economy are influenced to a much greater extent by sporadic political events than is the case in the UK. The effect of these events on price-earnings ratios could overshadow the effect of a change in the inflation rate. In each of figures 5.4, 5.5 and 5.6 the major discrepancy in the pattern of the relationship between the inflation rate and the earnings yield occur in the period 1976 to 1979. In 1976 South Africa experienced widespread political unrest. This became known as the Soweto riots, after the township of Soweto where the unrest started. As a result of the disturbances investors became pessimistic about the prospects for the South African economy. The prices of shares dropped accordingly. Prices (based on prospects) were therefore influenced by factors not reflected in historical or even current earnings. During this period the price-earnings relationship does not follow the pattern predicted by the steady-state model (see section 5.3.1).

5.5 CONCLUSIONS

The main conclusions to be drawn from the analyses presented in this chapter are:

(i) The theoretical model that is developed provides a benchmark from which price-earnings ratios could be interpreted under inflation. The model predicts a decline in price-earnings ratios with increasing inflation (and vice versa).

(ii) This model makes it unnecessary to attribute the decrease in price-earnings ratios with increasing inflation (reported in the United States) to the existence of an inflation induced illusion (Modigliani and Cohn, 1979 and Modigliani, 1982).

(iii) The model also shows that the decrease in price-earnings ratios with increasing inflation exists in the absence of corporate taxes. It therefore provides an alternative explanation to the tax-induced decrease in price-earnings ratios postulated by Feldstein (1982).

(iv) In the empirical section it was found that inflation has a statistically significant effect on earnings yields and price-earnings ratios in the UK. This agrees with the prediction of the model.

(v) In South Africa inflation does not have a statistically significant effect on price-earnings ratios. This contradicts the model. A lack of sufficient variation in the RSA inflation rate during the period of the study and the influence of sporadic political developments in South Africa are advanced as possible reasons for the difference between the results from the British and South African studies.

This chapter focused on the behaviour of average price-earnings ratios under inflation, but did not study inter-firm price-earnings differences. This will be investigated in the next chapter.

CHAPTER 6

THE EFFECT OF INFLATION ON THE PRICE-EARNINGS RATIOS OF INDUSTRIAL SHARES ON THE JOHANNESBURG STOCK EXCHANGE

6.1 INTRODUCTION

The aim of this chapter is to investigate whether the price-earnings ratios of industrial firms quoted on the Johannesburg Stock Exchange (JSE) does vary according to asset structure as the theory developed in earlier chapters of this thesis predicts.

A theoretical (predicted) price-earnings ratio will be calculated for each of the firms in the sample. This will then be compared to the actual ratio of each firm. The purpose of this analysis is to determine whether the theory explains a statistically significant portion of the inter-firm variation of price-earnings ratios.

The assumptions on which the calculations are based will be outlined in section 6.2. This is followed in section 6.3 by a discussion of the data used in the analysis. Section 6.4 deals with the computer program used in the manipulation of the data. The results of the analyses are presented in section 6.5 and the conclusions of the chapter are summarised in section 6.6.

6.2 ASSUMPTIONS

In order to calculate both the theoretical and the actual price-earnings ratios it is necessary to make some assumptions about numbers that are not reported in the annual financial statements of the firm. The development of the theory has also been based on some ideal conditions that are not always realised in practice. Some further assumptions about the data are therefore required to make the theory operational. The assumptions that have been made to calculate the theoretical and actual price-earnings ratios will be discussed in turn below.

6.2.1 Theoretical price-earnings ratios

6.2.1.1 Steady state

The theory developed in chapters 3 and 4 of this thesis assumed a theoretical firm in steady state. This steady state requires that the rate of inflation remains constant, that the characteristics of the assets employed by the firm stay the same and that the profitability of these assets does not vary. In practice this steady state position is not likely to be reached. Some transition effects that cannot be analysed by means of a steady state theory could be present. To reduce the influence of transition effects during the present analysis, the average of the parameters (taken over a period of ten years) will be considered.

For each of the firms in the sample an average asset structure (according to the book value of assets) is determined. The average project duration of each of the firms is estimated and together with the firm's book asset structure and the average inflation rate over the period this will be used to estimate the theoretical project asset structure. This "average" project asset structure is then used to calculate a theoretical price-earnings ratio for the firm.

6.2.1.2 Taxes and growth

The theory developed in chapter 3 of the thesis examined a firm that does not pay taxes and that does not show any real growth. In chapter 4 this theory was expanded to include taxpaying firms as well as firms experiencing real growth. It was found that the basic pattern of the discrepancy between POV and IR" that was established in chapter 3 also applied to these firms. It is therefore not likely that the accuracy of theoretical price-earnings ratios can be improved significantly by allowing for taxes or growth. The present analysis has therefore been undertaken without taking taxes or growth into account.

6.2.1.3 Investments

To determine the book asset structure of the firm the ratios of current, depreciable and non-depreciable assets as reported in the firm's annual financial statements are calculated. If the firm has investments that are not consolidated into the firm's annual statements the asset structure of these investments cannot be determined from the financial statements. In the present analysis the effect of these investments will therefore be ignored when determining the book asset structure. This is the same as assuming that these investments have the same asset structures as the remainder of the firm.

6.2.1.4 Project duration

The duration of the projects of a firm cannot be determined from the financial statements. To estimate this, the cost of the depreciable assets employed by the firm is divided by the depreciation reported on those assets during a year. The average is then calculated for all the years for which data are available. In appendix 9 of the thesis a mathematical derivation is presented that shows that this is an appropriate method to estimate the project duration. This derivation is based on steady state and assumes that assets are depreciated over their useful life.

6.2.1.5 Accounting conventions

The project asset structure is determined from the book asset structure assuming that these have been reported according to historical cost conventions. Depreciable assets are assumed to be depreciated over their useful lives. Non-depreciable assets are assumed to be revaluated (or replaced) at the end of each theoretical project.

6.2.1.6 Discount rate

To determine the theoretical price-earnings ratio of the firms an appropriate discount rate has to be assumed. According to the Capital Asset Pricing Model (CAPM) different discount rates would be appropriate for different firms because of differences in their systematic risk. Retief, Affleck-Graves and Hamman (1984, p.29) have found financial leverage to be an important factor in determining the systematic risk of shares quoted on the JSE. In this study the theoretical and actual price-earnings ratios of unleveraged firms will be compared. In doing so an important factor contributing to the systematic risk of firms is eliminated, and this will reduce (though not completely eliminate) errors resulting from the use of a single discount rate for all firms.

The discount rate that minimises the total absolute difference between actual and theoretical price-earnings ratios for all the firms included in the analysis will be determined by means of trial and error. This means that the rate that causes the average level of price-earnings ratios to be the closest to the average level of actual ratios will be used in the study. This rate will then be used to construct theoretical price-earnings ratios to determine whether these ratios can explain some of the inter-firm variation in actual price-earnings ratios.

6.2.1.7 Marginality

One of the important assumptions of the theory has been that the discount rate equals the true profitability of the firm. This assumes that all the firms are marginal firms, that none are making any excess profits and that the present value of all the firms' growth opportunities are equal to zero. This assumption will definitely not hold in practice and differences in the prospects of different firms will have to result in inter-firm differences in price-earnings ratios that cannot be explained by the theory. The theory can therefore only explain part of the inter-firm price-earnings variation, and it is the aim of the present analysis to determine whether this represents a significant part of the variation.

6.2.2 Actual price-earnings ratios

6.2.2.1 Loans and preferred shares

The theory used to calculate the theoretical price-earnings ratios has been developed for a theoretical unleveraged firm. These are to be compared to actual price-earnings ratios and the latter conseque. ave to be estimated for unleveraged firms as well. To do so, the total value of a firm has to be divided by its earnings before interest and tax. The ordinary shares of the firms in the sample are traded on the JSE and the market price is used to determine the value of ordinary shareholders funds. The other financing instruments are not usually actively traded and their value can therefore not be determined from a market price. In the present study the value of loans and - preferred shares is assumed to be equal to their book value. The book value of loans and preferred shares are therefore added to the value of ordinary shares to determine the total value of the firm.

6.2.2.2 Minority shareholders

If the firm has subsidiaries that are consolidated into the financial statements and these subsidiaries have minority shareholders the value of these shares are also to be added to determine the total value of the firm. Because the return on these shares are more volatile than the return on loans and preferred shares, their value could be expected to vary more than that of the other instruments. To use the book value of these minority shares as a proxy for their true value could result in serious estimation errors. For the present study the value of these shares will be estimated assuming that the market will place the s[illegible]e value on profits attributable to minority shareholder[illegible] that of the majority. This assumes a homogenous fi[illegible] the minority does not own shares in parts of the f[illegible]s better or worse prospects than the firm as a w[illegible]

In the present study the value of the minority shares i[illegible] therefore determined by scaling the total value o[illegible] th[illegible] ordinary shares according to the profits attributab[illegible] t[illegible] the minority and majority shareholders.

[illegible].3 DATA

The data for the present study consist of figures from the annual financial statements of firms and their share prices on the JSE.

The data were obtained from the Bureau of Financial Analysis (BFA) of the University of Pretoria. The BFA keeps a data bank containing the contents of the annual financial statements of all the industrial companies qu[illegible]ted on the JSE. Share prices are obtained from the pub[illegible]shed JSE reports, and the remaining data are obtained so[illegible]ely from the published annual reports of companies. The [illegible]FA uses its data bank to produce reports on industries and companies for investors or analysts. The data bank also provides convenient access to the published reports of companies and is regularly used by stockbrokers on the JSE who have contracted with the BFA for the use of the data bank. The BFA data used in the present study were transferred by magnetic tape to the central computer of the University of the Witwatersrand. Here the data could be accessed by the Fortran program used for data manipulation. (The program is discussed in more detail in section 6.4 of the thesis.)

The BFA refers to the original variables read into its data bank as "ratios". The BFA ratios that were used in the present study are discussed in section 6.3.1 below. This is followed in section 6.2.2 by a discussion of the selection of the sample of firms for the study. The effect of a change in the accounting period of a firm on the data is outlined in section 6.2.3. This is followed by a discussion of the inflation rate to be used in the present study.

6.3.1 BFA ratios

The BFA ratios used in the analysis are discussed in brief below. The ratios are defined in more detail in the manual for the users of the BFA ratio service (Zevenbergen,1984).

6.3.1.1 Current assets