Measuring a firm’s economic profitability: a study of the measurement of a firm’s economic profitability with proposals for, and evaluations of, an ex post measure, return on total capital employed (ROTCE), and an ex ante measure, a modified version of Tobin’s q (modq) employing current earnings in lieu of capital employed.
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MEASURING A FIRM'S ECONOMIC PROFITABILITY

A study of the measurement of a firm's economic profitability with proposals for, and evaluations of, an ex post measure, Return on Total Capital Employed (ROTCE), and an ex ante measure, a modified version of Tobin's q (modq) employing current earnings in lieu of capital employed.

by

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A Doctoral Thesis submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy of the Loughborough University of Technology.

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ABSTRACT

Despite its significance for industrial economics, utility regulation and competition policy, the measurement of the economic profitability of a firm remains a relatively under-researched area. The difference between the Accounting Rate of Return (ARR), measured on a net replacement cost or current cost basis, and a firm's estimated risk adjusted cost of capital is favoured by many economic researchers and is widely employed in utility regulation, but strong claims have been made for Tobin's q (q - the ratio of the market value of a firm's securities to the cost of replicating the firm, often identified with the net replacement cost of its net assets). Both measures have shortcomings. Davis and Kay have drawn attention to, but have failed to fully explain, a bias in ARR when firms buy in goods and services. Bias in q due to the omission of hidden capital can be significant.

In this paper, economic profitability is identified with a firm's input-output ratio expressed in present value terms, and with the internal rate of return on a firm's expenditure in the accounting year, both revenue and capital. In the case of ex post profitability, the last two measures are shown to be equivalent. Departures from the form of these ideal measures explains the biases in both ARR and q.

Employing the Capital Asset Pricing Model, two alternative, operational measures of a firm's economic profitability are derived from the ideal measures with a view to eliminating the biases in q and ARR. The ex post measure is called here the Return on Total Capital Employed (ROTCE) and the ex ante measure is called here modified Tobin's q (modq).

ROTCE is appraised using data from a simple corporate model. modq is appraised using data extracted from the accounts of companies comprising the Buildings Materials and Food Manufacturing sectors of the FTA All Share Index. In this study, 1/modq and 1/q are shown to be significantly correlated at the 95% confidence level, and some 45% of the difference between them can be associated with taxation effects. Associating market power with the product of Beta and the Return on Sales, 1/modq is found to be significantly related at the 95% confidence level with market power and wages deflated by market value.
I wish to record my thanks to Jim Finnie and Chris McEvoy for their unflagging support, encouragement and guidance throughout this research.
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MEASURING THE ECONOMIC PROFITABILITY OF A FIRM

CHAPTER 1

INTRODUCTION

1.1 Area of Research

Although much research effort has been expended on investigating the relationship between a firm’s ‘economic profitability’, its structure and the characteristics of its product-markets, much less attention has been paid to what is meant by ‘economic profitability’ and how it can be measured. According to Scherer (1984), further progress in understanding these micro-economic issues is unlikely until there has been significant progress in the measurement of economic profitability at the firm level. This, according to Scherer, is a situation that frequently arises in scientific research - Kepler could not, for example, have postulated the Laws of Motion without Tycho Brahe’s improved observational data. This paper is addressed to meeting this need.

The need for better measures of economic profitability is not, however, confined to econometrics. Utility regulators and competition authorities also need to know how it should be measured if economic resources are to allocated optimally within an economy.

There have been a number of significant developments since Scherer drew attention to the problem. There is now a greater understanding of the theoretical links between the Accounting Rate of Return (ARR) and the internal rate of return, both at the level of investment in the firm as a whole and in terms of the internal rate of return on the firm’s own investments. Notwithstanding these advances, there is a growing practice amongst econometricians to abandon ARR and other ex post measures of a firm’s economic profitability and to employ
instead an ex ante measure, Tobin's q. q is the ratio of the
market value of a firm ascribed to it by security markets to
its replication cost, i.e., the cost of re-creating the firm.
Tobin (1969) conceived this ratio as a macro-economic measure
of the divergence between the demand and supply prices of
capital goods which would determine the rate of investment in
an economy, powerful forces tending to restore the ratio to
unity whenever it moved above or below that level. Lindenberg
and Ross (1981), however, saw q as an ex-ante measure of the
profitability of an individual firm. Strong claims about the
advantages of q as a profitability measure have been made, but
many of these claims have not been examined in detail and
alternative ways of estimating q have not been explored.

Subsequently, many economic researchers have employed q to
analyse profitability at the firm level, but there has been
little research of q itself and there is little common
framework for q and ex post rate of return measures.

1.2 A Brief Outline of the Research Undertaken
In Chapter 2, the question of what exactly is meant by
'economic profitability' is addressed. Using input-output
ratios expressed in present value terms one ex ante measure
and one ex post measure is derived. A further ex post measure,
related to the first, is derived using the risk adjusted
internal rate of return. The review of relevant literature in
Chapter 3 reveals that, whilst q is a powerful measure of
corporate profitability, it is not without shortcomings. In
particular, it depends crucially on an assumption that capital
markets are efficient, a matter on which there is not
universal agreement; it is more susceptible to the omission of
intangible assets or 'hidden capital' from its denominator
than is ARR; and it is distorted by taxation effects. The
review of the literature also indicates, however, that there
are shortcomings in ex post rate of return measures of
economic profitability. In particular, Davis and Kay have
identified an unexplained bias in ARR associated with the
extent to which firms buy in goods and services.
In Chapter 4 the bias in ARR identified by Davis and Kay is examined. An alternative to ARR is derived from the theoretical measure of ex post profitability identified in Chapter 2. This measure, called here the Return on Total Capital Employed (ROTCE), is applied to a simple corporate model where it indicates that the bias in ARR and other ex post measures can be significant.

In Chapter 5 an alternative to q is derived from the theoretical measure of ex ante profitability identified in Chapter 2. This measure, called here 'modified Tobin's q', or 'modq', is intended to reduce the bias in q due to the omission of hidden capital and to taxation effects. Like q, it can be estimated from information in current cost accounts. modq is essentially derived by replacing the firm's capital employed forming the denominator of q with an estimate derived by combining the Dividend Growth Model (DGM) and the Capital Asset Pricing Model (CAPM). The chapter concludes with a discussion of whether modq can be adapted to eliminate any bias due to capital market inefficiency.

Whilst ROTCE could be appraised by examining synthetic data provided by a simple corporate model, modq, with its dependence on market values, is evaluated using real data. This exercise, which is far from straightforward, is dealt with in Chapters 6, 7 and 8. If an absolutely reliable ex ante measure of a firm's economic profitability existed, modq could be appraised simply by comparing it with this measure. No such measure exists. q has, however, theoretical strengths and weaknesses that can be identified. Two tests are therefore devised in Chapter 6 to ascertain whether modq relates to q in the way predicted by the analysis:

Test 1
Is modq positively correlated with q?
Test 2
Is the difference between modq and q related to hidden
capital and taxation effects which q ignores?

Both tests are constructed as tests of a null hypothesis. In
Test 1 the null hypothesis is that modq is unrelated to the
firm's profitability as measured by q, ie it is worthless as a
profitability measure. In Test 2 the null hypothesis is that
the difference between modq and q is unrelated to the biases
in q that modq should eliminate, ie modq is nothing more than
a noisy estimate of q and adds nothing by way of information.
A third test of modq is also undertaken which is independent
of the properties of q. This is

Test 3
Does modq give an indication of profitability that is
consistent with a simple economic model in which supra-
normal profits are due to market power and its
appropriation by labour?

This test too was constructed as a test of a null hypothesis.
In this case the null hypothesis was that modq fails to
indicate levels of profitability consistent with the model.

Each of the tests was successful in that the null hypotheses
were rejected at the 95% confidence level. It is, however,
emphasised in the paper that such tests cannot 'prove' that
modq is a reliable profitability measure. They represent no
more than initial tests to establish whether modq is
fundamentally flawed.

The difficult problems of estimating the independent variables
needed to perform these tests are dealt with in Chapter 7. In
order to undertake Test 3, a novel way of estimating a firm's
market power is devised which might have applications in other
econometric research.
The paper concludes at Chapter 9 with suggestions for further research.
NOTES TO CHAPTER 1

1. The widely followed convention of referring to q, rather than Q, even when beginning a sentence, is followed in this paper.

2. To maintain consistency with q (see note 1), this paper follows the convention of referring to modq, never Modq.
Measures of economic profitability that can, in practice, be directly observed or estimated can be considered to be proxies for ideal measures that cannot necessarily be directly observed or estimated. In this chapter two ideal measures are specified against which the practical measures described in later chapters can be compared and the nature of any divergence or 'accounting bias' inherent in the practical measures identified.

In the analysis which follows, Hicks's concept of economic profit is shown to be of limited use in specifying a firm's 'economic profitability'. When, however, the firm's replication cost is employed, both the input-output ratio employing present values and the internal rate of return can be used to specify ideal measures and the accounting bias in practical measures.

2.1 Hicksian Profit
According to Hicks (1946), a company’s economic profit for a year is

'the maximum value which the company can distribute during the year, and still expect to be as well off at the end of the year as it was at the beginning'.

This definition depends on what is meant by 'well off'. Edwards, Kay and Mayer (1987) describe the almost universal acceptance in the academic literature that the extent to which firms or individuals are well off is described by the present value of future benefits accruing to them. The distributions made by a company can only be provided by the internal cash flow generated by the business or by new capital. Recognising these two principles, Sandilands (1975), drawing to work by Bonbright
(1937) and others, defined economic profit as

'the discounted net present value of all future net cash flows at the end of the year, less the discounted net present value of the future net cash flows at the beginning of the year, plus the net cash flow arising within the year after making adjustments for the introduction of new capital during the year'.

This definition does not mention whether the perspective is ex ante or ex post. The ex ante perspective is no later than the start of the financial year. The ex post perspective is no earlier than the end of the financial year, at which time the expectations about cash flows arising in the year have crystallised. Hicksian profit can accommodate either perspective by associating the present values with the expected present values at, respectively, the start and end of the current accounting period.

The definition of economic profit proposed by Sandilands does not easily relate to a concept of economic profitability. Two approaches are possible. The first, sometimes followed in the literature of industrial economics, is simply to express the Hicksian economic profit as a percentage of some functionally appropriate measure which reflects the scale of the firm. Thus, for example, Sawyer (1981) asserts that a firm's sales is the most suitable deflator when the profitability measure is required for profit maximisation models, and capital employed is the most suitable deflator for decisions on market entry. Edwards, Kay and Mayer (1987) adopt a similar functional approach, describing economic profitability as the appropriate measure of economic profit for answering practical questions about investment and disinvestment, market entry and exit etc over a finite period of time. A functional approach can, however, provide neither insight into what is meant by profitability nor a framework for further analysis. It is based on an insufficiently rigorous definition of what is meant by economic profitability and is rejected in
this paper. The second approach which overcomes these objections involves incorporating Hicksian profit into an input output-ratio. This and other ways of constructing input-output ratios are described below.

2.2 Problems with Using Hicksian Profit to Specify an Ideal Measure of Economic Profitability

When a firm's inputs in a particular period and the 'resulting' outputs, ie the outputs causally linked with these inputs, are both expressed in terms of their present values at the start of the period, the ratio of the two present values is an input-output ratio that provides an ideal measure of the firm's economic profitability. When the outputs are sold in markets without barriers to entry and the inputs are created with factors of production whose replacement cost reflects their ordinary Ricardian rent, the input-output ratio equals 1. When there are barriers to entry, other conditions remaining unchanged, the extent to which the input-output ratio exceeds 1 reflects the present value attributable to the firm's market power divided by the present value of its inputs. Gains accruing to a firm as a result of its market power are termed in this paper "supra-normal profits".

If Hicksian profit itself corresponded to a present value at the start of the year, the present value of a firm's outputs could be deemed to comprise the Hicksian profit and the discounted net present value of the future net cash flows at the end of the year. The causally linked inputs would then be the discounted net present value of the future net cash flows at the beginning of the year. From an ex ante perspective, Hicksian economic profitability, $EP_H$, might be defined as:

$$EP_H = \frac{H + \sum_{i=1}^{t} PV_{0,1}(X_i)}{\sum_{i=0}^{t-1} PV_{0,1}(X_i)}$$  \hspace{1cm} (1)
where: H is Hicksian profit;

\[ X_i \] is the net cash flow arising in the year \( i \) after making adjustments for the introduction of new capital in the year; and

\( P_{V_{0,0}}(.) \) is the present value operator at time \( t=0 \) based on expectations at time \( t=0 \).

Hicksian profit is not, however, expressed in present value terms at a single time. According to Sandilands's definition, Hicksian profit in period 1 from an ex ante perspective is:

\[
H = \Sigma_{i=1}^{T} [P_{V_{1,0}}(X_i)] - \Sigma_{i=0}^{T} [P_{V_{0,0}}(X_i)] + P_{V_{0,0}}(X_1)
\]  \( (2) \)

This is a mixture of present values at times at the beginning and end of the year. If the definition is re-stated in terms of present values at the beginning of the year, this results in \( EP_H \) equal to zero in all situations. If \( H \) is considered to arise at the end of the year, and substituting \( P_{V_{0,0}}(.) \) for \( P_{V_{1,0}}(.) \) using the relationship

\[
P_{V_{1,0}}(.) = (1+r) P_{V_{0,0}}(.)
\]  \( (3) \)

results in \( EP_H \) in all situations equal to \( 1+r \), where \( r \) is the firm's expected cost of capital. The results from an ex post perspective introduce the effect of changed expectations in the year but are otherwise no more meaningful. It is therefore concluded that \( EP_H \) cannot readily be adapted to become a meaningful measure of economic profitability. If the input-output ratio concept is to be retained, alternative ways of specifying a firm’s inputs and outputs are required.
2.3 Using the Present Values of Cash Flows in Input-Output Ratios to Specify Ideal Measures of Economic Profitability

In the analysis which follows, the present values of the cash flows generated by a firm are used in input-output ratios to specify ideal measures of economic profitability. As in the preceding analysis, a firm's cash flows can be viewed from either an ex ante or an ex post perspective.

2.31 Economic Profitability from an Ex Ante Perspective

Consider the ex ante perspective. Assuming that positive net present values accrue only to the shareholders and providers of loan capital (i.e., there are no other stakeholders), a firm's outputs in a particular period are the expected present value of dividends and interest on loan capital, net of any capital adjustments, expected in the period and the present value the owners would expect to realise at the end of the period. Abstracting from the opportunity cost associated with the commitment to sunk investment hypothesised by Pindyck (1988), inputs would then correspond to the replication cost of the firm for the providers of capital at the start of the period, i.e., the notional cost of replicating their entire interest in the business in its existing state and potential, including the cost of reproducing the internal organisation and external relationships. Thus, abstracting from capital adjustments, the ex ante economic profitability in the forthcoming period commencing at \( t=0 \) and ending at \( t=t_1 \) is \( EP_{1,t_1} \), where:

\[
EP_{1,t_1} = \frac{PV_{0,0}(Div(t_1)) + PV_{0,0}(Int(t_1)) + PV_{0,0}(NRVO_{t_1})}{PV_{0,0}(C_0)}
\]  

where: 
- \( C_0 \) is the cost to the providers of capital of replicating their interest in the firm at time \( t_0 \);
- \( Div(t_1) \) is the dividend paid in the period ending \( t_1 \);
- \( Int(t_1) \) is the interest on loan capital paid in the period
NRVO_{t_1} is the present value the owners could realise from their investment at time t_{1}; and

PV_{0,0}(.) is the present value operator at time t=0 employing expectations at t=0.

PV_{0,0}(NRVO_{t_1}) cannot readily be estimated, but can be eliminated by assuming that

\[ \text{Limit}_{t_1} = PV_{0,0}(NRVO_{t_1}) = 0 \]  \hspace{1cm} (5)

so that

\[ \text{Limit}_{t_1} = EP_{1,t_1} = \frac{\sum_{i=1}^{\infty} [PV_{0,0}(Div_i) + PV_{0,0}(Int_i)]}{PV_{0,0}(C_0)} \]  \hspace{1cm} (6)

where: \( Div_i \) is the dividend in year \( i \); and \( Int_i \) is the interest paid in year \( i \).

The limit of \( EP_{1,t_1} \) as \( t_1 \) goes to infinity represents the firm's anticipated input output ratio over all future periods. Referring to this as \( EP_1 \), it represents an ideal measure of economic profitability. Thus

\[ EP_1 = \frac{\sum_{i=1}^{\infty} [PV_{0,0}(Div_i) + PV_{0,0}(Int_i)]}{PV_{0,0}(C_0)} \]  \hspace{1cm} (7)

One aspect of \( EP_1 \) that is worthy of note is the meaning of \( PV_{0,0}(C_0) \) and the implication this has for \( PV_{0,0}(Div_i) \) and \( PV_{0,0}(Int_i) \). \( PV_{0,0}(C_0) \) is the notional cost, in expected present cost terms, of replicating the entire business in its existing state and potential. The costs incurred are those born by the
providers of equity and loan capital. It is worth considering what these costs comprise. They include not only the cost of acquiring and assembling the land, buildings, machinery and other assets of the business and the cost of reproducing the internal organisation and external relationships, but also the cost that such investment might have proved unsuccessful. Consideration of prior expectations indicates that

$$PV_{0,0}(C_0) = PV_{0,0}(C_0^e) + \frac{P(F)}{1-P(F)} C_0^s$$

where: $C_0^e$ is the cost of assembling the firm;

$C_0^s$ is the sunk cost when assembling the firm; and

$P(F)$ is the probability of failure when assembling the firm.

The discount rates applied to arrive at $PV_{0,0}(\text{Div}_t)$ and $PV_{0,0}(\text{Int}_t)$ are then the rates which reflect the risks arising after $t=0$.

2.32 Economic Profitability from an Ex Post Perspective

From the ex post perspective, a firm's outputs in a particular year can be identified as the sales receipts in cash terms in that year and the terminal value of the firm at the end of the year. The appropriate terminal value is the opportunity cost of the firm's investment at the end of the year. In a going concern this opportunity cost can be represented by the cost to the firm of replicating itself at the end of the year, i.e. the notional cost of recreating the entire business in its existing state, including the internal organisation and external relationships. Abstracting again from the opportunity cost associated with sunk investment, the corresponding input is the cost to the owners of replicating the firm at the start of the year and the expenditure incurred in the year. Thus, assuming that a firm's operational cash flows in the year, $X$, comprise
where: \( S \) is sales receipts in the year;

\( E \) is the fixed expenditure in cash terms in the year, i.e., that part of firm's operational disbursements that does not vary with demand; and

\( BI \) is the variable (or bought in) expenditure in cash terms in the year, defined as that expenditure which varies directly with demand.

\( EP_2 \), the input-output ratio employing present values which expresses the ex post economic profitability in a particular year, is

\[
EP_2 = \frac{PV_{0,1}(S) + PV_{0,1}(K_1)}{PV_{0,1}(K_0) + PV_{0,1}(E) + PV_{0,1}(BI)}
\]

where: \( K_0 \) is the expenditure that would be incurred by the firm to replicate itself at the start of the year; and

\( K_1 \) is the replication cost at the end of the year.

Assuming capital markets are efficient, \( K_0 \) has the same meaning as \( C_0 \) in the preceding section, except that it refers to the costs that the firm would incur rather than the costs the providers of equity and loan capital would incur to replicate the firm. As argued in later chapters, the only differences between \( K_0 \) and \( C_0 \) are, in effect, those due to taxation.

\( PV_{0,1}(.) \) represents the present value operator at time 0 based on expectations at time 1, but a small modification is needed before this can be applied in an ex post perspective. An ex post risk adjusted cost of capital is a tautology, as from the ex post
perspective, the risks will have crystallised. Thus, whilst other information at time $t = 1$ may be used, the discount factors employed to arrive at present values should be the rates anticipated for the year at the start of the year. This ensures that, in a competitive market without barriers to entry at the start of the year, $EP_2 = 1$ and supra-normal profitability is identified with $EP_2 - 1$.

2.4 The Internal Rate of Return
An alternative approach to defining economic profitability in terms of an input-output ratio is provided by the difference between the internal rate of return on an investment in a year and its expected opportunity cost of capital, $r$, in that year.

Solomon (1963) defined the internal rate of return as

\begin{quote}
\text{'the rate at which the incremental cash benefits... [from an investment]... have a discounted present value which is exactly equal to the discounted present value of all incremental outlays'}.\end{quote}

Internal rate of return has, according to Merret and Sykes (1973), an impressive economic pedigree with Fisher and Keynes amongst its exponents. It is, however, subject to two inherent weaknesses:

i. the problem of multiple solutions - if negative benefits arise, the definition above may not result in a unique rate of return; and

ii. the problem of ranking mutually exclusive investments - the order indicated is not necessarily the same as that indicated by the NPV.

As explained below, neither of these weaknesses represent a problem when the risk adjusted internal rate of return is employed to define the economic profitability of a firm.
Assuming a single cash flow $X$ arising in a year, continuous interest rates and an ex ante perspective, the internal rate of return is, according to Solomon's definition, the solution $IRR$ to the equation:

$$ PV_{0,0}(Inv) = \int_0^1 X \cdot e^{-IRR \cdot t} \, dt $$

(10)

where: $Inv$ is the cash outlay, including the original investment at time $t = 0$ and any outlays in the year; and

$X$ is the cash benefit, or non-investment cash flow.

Where there are several cash flows in the year, $X_i$, each with the same perceived level of risk, the internal rate of return is simply

$$ PV_{0,0}(Inv) = \sum_i \int_0^1 X_i \cdot e^{-IRR \cdot t} \, dt $$

(11)

Brealey and Myers (1984, page 78) point out that, where the non-investment cash flows $X_i$ do not share a common perceived level of risk, the above definition of internal rate of return results in a complex average of different rates associated with each cash flow. In consequence, the internal rate of return does not correspond to the cost of capital associated with the investment in its entirety. To achieve this it is necessary to specify a risk adjusted internal rate of return.

From the ex ante perspective, each investment cash flow has associated with it a present value, $PV_{0,0}(X_i)$ corresponding to
where \( r_i \) is the expected cost of capital or discount rate specific to \( X_i \);

Thus each investment cash flow has associated with it an amount receivable one year hence, \( RAE(X_i) \), which has the same level of risk as the investment as a whole, equal to

\[
RAE(X_i) = e^r PV_{0,0}(X_i)
\]

where \( r \) is the expected cost of capital or discount rate of the entire investment.

The risk adjusted internal rate of return, RAIRR, is the internal rate of return on this amount, ie it is the solution to the equation:

\[
PV_{0,0}(Inv) = \sum_i RAE(X_i) e^{-RAIRR}
\]

Therefore the risk adjusted internal rate of return is the solution RAIRR to

\[
PV_{0,0}(Inv) = e^{r-RAIRR} \left( \sum_i PV_{0,0}(X_i) \right)
\]
The profitability of the investment is indicated by its excess return above its opportunity cost of capital, RAIRR-r.

Adopting an ex post perspective, the risk adjusted internal rate of return on an investment is the solution RAIRR to the equation

$$ PV_{0,1}(Inv) = e^{r-RAIRR} \sum PV_{0,1}(X_i) $$

(16)

As with the ex post input-output ratio, the present value operator, $PV_{0,1}(.)$ must be modified to employ the anticipated discount rates at the start of the year rather than the ex-post rates, assuming these could be defined. The risk adjusted internal rate of return can then be compared with the anticipated cost of capital at the start of the year.

The ex post risk adjusted internal rate of return may be applied to measuring the economic profitability of a firm in two ways:

a. by analysing a firm's cash flows into discrete packets corresponding to particular investments and the returns thereon; and

b. by considering a firm's operating cash flows in a single year to represent a single investment and the returns thereon in that year.

The identification of project-level internal rate of return with a firm's economic profitability is an approach associated with Salamon (1973) and is discussed in the next chapter. The second approach is applied below to arrive at $EP_3$, the third ideal measure of a firm's economic profitability.

In the context of a firm's operating cash flows in a year, the Investment, Inv, is represented by $K_0$, the replication cost (to
the firm) of the business at the start of the accounting year, and the operating expenditure, \(E+BI\) disbursed in the year\(^5\). Non-investment cash flow \(X_i\) comprises the sales receipts in the year, \(S\), and the terminal value represented by the firm's replication cost at the end of the year, \(K_i\). The discount rates, \(r_i\), correspond to the discount rate, \(r_s\), associated with sales receipts\(^6\) and the discount rate, \(r_k\), associated with the terminal value. Thus the risk adjusted internal rate of return on the firm's annual operating cash flows is the solution, RAIRR, to the equation:

\[
P_{V_0,1}(K_i) + P_{V_0,1}(E) + P_{V_0,1}(BI) = e^{\text{RAIRR}}(P_{V_0,1}(S) + P_{V_0,1}(K_i))
\]  

(17)

where: \(r_s\) is the discount rate specific to sales receipts; and \(r_k\) is the discount rate specific to the terminal value.

The firm's risk adjusted internal rate of return as defined above may be compared with the firm's risk adjusted cost of capital anticipated at the start of the year, \(r\). This can be estimated in a number of ways, eg using the Capital Asset Pricing Model (CAPM), the Dividend Growth Model (DGM), or by comparison with the known cost of capital of another firm. When the firm's sales are made in markets without barriers to entry and its investment is made with factors of production whose replacement cost reflects their ordinary Ricardian rent, RAIRR = \(r\). Assuming the latter condition holds, RAIRR - \(r\) reflects the excess return attributable to market power. This is referred to in this paper as the rate of "supra-normal profitability". RAIRR - \(r\) is the third ideal measure of economic profitability and is identified as EP3. Thus, rearranging equation 17, EP3 is defined as:

\[
EP_3 = \text{RAIRR} - r = \log \left( \frac{P_{V_0,1}(S) + P_{V_0,1}(K_i)}{P_{V_0,1}(K_0) + P_{V_0,1}(E) + P_{V_0,1}(BI)} \right)
\]  

(18)
where log is the natural logarithm.

Comparing equations 9 and 18

$$EP_3 = \log(EP_2)$$  \hspace{1cm} (19)

Thus the difference between the firm's risk adjusted internal rate of return and its cost of capital, $EP_3$, is equal to the log of its input output ratio, $EP_2$. This provides a measure of corroboration for the preceding analysis.

As mentioned above, the internal rate of return suffers from two inherent weaknesses: multiple solutions and failure to rank mutually exclusive investments according to NPV. Neither of these weaknesses is a problem for $EP_3$, as multiple solutions do not arise with typical corporate cash flows and the practical applications to which measures of economic profitability are put (competition policy, utility regulation and economic research) do not generally concern choosing between mutually exclusive investment opportunities.

2.5 Defining Accounting Bias

$EP_1$, $EP_2$, and $EP_3$ represent ideal forms of economic profitability. As such, they provide benchmarks for defining what is meant by the 'accounting bias' in more practical measures.

A practical measure of economic profitability, MOEP, would be unbiased if

$$MOEP = EP_1 + e^{-}$$  \hspace{1cm} (20)

where: $EP_1$ is $EP_1$, $EP_2$, or $EP_3$ as appropriate; and
e- is an error term with zero mean.

The bias in a hypothetical measure of economic profitability is therefore identified with the systematic difference between the measure and the appropriate theoretical measure. It can be expressed in percentage terms as

\[
\frac{MOEP - EP_i}{EP_i} \quad (21)
\]

Accounting bias can also be demonstrated when there exists a variable w such that

\[
\frac{d}{dw}(EP_i) = 0 \\
\frac{d}{dw}(MOEP) \neq 0 \quad (22)
\]

It may not be necessary to observe \( EP_i \) before assuming that \( d/dw(EP_i) = 0 \). For example, if w were the proportion of the firm's directors who had red hair, it would be reasonable to assume that \( d/dw(EP) = 0 \). In consequence, a finding that \( d/dw(MOEP) \neq 0 \) could be sufficient to indicate accounting bias.

Finally, whilst \( EP_i \) may not be observable, proxies may exist which would enable the accounting bias in practical measures to be assessed.
1. Strictly, the Sandilands's definition does not require cash flow in the year and any new capital introduced in the year to be stated in present value terms, but this is taken to be a simplification which is ignored below.

2. It is quite logical to associate the terminal value of an asset with its opportunity cost as this is, by definition, the revenue it would generate in the best alternative use.

3. The division of expenditure into fixed and variable elements and the assumption that all expenditure can be classified in this way is to facilitate analysis in later chapters and does not effect the principles expounded in this chapter.

4. As the risk adjusted internal rate of return is an annual return, not a variable that varies throughout the year, it is not the solution $R$ to the equation

$$ PV_{0,0}(Inv) = \sum_i \int_0^t RAE(X_i) e^{-R.t} dt $$

5. See footnote 2 above.

6. Assuming, of course that individual sales receipts, $S_i$, are all of the same degree of risk.

7. Further corroboration is provided by an alternative derivation of EP, which links the measure with the weighted average risk adjusted internal rate of return on separate investments. In the simplest case, the firm can be considered to comprise two activities:

   i. a manufacturing activity with a risk adjusted internal rate of return $R_1$, being the solution to the equation

   $$ PV_{0,1}(K_0) + PV_{0,1}(E) = [PV_{0,1}(S_1) + PV_{0,1}(K_1)] e^{r-R_1} $$

   ii. a trading activity with an internal rate of return $R_2$, being the solution to the equation

   $$ PV_{0,1}(BI) = PV_{0,1}(S_2) e^{r-R_2} $$

Assuming customers are indifferent to whether the product they buy is manufactured internally or bought in, the exponential of $EP$ is equal to the simple weighted average of $e^{R_1}$ and $e^{R_2}$, weighted in proportion to the present value of each investment.

8. Provided both sales receipts and the terminal value are positive. A necessary condition for multiple solutions is, as Merret and Sykes (1973) point out, that the sum of the cash flows from any point in time must be negative.
CHAPTER 3

REVIEW OF LITERATURE

Introduction

Literature relevant to the use of Tobin's q as a measure of the economic profitability of a firm is widely scattered. This chapter commences with a review of the small body of literature dealing q as a profitability measure, and the somewhat larger body where q is employed as a profitability measure rather than forming the subject of the research itself. Next, the literature on the following five topics is reviewed:

3.4. The Fundamental Model of share value;
3.5 A firm's capital and the valuation of tangible assets;
3.6. Intangible assets and Hidden Capital;
3.7 The influence of taxation on q; and
3.8 The relationship between Beta and market power.

These topics are critical to the use of q as a measure of a firm's economic profitability, but there is often little or no reference to q itself in this literature.

The literature on ex post measures of a firm's economic profitability is more concentrated. This chapter concludes with a review of the literature on these measures.

With the exception of a particularly important paper published in 1990 by Kay and Davis and described in 3.92 and 3.94, the literature reviewed includes publications up to the end of 1989. Important literature published after this date is briefly surveyed at the end of the chapter.
3.1 Tobin's q as a Measure of a Firm's Economic Profitability

Tobin (1969) conceived the q ratio as a macro-economic measure of the divergence between the demand and supply prices of capital goods. In this formulation, the numerator comprises the market price of capital goods in an economy as valued by financial markets and the denominator comprises their "current reproduction costs", corresponding to the replication cost defined in the previous chapter. Tobin hypothesised that this ratio would act as a determinant of the rate of investment in an economy, with powerful forces tending to restore the ratio to unity whenever it moved above or below that level. The Bank of England (1976) pointed out, however, that this process might take a considerable time: it depended mainly on capital stock being increased or reduced by changes in the rate of investment. There were difficulties and costs attached to rapid adjustment; and such factors as technical progress, changes in taste and government policy would result in the equilibrium being adjusted before it was reached, leading to a more or less permanent divergence from unity. Others who have questioned whether q provides a basis for a satisfactory, economy-wide investment model include Chirinko (1985).

Hayashi (1982) pointed out that whilst q, the ratio of existing financial capital to existing capital stock, could be observed, the factor which induced capital investment was the unobservable 'marginal q', the ratio of incremental change in financial capital to incremental change in capital stock. Hayashi also demonstrated, however, that when the profit and installation functions were linear homogeneous in respect to capital and investment, marginal q and q were equal.

Despite its conception by Tobin as a determinant of future investment, this aspect has largely been ignored by researchers of the firm-level q ratio. Lindenberg and Ross (1981), Hayashi and many subsequent researchers have effectively defined q for an individual firm as
where: \( V_e \) is the market value of the firm's equity securities;

\( V_b \) is the market value of the firm's loan capital; and

\( C_o \) is the cost of replicating the firm; and

\( PV_{0,0}(.) \) is the expected present value operator at time \( t=0 \), based on expectations at that time.

All variables are measured at the same point in time (\( t=0 \)). For convenience, the present value operator is omitted in the analysis which follows, \( C_o \) being taken to be a single payment at this time.

Having assumed that capital markets reflect rational and informed expectations about future cash flows accruing to the providers of capital, Lindenberg and Ross, Hayashi etc argued that, for a competitive firm in long run equilibrium, \( q \) should be close to unity and that values in excess of unity could only be sustained if the firm possessed market power as a result of barriers to market entry. Thus, whilst no ideal measure of economic profitability was postulated, \( q \) was seen as filling this function as a result of the property:

\[
q = \frac{V_e + V_b}{PV_{0,0}(SNP) + C_o} \tag{24}
\]

where \( SNP \) is supra-normal profits accruing to the
shareholders', i.e. profits in excess of the risk adjusted cost of capital. Thus $q$ was seen to be a practical measure of economic profitability in that

$$q = 1 + \frac{PV_{0,0}(SNP)}{C_0}$$  \hspace{1cm} (25)$$

i.e. it was equal to $1+$ the expected present value of supra-normal profits deflated by the replication cost of the firm. A fuller exposition of this analysis is given in Chapter 5. Lindenberg and Ross identified the replication cost of the firm with the net replacement cost of its net assets. No attempt was made to compare $q$ with an idealised concept of economic profitability such as those developed in Chapter 2. This is also addressed in Chapter 5.

Attempts were, however, made to relate $q$ to a fundamental variable in the economics of a firm: the elasticity of demand it experiences. Salinger (1984) adopted a similar, analytical approach to Lindenberg and Ross in considering a firm's $q$ in long-run equilibrium. His analysis was as follows:

Assume that, in long run equilibrium with constant returns to scale and with no taxes or inflation, the value of the firm in security markets reflects rational expectations, so that:

$$V_e + V_b = C_0 + \int_t^{\infty} Q(P^- - MC) e^{-r(s-t)} \, ds$$  \hspace{1cm} (26)$$

where: $P^-$ is the price of the firm's output;
MC is the marginal cost;

Q is output; and

r is the firm's risk adjusted cost of capital.

Thus:

\[ q = \frac{V_e + V_b}{C_0} = 1 + \int_t^\infty \frac{(P^* - MC)Qe^{-r(s-t)}}{C_0} ds \]  \tag{27}

Defining the elasticity of demand, \( e_d \), as

\[ e_d = -\frac{\delta Q}{\delta P^*} = -\frac{dQ}{dP^*} \frac{P^*}{Q} \]  \tag{28}

Profit maximisation implies that:

\[ \frac{1}{e_d} = \frac{P^* - MC}{P^*} \]  \tag{29}

Substituting for \( P^* - MC \)
\[ q = 1 + \int_t^\infty \frac{S}{C_0} \frac{1}{e_d} e^{-r(s-t)} \, ds \]  

(30)

where \( S = P^Q \), the firm's turnover.

In the steady state with the firm's sales growing at a constant rate, \( g \), which is less than \( r \), and \( e_d \) unchanging:

\[ q = 1 + \frac{S}{C_0} \frac{1}{e_d} \int_t^\infty e^{(g-r)(s-t)} \, ds \]  

(31)

Evaluating the integral

\[ q = 1 + \frac{S}{C_0} \frac{1}{e_d} \frac{1}{(r-g)} \]  

(32)

Thus, if \( S/C_0 \) and \( g \) could be observed or estimated, Salinger demonstrated that \( q \) would provide a means of estimating the elasticity of demand, \( e_d \).

Sawyer (1985 p 165) followed a similar approach to Salinger. He also assumed steady growth and, abstracting from borrowing, derived a relationship for \( q \) in terms of the Accounting Rate of Return, ARR, using discrete time. Sawyer's analysis is as
Assuming the stock market value of the firm, \( V_e \), is determined by the expected future dividends, ie the Dividend Growth Model (DGM):

\[
V_e = \sum_{t=1}^{\infty} \frac{p \cdot Pt}{(1+r)^t}
\]  

where: 
- \( p \) is the constant payout ratio; 
- \( r \) is the cost of capital; and 
- \( Pt \) is the profit in year \( t \).

By definition

\[
ARR = \frac{Pt}{K_{t-1}}
\]  

where: \( ARR \) is the Accounting Rate of Return; and 

\( K_{t-1} \) is the net replacement cost of the firm's capital stock, at the start of the year \( t \).

If \( ARR \) is constant

\[
g = (1-p)ARR
\]  

and
Thus

\[ V_e = \frac{p \text{ARR} K_0}{(1+r)} \sum_{t=1}^{\infty} \frac{(1+g)^t}{(1+r)^t} \]  

(37)

Summing the geometric progression:

\[ \frac{V_e}{K_0} = \frac{p \text{ARR}}{(r-g)} \]  

(38)

Assuming \( K_0 \) and \( C_0 \) are equivalent and substituting for \( p \)

\[ q = \frac{\text{ARR}-g}{r-g} \]  

(39)

Sawyer finished the analysis at this point, but a further step can be taken. Substituting for the unobservable \( g \) in the above and rearranging:

\[ q = \frac{p}{\text{ARR} - (1-p)} \]  

(40)

The above equation has attracted little attention but is significant for \( q \)'s use as a profitability measure. Whilst
recognising that it was derived from the DGM and therefore ignores Modigliani and Miller's argument (1958) that, if capital markets are efficient and taxes are ignored, payout ratios are irrelevant to valuation, it indicates that \( q \) depends on the payout ratio, ie \( dq/dp \neq 0 \). If the payout ratio is considered to be a purely financial variable that affects shareholders but not the economic profitability of the firm, and assuming there is no compensating error in the other terms, it indicates that, according to the criterion proposed in the previous chapter, \( q \) is subject to accounting bias.

Researchers have pointed out a number of advantages in using \( q \) to measure economic profitability. Salinger argued that, in a competitive market in which monopoly profits cannot be earned, a firm faces a horizontal demand curve, ie the elasticity of demand is infinite. In this situation, the equilibrium value of \( q \) is unity. Where the firm has some market power and is in a position to earn monopoly profits, it confronts a demand curve with a negative gradient ie the elasticity of demand is finite. Salinger observed that, assuming the term \((r-g)\) in equation 32 is small, and the market value of the firm's share capital reflects all anticipated monopoly profits, \( q \) is sensitive to these anticipated monopoly profits; but this sensitivity depends on all inputs being provided competitively: if, for example, labour were able to price itself so as to share in any monopoly profits, the sensitivity of \( q \) to these profits would be diminished. Salinger argued that this sensitivity to monopoly profits made \( q \) a better measure of profitability in economic studies of the structure-performance paradigm than accounting rates of return. Other advantages over accounting rates of return identified by Salinger were as follows:

(a) \( q \) was independent of the choice of an asset pricing model, while profit rates could only be compared with an estimate of the risk-adjusted required rate of return;
(b) the market value of a firm captured more information than accounting data; and

(c) q could be measured more precisely than the rate of profit as:

(i) profit is the difference between two larger items, revenues and costs, and was therefore highly sensitive to measurement errors in either;
(ii) the rate of profit could be distorted by the effects of inflation; and
(iii) depreciation charged in arriving at the accounting profit could differ from economic depreciation.

Hirschey (1985), apparently working independently of Salinger, saw similar advantages in using q to examine the relationship between profitability and market structure. He referred to the 'compelling virtue' of an approach based on the market value of the firm which minimised the effect of 'accounting bias'. He did not explain what he meant by 'accounting bias', but the context of his discussion suggests that he was primarily referring to the fact that market values reflect the value of intangible assets including the economic value of prior years' expenditure on R & D and advertising. It appears, however, that he may also have included in his concept of accounting bias the possibility that management can influence a firm's reported profits through exercising discretion over when profits are realised and manipulating reported profits by 'creative' or misleading accounting.

Shepherd (1986), in an exchange with Smirlock, Gilligan and Marshall (1986) following their (1984) study of market structure and Tobin's q, argued that there is no advantage in using q in econometric studies of the conduct-structure-performance paradigm as q was 'conceptually debatable' and difficult to measure due to the volatility of
market values and the difficulty in defining and estimating the replacement cost of net assets. McFarland (1987(1)) recognised that difficulty in estimating the replacement cost of net assets and the omission of intangible assets were features which Tobin's $q$ shared with the accounting rate of return, although not necessarily to the same extent. McFarland (1987(2)), nevertheless, considered $q$ 'far superior to the accounting rate of return as a measure of economic profitability', whilst recognising that:

(a) $q$ could only be applied to the activities of the firm as a whole; and

(b) $q$ could not detect otherwise supra-normal profits if these were captured by employees or managers or dissipated by inefficiency.

The failure of $q$ to reflect profits dissipated through inefficiency (referred to as 'x-inefficiency in the literature) is a feature shared with other measures of profitability. As, however, $q$ captures the present value of all future profits accruing to the shareholders, x-inefficiency is a problem when using $q$ for profit measurement only if it is persistent - or, more precisely, if financial markets believe it will be persistent. Ashton (1987) argued that there were a number of influences on firms which tended to eliminate x-inefficiency in the longer term, including the threat of take-over, the need to minimise costs in order to compete in export markets, the finite life of many product-markets and, in the case of contestable product markets, the threat of market entry. If Ashton is correct, $q$ should be less susceptible to x-inefficiency than other profitability measures as it reflects the present value of all future profits.
3.2 Econometric Studies Employing $q$

With the initial perception of $q$ as a determinant of economy wide investment, it is unsurprising that empirical studies were initially directed to this end using aggregated data. As Blundell, Devereux, Bond and Schiantarelli observed (1987), the model did not prove noticeably successful in explaining economy wide investment. Galeotti (1988) observed that the disappointing performance of the $q$ model in this area was associated with evidence of omitted variables, mis-specification and poor goodness of fit.

Lindenberg and Ross (1981) pioneered the use of $q$ as a corporate level measure of profitability in empirical studies. $q$ was estimated for some 250 US corporations, average values for each firm over the years 1960-1977 being calculated. The market value of the firm was taken to be the sum of the market value of equity, preference shares and debt: equity was valued as the product of the quoted share price and the number of shares in issue; preference shares were valued by comparing their yield with the Standard and Poor's Stock Yield; and debt was valued in terms of the coupon rate, the current yield to maturity associated with that firm's bond rating and simple assumptions about how debt matured. The unavailability of replacement cost data for all but the year 1977 required Lindenberg and Ross to estimate earlier replacement costs of fixed assets by a method involving indexation and backward extrapolation from the 1977 figure. The fact that advertising expenditure, R & D and specific training costs were expensed in accounts but could represent substantial intangible assets was noted, but no allowance was made for these factors other than to note that they would bias $q$ upwards. The mean share price over many years appears to have been taken in order to average out disequilibrium effects. Finding an average value of $q$ for the sample of about 1.5, Lindenberg and Ross commented that "capitalised rents [ie monopoly profits] earned by firms in the sample had been sufficient to keep the firm's market value approximately 50% above the replacement cost of
its assets". Such a conclusion appears not to be very soundly based, given the likelihood that there were intangible assets which had been ignored. Lindenberg and Ross concluded their study by regressing \( q \) on an estimate of Lerner's Index\(^6\) and the estimated weighted four-firm concentration ratio for each firm in the sample. They found that the Lerner Index, represented by the ratio of sales less operating expenses to sales, was a statistically significant independent variable but there was no significant relationship between \( q \) and concentration. The explanatory power of Lerner's Index was, however, slight - \( R^2 \) was only 0.08 - although the researchers claimed this was not unreasonable for cross-sectional regressions.

Lindenberg and Ross's general approach to calculating \( q \) has been adopted, with minor variations, by subsequent researchers. Typically, \( q \) has been estimated in a similar manner and employed as the dependent variable in ordinary least squares regression studies in which the independent variables reflect the structure of the firm and its markets. Thus, Smirlock, Gilligan and Marshall (1984, 1986) estimated the net replacement cost of fixed assets by forward extrapolation from an estimate of the commencing replacement cost found by indexing the book value, rather than by the backward extrapolation used by Lindenberg and Ross. An average \( q \) was calculated for each firm in a sample of 132 US manufacturing firms for the period 1960-69. High \( q \), assumed to reflect monopoly profits was found to be associated with high market share but not with market concentration. This finding, they argued, weakened the validity of the so-called Structure-Conduct-Performance paradigm, although this conclusion was hotly denied by Shepherd (1986). Wernerfelt and Montgomery (1988) used Lindenberg and Ross's data to conclude that narrowly diversified firms do better than widely diversified firms.

Salinger (1984) also adopted similar procedures to Lindenberg
and Ross, except that $q$ for a specific year (1979) for 252 US corporations was calculated, rather than the average $q$ for a number of years. Reasoning that with such a narrow temporal cross-section, disequilibrium might be a significant factor, an independent variable representing growth in demand was included in the regression. The intangible assets representing earlier years' investment in advertising and R&D were represented by three years' expenditure on advertising adjusted for inflation, depreciated exponentially at a rate of 0.3, and three years expenditure on R&D, depreciated exponentially at a rate of 0.1. Each item was divided by the estimated replacement cost of tangible capital forming the denominator of $q$ and was included among the independent variables. The coefficients of these terms were found to be positive and significant. Independent variables representing market concentration were, again, found not to be significant. $R^2$ was 0.43. In a further study of 175 firms the influence of labour unionisation was studied. This study involved non-linear least squares (OLS) regression and, while the results were somewhat ambiguous, they suggested that unionised workers captured on average 77% of the monopoly profits that might otherwise have accrued to the shareholders.

Like Salinger, Hirschey (ibid) made some allowance for intangible assets formed by past expenditure on advertising and R&D by inclusion of the ratios of advertising spend to sales and R&D spend to sales as independent variables in an OLS study of 370 US corporations. Also like Salinger, there was no attempt to estimate a firm's average $q$ over a long period: market values at a single date (31 December 1977) were estimated to arrive at the numerator of $q$; the accounting data used to estimate the denominator of $q$ presumably referred to the nearest accounting year end to this date, but no confirmation of this is given in the paper. $R^2$ of about 0.3 was achieved and, whilst the independent effects of both market share and related firm size were statistically insignificant, the effect of concentration was found to be
negative and "modestly significant" in explaining q.
Contrasting with these findings, q was found to be more closely related, in terms of both significant individual coefficients and overall explanatory power, to growth in earnings and to R&D and advertising intensity, leading Hirschey to comment that previous uncertainty over the economic importance of various market structure variables might have been caused, at least in part, by failure adequately to consider the influence of R&D and advertising.

Other empirical studies of q for US firms have been undertaken - for example, Smirlock, Gilligan and Marshall (1984), Lustgarten and Thomadakis (1987), and McFarland (1987(2)). The last named researcher is notable for seeking to overcome the disequilibrium effect by comparing the firm's q ratio, not with the theoretical unity value but with the average q of all non-financial firms.

McFarland (1987(1)) adopted a totally different approach to empirical research of q by studying the relative error in q and the accounting rate of return (ARR) arising from ignoring hidden capital and employing depreciation schedules for tangible capital assets which do not reflect economic depreciation. Employing Monte Carlo methods on synthetic data from a universe of 20,000 firms, McFarland found that both q and ARR were fairly highly correlated with the internal rate of return on new investment, and both measures indicated in most cases the presence or absence of supra-normal profits. Both measures were, however, found to be subject to large errors in individual cases and these errors could be seriously misleading. Tobin's q generally had smaller errors than ARR and a higher correlation with the internal rate of return on new investment, which led McFarland to conclude that it was more suitable than ARR for econometric studies, but performed neither consistently better nor consistently worse than the accounting rate of return for detecting supra-normal profits earned by a particular firm.
Many interesting avenues for empirical research of \( q \) remain unexplored. Most empirical research using firm level data has been based on US firms (an exception is Blundell, Devereux, Bond and Schiantarelli (ibid)) and the data has generally been obtained from computer files such as Compustat in a rather mechanistic manner. The estimation of replacement costs of fixed assets using forward or backward iteration is, at best, a means of arriving at a rough estimate and, for UK companies, ignores a largely unutilised source of data: the published information on the current cost of assets contained in the Current Cost Accounts published in the first half of the 1980s. In the work cited above, no account was taken of the influence of taxation and gearing on the equilibrium value of \( q \); and financial markets were assumed, often implicitly, to be efficient in the sense that they reflected rational expectations (this is also true of McFarland’s study on synthetic data). Growth in earnings or capital was found to be an important determinant of \( q \) by Hirschey, yet the inclusion of this variable suggests that the true causal variable was not identified.

3.3 Other Applications of \( q \) as a Profitability Measure
Apart from McFarland, economists have generally confined their interest in and use of \( q \) at the corporate level to measuring profitability in econometric studies. In such studies, which are often concerned with the relationship between sustainable and undiversifiable supra-normal profits and market structure, a portfolio approach is generally employed, so that transitory and firm-specific excess profits, which are of little interest in this context, are eliminated. Ohlson (1989) recognised, however, that such profits are reflected in the \( q \) of an individual firm. It might therefore be thought that \( q \) would be of interest to a wider group including financial analysts and the wider financial community. These groups have, however, shown little interest in \( q \). Unlike that other ratio combining financial market and accounting data, the Price Earnings ratio, \( q \) receives relatively little attention in the financial
press and is not, as a rule, discussed in general texts describing useful ratios in financial analysis. This may reflect a view that, whilst q may be of potential interest to competition authorities engaged in detecting supra-normal profits, it does not appear very suitable for detecting 'under-valued' shares in financial markets subject to asymmetrical information. By including the market value of the firm in the denominator, q may be seen as already compounding all the available information about the firm's prospects. This view, however, overlooks the fact that the analyst's skills are still needed to evaluate the denominator of q, and, by including the market value of the firm in the numerator, the extent to which market views are compounded may be no more than occurs when, say, the Accounting Rate of Return of a firm is compared with a market derived estimate of its cost of capital. As, however, the concern of this paper is with measuring economic profitability with a view to meeting the requirements of econometricians, utility regulators and competition authorities, any failings of q perceived by financial analysts are of limited concern.

3.4 The Fundamental Model of Share Value
The question whether financial analysts can identify 'under-valued' shares using any conceivable profitability measure may be beyond the scope of this paper, but the question of whether, to what extent, and in what sense, capital markets are efficient must still be addressed. Both Lindenberg and Ross's conclusion that q reflects anticipated supra-normal profits and Salinger's conclusion that q reflects the elasticity of demand rely on the assumption that capital markets reflect rational and informed expectations about future cash flows accruing to the providers of capital. In effect, it is assumed that stock prices reflect the present or discounted value of future dividends. Furthermore, as the market value of a company is found by multiplying the current share price by the number of shares in issue, there is also a requirement that these expectations, and the discount factors
employed are homogeneous. Such assumptions are referred to in
the literature as the Fundamental Model of share value. If the
Fundamental Model is to be employed in the subsequent analysis
this paper, it is necessary to consider whether it remains
plausible.

The concept of stock market "efficiency" is also employed in a
related but different context to that of the Fundamental
Model. According to the Efficient Capital Markets Hypothesis
(ECMH), stock prices reflect all the information that is
available about the future cash flows from firms to
shareholders. Three levels of efficiency are recognised in the
literature:

a. Weak Efficiency, when share prices fully reflect the
   information implied by all prior price movements;

b. Semi-Strong Efficiency, when share prices respond
   instantaneously and without bias to newly published
   information; and

c. Strong Efficiency, when share prices fully reflect all
   relevant information including data not yet publicly
   available.

Le Roy and Porter (1981) demonstrated that ECMH implies and is
implied by the Fundamental Model. Thus rejection of ECMH would
result in rejection of the Fundamental Model. Jensen (1986)
asserted that there is no better documented proposition than
Weak and Semi-Strong Efficiency in any of the social sciences.
Summers (1986), on the other hand, argued that many of the
statistical tests used to support capital market efficiency,
especially those indicating that share prices follow a random
walk (Weak Efficiency), have very low power. Scepticism about
ECMH has been growing as a result of apparent stock market
anomalies which would appear to provide opportunities to earn
"excess" profits. Fama and French (1988), for example,
referred to the mounting evidence that stock returns are
predictable. Others, however, find this evidence
unpersuasive. Thus, for example, Pearce (1987) concluded after an extensive review of the literature that this type of evidence was insufficient to reject the ECMH. The issue remains, however, one of the most fiercely debated in economics.

Other evidence concerning capital market efficiency is more directly relevant to the Fundamental Model. Tobin himself (1984) observed that, whilst it was [then] the long standing judgment of almost all academics in economics and finance that securities markets were efficient in terms of Weak and Semi-Strong Efficiency, the Fundamental Model was more doubtful. Tobin quoted two pieces of evidence for this view: Shiller's (1981) study of share price volatility; and the behaviour of share prices when there are takeovers, which he described in the following terms:

"Takeover mania, motivated by egregious under valuations, is testimony to the failure of the market in this fundamental valuation criterion of efficiency".

In the study referred to by Tobin, Shiller, using an approach similar to that of LeRoy and Porter (ibid), examined the volatility of the Standard & Poors Composite Index over the years 1871-1979 and concluded that it exhibited volatility of between five to 13 times that which would have been expected with perfect foresight of dividends. Such 'excess volatility' can be explained by volatility in real rates of interest, but the range of some ten percentage points required appeared to be unreasonably high. The validity of these tests for 'excess volatility' turns on the adequacy of the statistical tests employed. Scott (1985), for example, modified the statistical approach and found "overwhelming evidence" against the Fundamental Model; but whether the existence of 'excess
volatility' has been demonstrated sufficiently to undermine the Fundamental Model remains a matter of dispute, as West's (1988) review of the literature confirms.

Tobin's view that merger and acquisition activity in security markets was inconsistent with the Fundamental Model appears to be a popularly held view in the financial press, where merger activity is attributed to the detection of 'under-valued' companies. Thus, prior to a bid, a firm is seen as being valued too cheaply, at least by those trading in small quantities of shares relative to its value under rational expectations. Under an alternative view, which also implies market inefficiency, much merger activity is seen as the result of over-ambitious management of bidding companies who are prepared to pay unjustified premiums to acquire target companies ('merger mania').

According to the Fundamental Model, markets do not 'under value' firms prior to a bid. Any premium to the market price is attributed to a payment to secure for the bidder a share of advantages accruing to the enlarged group such as increased market power, savings in overheads resulting from joint operation and other synergy. Thus, whilst some departure from homogeneous expectations is implied, merger-induced premiums in the share prices of companies are held to be consistent with the Fundamental Model. Another explanation for merger-induced premiums, which is also consistent with the Fundamental Model, is provided by Shleifer and Summers (1987) who argued that takeover gains come largely from breaching implicit contracts with stakeholders of the firm such as employees and suppliers.

It is difficult to establish by empirical studies whether merger activity does indeed represent a departure from the Fundamental Model. Franks and Harris's (1986) study of over 1800 UK mergers in the period 1955-1985 found that the target company's share price rose by an average of 23% on an equal
weighting basis in the month of the bids. This premium was 30% for a six month period around the bid to allow for leakage of information and delayed reaction to the news. Consistent with other studies, significant gains for the acquiring shareholders were not, however, detected. If the premium in the target company's shares was due to anticipated gains through improved efficiency or increased market power (which creates shareholder gains but no social wealth), it is difficult to see why these gains were not more equally shared between vendor and acquire. Perhaps the only safe conclusion to draw from all aspects of the debate on merger activity as it affects q as a profitability measure is that, when a company is known to be the target of a bid, q will not reliably indicate future profitability of the existing undertakings.

Doubts about the efficiency of capital markets in a fundamental sense are not confined to the issues of 'excess volatility' and 'merger mania'. Summers (1986) argued that the Fundamental Model and a 'fads' hypothesis under which prices react immediately but too violently to new information would be indistinguishable in most tests. A study by Nickell and Wadhwani (1986) suggested that the 'fads' hypothesis takes the form of market myopia in which short term events are over-valued relative to more distant prospects ('short termism'), but Porterba and Summers (1986) found that shocks to stock prices did not persist for long periods - many had half lives of less than six months and some had lives as short as one month. This suggests that the effect of this type of market inefficiency on Tobin's q might be overcome by employing the average security price over a number of months.

Pindyck (1984) pointed out that how investors perceived risk was an important issue that required more attention: if, for example, investors believed that there was a low but non-negligible probability of economic catastrophe (as many UK investors must have thought in 1974) this might have a
significant and rational downward influence on share prices but, in the absence of the feared collapse, would not show up in tests of market efficiency based on subsequent earning and dividends. Also relevant to this problem is an earlier investigation by Brainard, Shoven and Weiss (1980) into the decline in US corporate stock values in the 1970s. This study was based on a sample of 187 firms for which they computed the ratio of aggregate market value to aggregate intrinsic value under a variety of assumptions about rational expectations. Attempts were made to explain this so-called Z value in terms of various independent variables, but with only limited success. Brainard, Shoven and Weiss, like Pindyck, concluded that general pessimism about the future was the hardest factor to capture when examining the rationality of market values. They did claim, however, that changes in the 1970s in some of the explanatory variables they examined suggested that there had been a general loss in confidence in the US capital markets in this period, a finding which would help to explain the fall in share prices at that time without conflicting with Semi-Strong Efficiency. A finding by Brainard, Shoven and Weiss of particular interest for the study of \( q \) was that the most important variable for explaining the Z value was the gross rate of return of the particular firm. The coefficient for this variable was generally positive and significant, which they interpreted as an indication that firms possess substantial and long lived intangible assets such as 'trademarks, monopoly power or key personnel'. Weiss also agreed that this 'hidden capital' did not appear to depreciate as quickly as tangible assets, although the evidence for such a conclusion appears, in both instances, to be thin.

Many non-academics in economics and finance, particularly market practitioners, are less than convinced about all forms of market efficiency. Fundamental analysis in the securities industry involves detecting 'under-valued' securities, reflecting the assumption in Graham and Dodd's standard work for investment analysts (revised 1988) that share prices
oscillate around their rational equilibriums.

A common technique used by investment analysis is to look for departures of the level of wide-ranging indices, such as the FTA All Share Index, from the levels suggested by the Fundamental Model. This 'misvaluation', if it exists, would represent a 'systematic' over or under-valuation of the individual security which would not be eliminated in cross-sectional samples. It is therefore referred to in this paper as 'Systematic Inefficiency'. The Equity Risk Premium Chart from County Nat West Wood Mac is an example of a belief in Systematic Inefficiency. Ross's presentation to the 1988 National Association of Pension Funds Conference confirms that the concept is also inherent in the way actuaries value investments. In his presentation, the FTA All Share Index was compared by Ross with the value estimated using actuarial principles and assumptions, a key one of which was, in effect, the Fundamental Model. Ross found over and under-valuations of up to 40% persisting for a year or more. Another example of the actuarial approach is found in the estimation of over and under-valuation of the FTA 500/487 Industrials Index by Plymen (1987). Plymen compared what he referred to as the 'real yield' on the index with the return on long dated government securities from which the return due to future inflation had been eliminated. The 'real yield' employed by Plymen was simply the yield calculated in terms of the dividends paid in the following year so as to make some allowance for the lag due to deferred declaration and payment of dividends. This particular piece of work is flawed: the correction for future inflation is tautologous: in effect the 'real' interest rate is simply the return on index linked government securities which, for periods prior to their introduction, was assumed to be 3.5% or, when the return on long dated government gilts was above 12%, 4% to reflect in an admittedly arbitrary fashion the premium afforded to indexation at times of high inflation. Furthermore, Plymen made allowance neither for the risk premium on equities needed to compensate for their greater
volatility relative to that of government securities nor for the anticipated long-term growth in the real level of dividends. An important implicit assumption made by Plymen and used in other examples of this type of work is Irving Fisher's proposition that nominal interest rates reflect the expected, real interest rate and the expected rate of inflation. Bleaney (1987) commented that this proposition has a long history of failure in tests against empirical data, although Bleaney's own tests using data from eleven OECD countries from 1961 to 1981, went some way to correcting this.

Black (1986) took a position midway between academics committed to capital market efficiency and practitioners whose livelihood depends on exploiting perceived inefficiencies. Black generously defined an efficient capital market as one in which price was within a factor of two of the fundamental value for at least 90% of the time. In Black's view, 'almost all markets' are efficient in this sense, but, in a way reminiscent of Heizenberg's Uncertainty Principle, he postulated that 'noise' in information on future returns to shareholders ensured that deviations in market prices from fundamental values could not be measured with precision.

Non-heterogeneous expectations amongst shareholders would not be consistent with the Fundamental Model. As Steele (1986) pointed out, if expectations about a firm's future cash flows are non-heterogeneous, the demand curve, AB, for a firm's shares, illustrated below, would be downward sloping:
Demand for Shares when Expectations are Non-heterogeneous

Thus, if the quoted price is determined by the price \( P_1 \) at which a small number of shares \( Q_1 \) can be sold, and larger volumes, say \( Q_2 \), can only be sold to potential buyers for a lower price \( P_2 \), reflecting their less sanguine expectations about the firm’s future cash flows, the product of the quoted share price and the number of shares in issue would over-state the market value of the firm, with the result that \( q \) would be over-stated.

A popular view often reflected in the financial press is that price and quantity are inversely related, i.e., the demand curve is indeed initially downward sloping. This view appears to be based on the casual, empirical evidence that it is difficult to realise large blocks of shares at the quoted price. In this respect, it is notable that the London Stock Exchange SEAQ trading system assumes that prices and volumes are related. Similar assumptions underlie the TSA Capital Adequacy Rules. Research by Scholes (1972) of secondary share issues on the NYSE suggests, however, that this view is mistaken. Scholes found no significant relationship between the size of the

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issue and the deviation of the share price, and concluded that elasticities of demand were negative and large, ie the demand curve corresponded to CD in the diagram, not AB. Scholes' study was carefully constructed to avoid any possibility that the share disposals examined were associated with inside knowledge and new information reaching the market. This condition may not apply to more typical large transactions. Thus Holthausen, Leftwich and Mayers (1987) found some evidence that large transactions initiated by buyers on the NYSE had a permanent, upward effect on prices which was related to the transaction size, but no evidence of a corresponding, permanent downward effect from seller-initiated transactions was found, and the authors concluded that the effect could have been due either to imperfectly elastic supply curves or the impact of buyers' information. They also pointed to earlier, empirical studies which generally indicated a permanent price effect, but which disagreed over whether these effects were related to the size of the transaction. Thus the apparent relationship between quantity and price does not necessarily signify that the Fundamental Model has broken down: it could be the result of the demand schedule slipping from CD to EF due to new information reaching the market. This information could simply be the market's belief that the shareholder selling the large volume of shares has some inside knowledge that the shares should be sold at price $P_1$. Non-heterogeneous expectations and the Fundamental Model are therefore difficult to distinguish.

It is not easy to reach a final conclusion on whether the Fundamental Model of share value should be rejected. Tobin's argument that the excess volatility observed in share prices and the behaviour of the corporate mergers are inconsistent with the Model has been disputed by others. The circumstantial evidence of non-heterogeneous expectations is open to alternative explanation and has not been confirmed by some empirical research. Alternatives to the Fundamental Model, such as Summers's fads hypothesis, have not won universal
acceptance. Thus the Fundamental Model cannot be said to have been discredited. Whilst it may not provide a perfect model of share pricing, its employment in later sections of this paper would, therefore, appear to be justified. The possibility that share prices incorporate a degree of systematic over or under-valuation is not, however, dismissed. Such a possibility is considered in the subsequent analysis.

3.5 A Firm's Capital and the Valuation of Tangible Assets

According to Tobin's original formulation, the denominator of q is the current 'reproduction cost' of the firm's capital. Tobin did not define the term, but he appears to mean the cost of replicating the firm, including its intangible assets such as trained staff, brands and knowhow. The term used in Chapter 2 for the same concept is the firm's 'replication cost'. When adapted by Lindenberg and Ross and others as a practical firm-level measure of profitability, the denominator of q has been represented by the book value (i.e., the value extracted from accounts) of tangible assets less liabilities valued on a replacement cost basis. Hirschey (1985) is typical in his use of q in that the denominator is taken to be the net replacement cost of 'tangible assets' disclosed in the 10K reports filed by US corporations with the Securities and Exchange Commission, and there is no indication that care was taken to match, in a logical way, the denominator with the chosen numerator. Assuming borrowing is included in the q numerator, and ignoring the intangibles not disclosed in accounts, the q denominator should comprise, in accounting terminology:

fixed assets;
current assets;
less liabilities and provisions other than borrowing and dividends due.

Reflecting their background as economists rather than
financial analysts, most researchers using q in econometric studies have shown little interest in the precise form used and whether data derived from accounting systems and intended for very different purposes are suitable. They have generally relied on summarised data such as that provided by Compustat and 10K reports with little qualification or justification. In particular, whether, even in the absence of intangible assets, net replacement cost is a suitable proxy for 'reproduction cost' has generally not been addressed in this context. In a different area of research, that of accounting theory, there is, however, a considerable body of literature on the question of asset valuation which is highly relevant to the consideration of what is the appropriate denominator of q.

The Sandiland Report (1975) observed that the concept of deprival value had been originally proposed by Bonbright (1933) and was accepted by a large number of researchers of accounting as representing the value of an asset to its owner. In proposing the use of deprival value for accounting purposes, Bonbright commented that:-

'The value of a property to its owner is identical in amount to the value of the entire loss, direct or indirect, that the owner might expect to suffer if he were to be deprived of the property'.

Edwards, Kay and Mayer (1987) stated that the basic technique of establishing the minimum loss a firm would suffer if it were deprived of an asset, pre-dated Bonbright and originated from the USA in the 1920s.

The basis of valuation now referred to as the current cost basis is related to deprival value and can be expressed as follows:

\[
CC = \text{Min} \ (RC, EV)
\]
and

\[ EV = \text{Max} \ (PV, NRV) \]

where:
- CC is the current cost or value to the owner;
- RC is the net replacement cost;
- EV is the economic value, defined as above;
- PV is present value of future cash flows discounted at the risk adjusted cost of capital; and
- NRV is the net realisable value.

Whittington (1983) considered this basis of valuation to be to some extent a practical technique without much theoretical justification; but according to Kay and Mayer (1985) and Edwards, Kay and Mayer (1986), economically significant results are obtained when the basis is employed to value initial and terminal values in discounted cash flow calculations. This conclusion was corroborated by Devereux's (1986) simulation exercise, notwithstanding the use of straight line depreciation to arrive at the net replacement cost of assets.

Edwards, Kay and Mayer described four 'practical objections' to the current cost basis. They appear to mean by this that there are difficulties in employing the current cost basis, but a corollary of their concerns is that published current cost valuations may be unreliable. The four practical objections identified were:

(a) **Subjectivity** - this is a feature of all aspects of the current cost asset valuation process, but is particularly significant in the estimation of present
values.

(b) **Arbitrary Capitalisation** - expenditure is capitalised or written off according to accounting convention which embodies no universal recognition that accounts should reflect the economic substance over form.

(c) **Inconsistent Valuation of Intangible Assets** - again intangible assets may be included, or more usually, excluded from company balance sheets according to accounting convention.

(d) **Aggregation** - Edwards et al pointed out that under the current cost convention, rules were needed to allow for any interdependence of assets under which the replacement cost of groups of assets would not equal the sum of individual costs, or the economic value of groups of assets would not equal the sum of individual economic values. They proposed that, in order to adhere to the principle of valuing according to the minimum loss suffered on deprival of an asset, replacement cost, \( RC \), in the definition of current cost should be defined in ex post analysis as:

\[
RC = \min \left[ \sum_{i=1}^{N} \min (RC_i, EV_i), RC_i \right]
\]  

(41)

where: \( RC_i \) is the replacement cost of the \( i \)th asset (or liability);

\( EV_i \) is the economic value of the \( i \)th asset (or liability):
RC\textsubscript{T} is cost of replacing all the firm’s N assets and liabilities.

The ASC’s Guidance Notes on SSAP 16 (1980) recommended practical methods intended to assist those preparing current cost accounts, but did not address the problem of aggregation.

Differences also exist between current reproduction cost conceived by Tobin and the corresponding net replacement cost employed in current cost accounting, sometimes called the ‘net current replacement cost’. As the ASC Guidance Notes make clear, net current replacement cost comprises two elements: gross current replacement cost, representing the cost of acquiring a new, modern equivalent asset with the same service potential, and accumulated depreciation, representing consumption of this service potential. The method of calculating depreciation is, therefore, an important determinant in the valuation of fixed assets.

According to the ASC Guidance Notes, the cost of a modern equivalent asset was generally to be estimated using specific indices. Secondhand market prices were only to be used to determine gross replacement costs, and only then when existing assets were bought in that market. As subsequently recognised by the ASC Handbook on Accounting for the Effects of Changing Prices (1986), this approach reflected the concept of Physical Capital Maintenance. An alternative approach, advocated by Kay and Mayer (1985), recognised in the ASC Handbook, and recommended by Byatt (1986), is the concept of Financial Capital Maintenance. Under this concept, which derives from the concept of a contestable market, assets should be valued at the price at which they could be bought for in a rational second-hand market. Given the original analysis in terms of the divergence of the markets for financial and physical assets, this is closer to Tobin’s original concept of current
reproduction cost than it is to Physical Capital Maintenance advocated under SSAP 16. This difference will tend to generate different depreciation profiles, and hence different net replacement costs under the two concepts, but in practice the accounting depreciation profile employed in published Current Cost accounts is invariably arrived at under the straight line method. Negative depreciation, required for example under Physical Capital Maintenance when the service potential is enhanced, is not allowed on account of the definition of depreciation in SSAP 12, originally as the allocation of capital to revenue so as to charge a fair proportion to each accounting period, and, in the current version, the measure of the wearing out, consumption or other reduction in the useful economic life of a fixed asset. The employment of conventional depreciation profiles, particularly straight line depreciation, in published Current Cost accounts suggests that net current replacement costs disclosed in such accounts may be systematically over or under-stated relative to the theoretical current reproduction cost. Carsberg and Lumby (1986) proposed a method of estimating economic depreciation in the water industry by employing so called 'tilted annuities'. OFTEL in effect employed this approach (1986) to estimate the current reproduction cost of British Telecom's tangible net assets. This approach is, however, based on an assumption that the net revenue generated by fixed assets over their entire lives is constant after allowing for specific inflation. Such an assumption may be reasonable for a state regulated monopoly where the regulatory authority is concerned to ensure that different generations of consumers do not cross-subsidise each other; but it would be less suitable for a price-taker where net revenues cannot be controlled by the firm through the pricing mechanism. Furthermore, Awerbuch (1988) has pointed out that annuity depreciation is sensitive to departures from constant net revenue generation assumed by OFTEL and is unlikely to produce accounting measures any better than those obtained with straight line depreciation; and, as already noted, Devereux found in a simulation exercise
that, in aggregate, straight line depreciation performed well. In the absence of knowledge about the profile of the cash flow anticipated from the continued employment of existing assets, the net current replacement cost of a firm's fixed assets disclosed in the firm's current cost accounts may therefore represent a reasonable proxy for their current reproduction cost required as the denominator of \( q \). Similarly, straight line depreciation can be expected to perform adequately in iterative techniques used by Lindenberg and Ross and others for estimating net current replacement costs from indexed historical costs.

Econometricians have generally employed exponential depreciation in their empirical work. This is computationally simple as, when the real rate of growth in capital expenditure is constant, a book value for the capital stock of assets on a net replacement cost basis may be estimated as follows:

\[
BV_0 = \frac{I_0}{g+d}
\]

(42)

where: \( BV_0 \) is the net current replacement cost book value;

\( I_0 \) is the current level of capital expenditure;

\( g \) is the 'real' rate of growth in capital expenditure in previous years; and

\( d \) is the rate of exponential depreciation.
The real rate of growth in capital expenditure, \( g \), is estimated from past levels of capital expenditure indexed by an appropriate index of replacement costs.

Financial economists (eg Brealey and Myers, page 248) are content to define 'economic depreciation' as the decline in the present value of an asset, but do not explain what discount rate should be used to arrive at this present value and give little indication of the relationship between the replacement cost of a new and a used asset. These shortcomings and the significance of exponential and other conventional depreciation methods are examined in Appendix 1.

3.6 Intangible Assets and Hidden Capital

If \( q \) is to indicate profitability as in equation 25, capital cannot be confined to net tangible assets. If a firm without supra-normal profits is to retain a \( q \) value of 1, account must be taken of intangible assets. Such intangible assets are referred to as 'hidden capital'.

There is some guidance on the disclosure in accounts of current values of intangible assets, including brands and goodwill, but the practices recommended are not conducive to systematic disclosure of information that might be used in quantitative analysis.

SSAP 16 required intangible assets other than goodwill to be valued in Current Cost accounts in the same way as tangible assets, but the Guidance Notes on SSAP 16 state that:

'\ldots it is not intended that current capital costs should be established where it has not been the practice under the historical cost convention to capitalise such costs.'

In the absence of a requirement to disclose current values of
such intangible assets as patents and copyrights in a comprehensive way, any amounts disclosed in Current Cost accounts will generally be of limited interest.

The acquisition cost of acquired brands which are separately identifiable may be disclosed in balance sheets, but revaluation was discouraged in Technical Release TR7 38 issued by the Accounting Standards Committee in 1989 on the grounds that there was no generally accepted method of calculation.

Purchased goodwill arises when a business combination is accounted for as an acquisition. SSAP 22, issued in December 1984, defined purchased goodwill as the difference between the fair value of the consideration given and the aggregate of the fair values of the 'separable net assets' acquired. It is required to be written off immediately or, alternatively, capitalised and amortised on a systematic basis over its 'useful economic life'. SSAP 16 did not, however, require capitalised goodwill to be re-stated in current cost terms.

The historical cost of purchased goodwill is of limited interest even at the time of the acquisition. Edwards, Kay and Mayer pointed out that the economic value of an acquisition can exceed its cost as the consideration paid would reflect the existing reputation of the acquiring company and efficiency gains following acquisition in addition to the reputation of the acquired company. Other factors not mentioned by Edwards, Kay and Mayer include the non-additivity of elements of economic value and the contribution to the historical cost of purchased goodwill represented by payment to acquire and extend market power. Economic interpretation of the historical cost of purchased goodwill in the years following the acquisition is further impeded by the absence of a rational basis for determining how the historical cost should be depreciated. Simon and Unwin (1981) criticised the analysis in a Discussion Paper by a working party of the
Accounting Standards Committee (1980) which concluded that the useful economic life of purchased goodwill was approximately 2½ times the exit PE ratio of the acquired firm. It may, however, have been less in recognition of Simon and Unwin’s criticism than in response to pressure from preparers of accounts to minimise the charge to the profit and loss account that the subsequent Exposure Draft, ED30, made no mention of the approach recommended in the Discussion Paper - Appendix 1 to SSAP 22 simply states that it is not possible to specify general rules regarding the useful economic life of purchased goodwill. Views of preparers of accounts are perhaps better represented by Stacey (1987) who argued that purchased goodwill was sufficiently long lived to require capitalisation but no depreciation. Although rejected in subsequent guidance from the ASC, support for such a policy is provided by Utton’s (1986) study of the profitability of markets and firms referred to the Monopolies and Mergers Commission. This study found that monopoly profits could persist for decades. Thus, to the extent that purchased goodwill reflects the capital value of future monopoly profits, a policy of capitalisation without depreciation makes sense.

As SSAP22 acknowledged, there is no difference in character between purchased goodwill and non-purchased goodwill. The exclusion of the latter from published accounts means that, even if the problems of valuation and depreciation referred to above were resolved, the amounts disclosed are only of interest in the context of merger activity. Thus the amounts disclosed as goodwill by companies will seldom through any light on the firm’s current reproduction cost forming the denominator of Tobin’s q.

There is wide agreement that, as a result of the accruals concept, ‘assets’ under both the historical and current/replacement cost conventions comprise expenditure that is capitalised in order that depreciation can be matched against the resulting ‘future economic benefits’ - this
expression is used in FASB's Statement of Financial Concepts (1980), IASC's Exposure Draft on a Framework for the Preparation and Presentation of Financial Statements (1988), and in Exposure Draft 42 (1988). The items actually treated as 'assets' in published accounts represent, however, a more narrowly chosen selection of capitalised expenditures whose range is largely determined by ad hoc accounting conventions. The term 'hidden capital' is used in this paper to represent those expenditures which result in 'future economic benefit', but which are expensed in the accounts.

Expenditure on advertising has long been identified as a possible source of hidden capital. Weiss (1969) commented that 'the treatment of long-lived advertising as current expenses leads firms that invest heavily in such intangibles to over-state their rates of return since their equity is under-stated ... Investments in research and on-the-job training are also "expensed" although they yield benefits mainly in the future'. Telser (1961) argued that advertising expenditure can be viewed as a capital good which depreciates over time and needs maintenance and repair. Ayanian (1983) observed that the on-going debate over the competitive effects of advertising which has been, in large measure, a debate about the economic durability of advertising expenditure, commenting that:

'Knowledge of this durability is crucial to interpretation of the well-known positive cross-sectional relation between accounting rates of return and advertising intensity, as measured by advertising to sales ratios. Although other explanations are possible, the main contending hypotheses to explain this relation are barriers to entry and accounting bias.'

One of the 'other explanations' referred to by Ayanian is that firms that advertise really are more profitable than those that do not. Moriarty and Salamon (1988) argued that, even if
the effect of advertising lasts for months rather than years as Comanor and Wilson (1974) and Clarke (1976) concluded, a positive association between advertising intensity and profitability would still arise if profit maximising firms spent more on advertising to defend products earning supernormal profits behind existing barriers to entry. This explanation is referred to below as the 'Sub-optimal Expenditure Hypothesis'.

The idea that expenditure on R&D can generate hidden capital has been accepted more readily. Before SSAP 13, issued in 1977, prohibited the capitalisation of research expenditure and set tough conditions for the capitalisation of development expenditure, some firms did indeed capitalise R&D expenditure. The reason given in SSAP 13 for effectively prohibiting capitalisation was that no one period could be expected to benefit from the expenditure. This argument is disingenuous - no fixed asset can be said, ex ante, to benefit any particular future period. It is true that most R&D expenditure is, by its nature, unsuccessful, but, as Stauffer (1975) pointed out, unsuccessful R&D is an unwelcome but integral part of the process of obtaining success and all outlays in a given period should be charged against the future income streams generated by the fraction of the expenditure which is successful. Hirschey and Weygandt (1985) commented that, while a policy of capitalising advertising and R&D was controversial, acceptance of the view that they represented intangible assets was increasing. A more likely explanation for the policy promulgated in SSAP 13 is, therefore, that it was felt that, following the collapse of Rolls Royce, companies could not be trusted to write capitalised R&D down to the lower of cost and realisable value and a policy of almost total prudence was called for in this area.

Attempts by econometricians to value hidden capital arising from expenditure on advertising and R&D have generally involved capitalising the relevant expenditure, often after
some form of indexation has been applied, to arrive at gross current replacement cost, and then deducting the estimated accumulated depreciation. In order to estimate the accumulated depreciation, it is necessary to employ a depreciation method. The depreciation method often employed by econometricians is the computationally simple one of exponential depreciation, but, as explained in Appendix 1, this method depends on a number of assumptions about the nature of the lag between expenditure and benefit which may not be appropriate.

Evidence about the lag between expenditure on advertising and R&D and the subsequent benefits is limited. In the case of R&D, Schott’s (1976) study based on answers to a questionnaire sent to 300 major UK manufacturing companies is informative. The survey concerned the characteristics of applied research in 1971 or 1972. 178 replies were received: of these, 17 failed to quantify their answers and 63 said they did no applied research. Results from the remainder indicated that, on average, 36% of the research effort was devoted to projects completed in the year, 9% to projects abandoned in the year and 55% was devoted to projects which continued in subsequent years. 60% of research projects worked on in the year were completed within two years. These estimates suggest that applied research undertaken by UK manufacturers is of relatively short duration. The delay between completion of a research project and incorporation in a product or process was also found to be relatively short: 64% of projects were expected to be incorporated within one year and 80% within two. On the other hand, the lifespans of processes and products incorporating the research were thought to be long. The survey showed the following anticipated lifespans:

<table>
<thead>
<tr>
<th>Process</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 years</td>
<td>25</td>
</tr>
<tr>
<td>6-10 years</td>
<td>40</td>
</tr>
<tr>
<td>11-15 years</td>
<td>19</td>
</tr>
<tr>
<td>More than 16 years</td>
<td>16</td>
</tr>
</tbody>
</table>
It is clear from the above that the benefits to UK manufacturers from applied research could, after a fallow period of two or three years, accrue over a decade or so. This suggests that, when the research spend over a number of years is known, a more complex depreciation profile than the exponential might usefully be employed. This idea is developed further in Appendix 1.

Evidence from the pharmaceutical industry also indicates that the lag between R&D expenditure and the benefit arising is not straightforward. Jordan’s 1986 survey of the industry stated that it took between 12 and 14 years to develop a new drug and bring it to the market. The survey quoted the Association of the British Pharmaceutical Industry as considering that there then remained only about four years in which the invention might be exploited. As in most countries patents are filed at a very early stage of R&D and last for twenty years, the ABPI estimate may indicate that the protection afforded by patenting breaks down before the patent expires. Barclays de Zoete Wedd (1988) estimated a shorter development time - some 6-9½ years, broken down as follows:

<table>
<thead>
<tr>
<th>Duration</th>
<th>Success rate¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research planning, chemistry and patent search</td>
<td>1-2 years</td>
</tr>
<tr>
<td>Pre-clinical testing on animals</td>
<td>2-3 years</td>
</tr>
<tr>
<td>Testing on healthy humans</td>
<td>0.5-1 year</td>
</tr>
<tr>
<td>Small group trials</td>
<td>1-1.5 years</td>
</tr>
<tr>
<td>100+ patient studies concurrent with factory scale-up</td>
<td>1.5-2 years</td>
</tr>
</tbody>
</table>

¹ Success rate is the likelihood of a compound tested reaching the market.
These estimates suggest that the lag between R&D expenditure and the benefit arising differs fundamentally in the pharmaceutical industry from that in manufacturing industry: in the former, the fallow period is long and the period over which benefits are generated is short; in the latter Schott's data suggest that the opposite is more typical.

There is very little evidence about the typical lag between expenditure on advertising and the subsequent benefits. Comanor and Wilson (1974) and others have attempted to estimate the rate of decay of advertised-induced sales from the correlation between current sales and advertising spend. Ayanian (1983) criticised this approach on the grounds that the estimated sales decay rates were marginal sales decay rates and did not reflect long-run effects. As Ayanian demonstrated, a significant portion of advertising expenditure depreciating rapidly is not inconsistent with a low overall average advertising depreciation rate. Kotler (1976, p 367) described techniques used by advertising practitioners, such as recall and recognition testing, which could be adapted to estimating typical advertising decay rates but commented that the amount of fundamental research on advertising effectiveness was 'appallingly small'.

Hirschey and Weygandt (1985) said that there was no consensus over the depreciation rates or estimated useful lives of the hidden capital represented by expenditure on advertising and R&D; their own estimates, based on an empirical study of 390 large US firms with $q$ as the dependent variable, indicated that R&D amortisation rates generally fell in the 10 to 20% range and advertising amortisation rates were in the 10 to 20% range for non-durable goods and 30 to 60% range for durable goods. Hirschey's earlier (1982) study of the same data used the ratio of firm market value to the book value of assets as the dependent variable and was a cruder effort. It
nevertheless produced not dissimilar results. In Hirschey's later (1985) study of the same data, market concentration, market share and relative firm size added little explanatory power to the model when q was used as the dependent variable. Ayanian (1983) employed data from Comanor and Wilson's 1974 study of 39 US industries to re-estimate the original regression equation in which the dependent variable was the industry average accounting rate of return. The independent variables were amended to include the ratio of advertising spend to tangible capital employed and the explanatory power of the regression equation was found to be maximised when, in effect, a depreciation rate of 20 to 30% was applied to capitalised advertising expenditure.

One difficulty with the above studies that is not always recognised by the researchers is that, while the findings are generally inconsistent with the Sub-optimal Expenditure Hypothesis, the explanation that the expenditure creates a barrier to entry enabling supra-normal profits to be earned cannot be so readily dismissed. This explanation is a plausible one and has, for example, led the Monopolies and Mergers Commission (then the Monopolies Commission) to recommend limits to advertising intensity in the detergents market (1966).

It is difficult to distinguish between the hidden capital effect and the barrier to market entry effect. There is, however, some evidence to suggest that the hidden capital effect is the correct explanation. Ayanian (1983) found that when an accounting policy of depreciating hidden capital at the rates he had estimated was adopted, industries with a high advertising intensity were, on average, no more profitable than those with a lower advertising intensity. Demsetz (1979) examined the inter-temporal correlation of profit rates of groups of industries with different advertising intensities and rates of growth in advertising and, finding no difference between producer and consumer goods industries, concluded that
advertising does not create a barrier to entry.

The possibility that expenditure on staff could generate hidden capital was recognised by Telser (1961) but has generally been the subject of separate research. Much of this research has been directed at ways in which firms should account in their management accounts for this so-called 'human capital'. Some of the research is, however, helpful in indicating how an external financial analyst might value human capital. Thus, the Report of the American Accounting Association Committee on Human Resource Accounting (1973) identified the costs associated with human capital as those of recruiting, selecting, hiring, training, placing and developing staff. Less attention has, however, been paid in economic literature to other elements of human capital represented by expensed items which generate deferred benefits to the employing firm such as:

(a) deferred remuneration, eg loyalty payments and employee and executive share option schemes, which are accounted for under generally accepted accounting practices in a prudent manner;

(b) pension fund contributions - even following the introduction of SSAP 24 in May 1988, pension contributions are accounted for in a conservative manner with no immediate account taken of pension fund surpluses and the benefit accruing to the employing firm as a result of depressed transfer values which provide, in effect, a deferred loyalty payment to long stayers; and

(c) the opportunity cost of restrictions on the free movement of staff within an industry, eg covert no-poaching agreements between firms.
Likert and Pyle (1971) defined human capital as the cost of replacing the entire human organisation of a firm. This definition takes account of the firm's investment in infrastructure as well as those elements deriving from deferred remuneration identified above. Managers, when asked by Likert and Pyle to estimate such human capital, came up with figures within a range of two to ten times the annual payroll. The wide range undoubtedly reflects uncertainty over the concept as well as estimating error and firm diversity.

Sydenham (1979) described mathematical models using the Markov process to model the expenditure/benefit profile of investment in human resources and suggested that human capital could be negative for some firms. The distinction between negative human capital and an ability of a well organised workforce to appropriate supra-normal profits is, however, a fine one: as already noted, Salinger found unionisation negatively associated with Tobin's q for a sample of US firms - a finding he interpreted as employee appropriation, but negative human capital would also provide an explanation.

The valuation of human capital is also of interest to financial analysts, especially where firms have skilled employees and few tangible assets, i.e. so-called people intensive businesses. This interest was intensified by the wave of take-overs of financial services and advertising companies in the second half of the 1980s. Sydenham (1979) had argued that there was no conceptual basis for capitalising salaries of higher paid employees with a bigger multiplier than was applied to less well paid employees. While this argument appears counter-intuitive, some financial analysts appear to agree: Financial Weekly (17 September 1987, p.4) referred to a so-called PD or People Dependent ratio for assessing financial services companies; this ratio employed staff numbers, rather than staff costs, as the denominator, the numerator being the market value of the firm less the net book value of its assets.
Shleifer and Summers (1987) argued that a firm is a nexus of informal, long-term contracts between shareholders and stakeholders (employees, suppliers etc). Such contracts could also represent an investment with a non-zero replacement cost and would therefore represent another form of hidden capital, i.e. 'stakeholders' capital'. Neither economists nor financial analysts appear to have addressed how the replacement cost of stakeholders' capital might be estimated.

It has been assumed above that the appropriate basis for valuing the various forms of hidden capital identified is replacement cost. It is possible, however, that, like any other asset, the replacement cost of hidden capital might exceed its economic value, in which case the lower value would represent its current cost or deprival value. Edwards, Kay and Mayer commented that a firm's hidden capital (which they associated with its reputation) would typically have an economic value less than its replacement cost, but their reasons for this view are not completely clear. There would certainly be huge diseconomies of scale in replicating investment in R&D, brands and people if this were attempted within too short a time, but the concept of replication should allow for orderly and optimal expenditure discounted to a single present value to arrive at replacement cost.

Furthermore, empirical research by Grabowski and Mueller (1978) indicates that the economic value of R&D generated hidden capital exceeds its replacement cost: above average returns on investment in hidden capital generated by research and development expenditure were found, indicating that the economic value of the investment in R&D exceeded its replication cost. This finding needs, however, to be treated with caution: as Freeman (1974) commented, the uncertainty surrounding innovation means that, among alternative investment possibilities, R&D projects were unusually dependent on what Keynes described in a celebrated passage (1936) as "animal spirits". Freeman also noted that empirical evidence indicated that, in practice, more advanced portfolio
methods were seldom used for R&D selection. This might help explain the above average returns on R&D found by Grabowski and Mueller: if decisions on investment in R&D ignored portfolio effects, it might result in sub-optimal investment levels, ie R&D projects would be declined even though their anticipated returns were sufficient to recover their risk adjusted cost of capital. This could have the effect of inflating the rate of return on the investment that was made.

An assumption implicit in valuing hidden capital in terms of capitalised and depreciated expenditure is that the benefits of the expenditure are not shared with other firms. This would not be the case if firms engaged in, possibly covert, co-operative agreements on R&D. Jacquemin (1987) argued that such agreements would be fragile and unstable and are therefore not very common. R&D 'spillover' need not, however, depend on collaboration between firms. Empirical research by Jaffe (1984) on US corporations indicates that all R&D expenditure influences the performance of firms with related products and technology: where R&D in a firm's vicinity in what Jaffe describes as "product-technology space" increased, the firm tended to do more R&D itself, to produce more patents per dollar from this work and to increase its overall productivity more quickly, suggesting that R&D generated hidden capital depends on the expenditure of firms engaged in the same or related markets or employing similar technology. The possibility of spillover of other categories of hidden capital has received less attention, even though it appears likely: advertising spillover would arise when advertising has a generic component or where it assists in blocking market entry by potential competitors; human capital spillover would arise when firms draw from the same labour market - for example, when staff join another employer in the same industry, some of the benefits of training might accrue to the new employer. Finally, the interaction between advertising, R&D and investment in staff is possible. Hula (1988) argued that advertising could affect a firm's incentive, ability and
willingness to engage in R&D and might encourage R&D through making diversification more attractive. Similar interactions involving staff investment are conceivable but appear not to have been addressed.

3.7 The Influence of Taxation on q

Under a so-called 'classical' corporation tax system in which interest on borrowing is deductible in arriving at a company's taxable profits, dividends are not tax deductible, and interest and dividends are taxed at the same rate in the hands of the recipients, the owners of a firm can increase their post-tax income by converting part of their interest in a company from equity into loan capital. As, according to the Fundamental Model, the value of a company reflects rational expectations about future cash flows accruing to the providers of capital, and these cash flows are, by definition, post tax, it suggests that the value of a company with loan capital should be greater than the value of the same company without loan capital. This increase in value is referred to in the literature as the 'tax shield' on borrowing.

The tax shield is described by Brealey and Myers as a "valuable asset" of a company. The concept that such an increase in capital value can be viewed as an intangible asset, rather than, say, a reduction in the company's cost of capital, may appear to conflict with accountants' concepts of what comprises an asset. There is no formally accepted definition in the UK of what comprises an asset, but the ASC proposed in ED 42 (1988, para 14) that assets are

'probable future economic benefits controlled by and accruing to a particular enterprise as a result of past transactions or events'.

The tax shield is consistent with this definition, in that:
a. there is a probable future economic benefit in the form of the increased cash flow payable to the shareholders of the company;

b. the benefit is not under the control of anyone other than the company and its shareholders and accrues to the company and its shareholders; and

c. it arises as a result of past transactions and events, namely the incidence of the borrowing and the imposition of tax by the government.

The significance of the tax shield for \( q \) is that the inclusion of such an intangible asset in the denominator normalises \( q \) in a world of taxes and borrowing, so that \( q=1 \) continues to correspond to 'normal' profitability. This is referred to in the literature as the 'tax wedge effect'. According to Porterba and Summers (1983) and King (1986(2)), there are, however, two views of the valuation of corporate equity. Under the so-called 'traditional view', the market value of a firm would, in a steady state, exactly equal the replacement cost of its assets, ie the equilibrium value of \( q \) would be unity. In effect, there would be no tax wedge, ie the value of the tax shield asset would be nil. Under the alternative 'trapped equity model', the tax relief on borrowing is capitalised into share price, so that, if the tax shield asset is ignored, the equilibrium value of \( q \) is less than unity. In a simplified version of the trapped equity model, King (1986(1)) demonstrated that the equilibrium value of \( q \) under the UK imputation tax system would be:

\[
\frac{1-T}{1-t}
\]

(43)
In a fuller analysis (1986(1)), King made it clear that this result depends on the assumption that the company is indifferent as to its choice of its debt - equity ratio as per the Modigliani-Miller theorem (see below) and as to its dividend policy. Two other models were also considered by King:

(a) a model in which agency costs of borrowing and/or bankruptcy costs become positive after some critical debt-equity ratio - under this regime the equilibrium value of q lies between \((1-T)/(1-t)\) and 1; and

(b) a model in which agency costs of borrowing are a function of the debt-equity ratio, resulting in an equilibrium debt-equity ratio - under this regime, the equilibrium value of q is unity.

Ashton (1989) addressed the question of whether personal taxation could be ignored and pointed to a lack of detailed and accessible discussion of the UK imputation tax system. He concluded that it was possible to use formulae and models that made no explicit reference to personal tax rates, but fairly strong assumptions about the nature of equilibrium returns were necessary - in particular the irrelevancy of dividend policy.

It is shown in Appendix 2 that, with the UK imputation tax system, the equilibrium value of q under the trapped equity model is:

\[
1 - \frac{T - tp}{1 - tp} = \frac{1 - T}{1 - tp}
\]

(44)

where \(p\) is the payout ratio. This, of course, implies that the value of a company is reduced by the payment of dividends (an apparent paradox given that firms do pay dividends referred to
as the 'Dividend Puzzle').

A consideration of the trapped equity model begins with Modigliani and Miller's seminal analyses (1958 and 1963). According to this analysis,

\[ TSB = V_b T' \]  \hspace{1cm} (45)

where: \( TSB \) is the present value of the tax shield;
\( V_b \) is the market value of borrowing; and
\( T' \) is the anticipated corporation tax rate under a 'classical' corporation tax system.

Lewellen and Emery (1986) and others have adapted equation 45 to the UK imputation tax system by substituting

\[ T' = \frac{T - t}{1 - t} \]  \hspace{1cm} (46)

where: \( T \) is the Corporation Tax rate; and
\( t \) is the income tax rate.

This, however, ignores the fact that only that portion of taxable profits that is paid out as dividend results in a tax credit. If UK corporation tax is considered to result in a mainstream corporation tax charge and personal taxes are ignored (ie the cost of capital is considered for convenience to be the rate at which pre-personal tax cash flows are discounted):
where $p$ is the payout ratio, i.e. the ratio of gross dividends to profits after mainstream corporation tax. Thus, on an imputation tax basis which applies in the UK, the tax shield predicted by Modigliani and Miller is:

$$TSB = V_b \frac{T - tp}{1 - tp}$$ (48)

The payout ratio and the tax rates employed above are the anticipated rates which could be assumed to be constant in all future periods. Another key assumption employed above is that investors consider it to be the intention of management to maintain the present level of debt, $V_b$, indefinitely and are fully confident that this can be achieved. Lewellen and Emery preferred the assumption made by Miles and Ezzell (1980 and 1983) that borrowing is assumed to be periodically re-balanced in response to evolving information on cash flows. In effect, the capital gearing ratio is maintained at the initial level and the annual tax saving is seen as dependent on there being sufficient profit to support this level. Accordingly, after the first accounting period, tax savings are discounted at the firm's (unleveraged) cost of equity capital. Under this approach:

$$TSB = V_b \frac{r_u (1 + r_u)}{(r_u - g) (1 + r_0)} T'$$ (49)
where: \( r_o \) is the interest rate on default-free debt;
\( r_u \) is the firm's (unleveraged) cost of equity capital;
and
\( g \) is the anticipated steady rate of growth in earnings,
dividends and debt.

Masulis (1983) commented that, despite a wide acceptance in principle of the tax shield effect, there was little empirical evidence of any relationship between capital structure and firm value other than Modigliani and Miller's rather narrowly based work on public utilities. To fill this gap, Masulis conducted a study of 14 recapitalisations and 119 exchange offers in the US between 1963 and 1978. Ignoring anticipated growth in borrowing, his findings were consistent with a tax shield effect with a valuation enhancement per dollar of borrowing in the range 0.23 to 0.45.

Under the Adjusted Present Value (APV) approach favoured by Brealey and Myers (1984), tax savings from debt are discounted at the default-free interest rate, ie they are assumed to be pre-scheduled and certain. Lewellen and Emery (ibid) demonstrated that the APV approach is equivalent to valuing the tax shield as follows:

\[
TSB = V_b \left( \frac{r_o}{r_o - g} \right) T' \tag{50}
\]

Whilst the trapped equity model is both plausible and supported Masulis's findings, none of the methods above to value the tax shield is completely satisfactory. In arriving at equation 48 it is unrealistic to assume that tax savings are pre-scheduled and certain. This formulation does, however, avoid the awkward assumption in equation 49 that the riskiness
of the tax saving changes abruptly at the end of the current accounting period. Furthermore, equation 49 employs \( r_u \) - the firm's cost of (unleveraged) equity capital - which introduces a degree of circularity into the equation, as the cost of unleveraged equity is unobservable and must be estimated after making assumptions about the tax saving from debt. Furthermore, equation 50 assumes that \( r_u \) is greater than \( g \). This is not a necessary condition for the firm as a whole. At a more fundamental level, none of the models explains why companies in practice limit borrowing. Thus no account is taken of the risk of corporate bankruptcy, no allowance is made for personal tax liability, and the possibility of future tax exhaustion whereby profits may be insufficient to use the tax relief on interest is ignored.

One way to accommodate such concerns would be with a stochastic model such as that developed by Mayer (1984). With this model Mayer demonstrated that, even without bankruptcy effects, an optimal level of gearing exists which depends only on exogenously determined tax rates and the firm's investment policy. According to Mayer's model, tax exhaustion results in a progressive effective corporation tax rate which limits firms' borrowing; but, as formulated, the model does not provide a practical means of valuing the tax shield of a firm from published data.

Lewellen and Emery (ibid) suggested a very practical means of valuing the tax shield. Recognising that the effect might not be related to the full extent of the tax deduction, might be a combination of tax and other influences, or might not even be tax-related at all, they proposed that the tax shield could be evaluated using an empirically estimated universal 'debt advantage multiplier' on firm's borrowing. This approach was, in effect, adopted by Masulis in his empirical study. There appears, however, to be little theoretical justification for assuming a universal constant, given the variations in tax positions of individual firms.
The tax effects described above do not take account of any initial and capital allowances granted for tax purposes which are an integral part of the UK tax system. As Hayashi (1982) demonstrated, it is relatively easy to adapt such models if simplifying assumptions about the rate of allowances are made, but diversity in allowances for different types of asset make such assumption unrealistic. A better approach which would allow for this diversity would be to employ the so-called liability for deferred taxation. In published accounts, the deferred taxation liability relates to the liability to pay corporation tax, including the ACT element, and is accounted for as a timing difference subject to adjustment for the extent to which it is probable that a liability will crystallise. This basis does not reflect present values and results in figures which have little relevance in the evaluation of the present value of the tax shield. Edwards, Kay and Mayer have, however, observed that under the current cost conventions the deferred tax liability at any time is that balance which, when deducted from the overall book value of capital employed determined under pre-tax value-to-the-owner conventions, gives the value-to-the-owner on a post-tax basis. When assets are valued at net replacement cost, the deferred tax liability would be the present value of initial and capital allowances that could be claimed at current tax rates when investing in these assets; for assets valued at net realisable value, the deferred tax liability would correspond to the tax liability which would arise on disposal; and, for assets valued at present value, the deferred tax liability would be the present value of expected future taxes on the cash flow generated by the operation of these assets. Edwards, Kay and Mayer did not explain precisely how capital allowances on existing assets could be estimated, but this would be relatively straightforward if the assumptions, employed in their empirical study of post-tax corporate profitability, that all assets are valued at replacement cost and there is no tax exhaustion, were
repeated. Edwards, Kay and Mayer disregarded deferred tax on intangible assets including hidden capital, but as expenditure on hidden capital is generally allowed for tax purposes in the year in which it is incurred, this would appear to be correct.

In Appendix 2 it is demonstrated that the tax wedge effect is eliminated if deferred tax calculated in the manner proposed by Edwards, Kay and Mayer is treated as a liability and included in the denominator of q.

Estimation of the deferred tax liability using the principles expounded by Edwards, Kay and Mayer provides the best way identified in the literature of evaluating a company’s tax shield. This is the method adopted in later chapters.

3.8 The Relationship Between Beta and Market Power
Salinger’s analysis described in section 3.1 above demonstrating that values of q in excess of one arise when there is market power in the form of a non-zero reciprocal of the elasticity of demand is one of a number of such analyses, eg Booth (1981), Conine (1983), Spiller (1984) and Chen, Cheng and Hite (1986). Despite the complexity of some of these analyses, this relationship can be inferred simply by noting that, in a competitive product market and an efficient capital market, the absence of barriers to entry would ensure that the expected present value of supra-normal profits from the exploitation of market power is zero. Whilst, however, the influence of elasticity of demand on q is uncontroversial, it is (as discussed in Chapter 6) difficult to estimate at the firm level. The degree of systematic risk experienced by a firm can, however, be inferred from its Beta Coefficient, being the covariance of the return on its securities and the market return, divided by the variance of the market return. Any relationship that would enable the average elasticity of demand experienced by a firm to be estimated from its Beta would therefore be invaluable in assessing the reliability of
a profitability measure. Literature dealing with this possibility is now reviewed.

It is common practice to include the Beta Coefficient among the independent variables when studying the correlation between profitability and market structure, e.g., Sullivan (1978), Hirschey (1985), Bernier (1987), but often the correlation has been found not to be significant. As the theoretical justification is often not explained, such persistence may reflect the ready availability of Betas rather than the existence of a coherent model linking Beta and profitability. Although it is intuitively appealing that the absence of competition would enable a monopolist to enjoy a low level of systematic risk, Booth (1981) commented there is no a priori reason why this should be so; but, Spiller (1984), Booth (ibid), Conine (ibid), and others have nevertheless, demonstrated that, while market power cannot be unambiguously inferred from Beta, the cost of equity capital, and hence Beta, decreases as market power increases. Chen, Cheng and Hite, extending a model developed by Subrahmaniam and Thomadakis (1980), also concluded that market power and Beta were inversely related but claimed that market power could be inferred from Beta. Abstracting all other factors except market power that could result in \( q > 1 \) and using a one period model of the firm in which the value of the firm is maximised by restricting output, ie

\[
\frac{d}{dQ} (V_e + V_b) = 0
\]

(51)

where: \( V_e + V_b \) is the market value of the firm’s securities, equal to the net present value of future earnings; and

\( Q \) is the quantity demanded.
Chen et al concluded that:

\[ q = (1 + \frac{V_b}{V_e}) \frac{\text{Cov}(\frac{S}{K_0}, r_m)}{\text{Var}(r_m)} \frac{1}{\text{Beta}} \]  

(52)

where: \( S/K_0 \) is the ratio of sales to capital employed;
\( r_m \) is the market return;
\( V_b \) is the market value of the firm's debt;
\( V_e \) is the market value of the firm's equity capital;
\( \text{Beta} \) is the firm's equity Beta Coefficient;
\( \text{Cov} (\quad) \) signifies covariance; and
\( \text{Var} (\quad) \) signifies variance.

Unlike the result reached earlier by Spiller (1984)\textsuperscript{15}, the elasticity of demand itself is eliminated from the right hand side of equation. All the terms on the right hand side are therefore observable, and this expression can therefore be used as an independent variable representing market power. Such use is, however, rejected as Cheng et al's derivation has three significant flaws:

i. \( S/K_0 \) is retained within the covariance term. This results in inadequate separation of the influence of operational leverage and market power. Chen, Cheng and Hite argue that the \( \text{cov}(S/K, r_m) \) is similar in concept to the Accounting Beta conceived by Beaver, Kettler and Scholes (1970). It would certainly be just as hard to estimate, as accounting data in the UK are published only annually or, at most, biannually. A more fundamental objection, however, as argued in Chapters 5 and 8, price effects should be eliminated from covariance term, reducing it to \( \text{Cov}(\delta Q/Q, r_m) \).

ii. \( S/K_0 \) is employed as a proxy for the sales generated by £1 of new investment. It is a poor measure of this
given the existence of economies of scale, and, as
Spiller (ibid) observed, could be expected to vary
independently with efficiency.

iii. it is assumed that \( \frac{dr}{dQ} = 0 \), where \( r \) is the cost
of capital and \( Q \) is demand. In Chapter 5 this is shown
not to be the case.

Some less serious matters are raised by equation 52. The term
\((1 + \frac{V_b}{V_e})\) represents the adjustment factor necessary to convert
the firm’s observed equity Beta Coefficient into the ungeared
Beta associated with the systematic risk of the firm’s
activities. If allowance is made for the tax effect of
borrowing and the treatment of mainstream corporation tax
employed elsewhere in this paper is adhered to, this term
becomes:

\[
1 + \frac{V_b}{V_e} \cdot \frac{1 - T}{1 - tp}
\]  

(53)

where: \( T \) is the Corporation Tax rate; and

\( p \) is the payout ratio; and

\( t \) is the Income Tax rate.

Buckley (1981) and Schnabel (1983) have pointed out that this
simple adjustment for tax does not take account of the
riskiness of corporate borrowing. If allowance is made for the
fact that firms cannot borrow at the risk free rate, the
relationship is:
\[ \text{Beta asset} = \frac{\text{Beta} + \alpha}{V_b \cdot \frac{1-T}{1-cp}} \]  

where: \( \alpha \) is Buckley's Correction Factor, such that

\[ \alpha = \frac{V_b \cdot 1-T \cdot (r_b - r_0)}{V_o \cdot 1-cp \cdot (r_m - r_0)} \]  

where \( r_b \) is the cost of corporate borrowing.

Nevertheless, the simple adjustment for tax is still widely used and may represent a reasonable approximation to the formulation proposed by Buckley and Schnabel. One further modification is, however, justified: calculating \( V_b \) net of any cash on deposit. Where cash exceeds borrowing, it could also be argued that \( V_b \) should be negative so as to allow for the effect of high liquidity depressing systematic risk.

It should be noted that, notwithstanding the theoretical objections to Chen, Cheng and Hite's model described above, they nevertheless reported significant results from a principal component analysis using equation 52.

3.9 Ex Post Measures of Economic Profitability
The literature on ex post measures of the economic profitability of a firm is generally both separate from that dealing with \( q \) and less scattered. There is, however, a measure of overlap. Some of the issues already covered are equally relevant to ex post measures, and some of the issues identified in the literature on ex post measures is relevant
Lindenberg and Ross’s original claim for q as a measure of economic profitability was based on the argument that, in a competitive market without barriers to entry, a firm cannot sustain q in excess of 1. In consequence the extent to which q exceeds 1 is an indication of the expected present value of supra-normal profits deflated by the net replacement cost of the firm’s capital stock. Claims that various rates of return can be used to measure a firm’s economic profitability have generally been based on a similar argument: in a competitive market without barriers to entry, a firm cannot sustain a rate of return in excess of the risk adjusted cost of capital, anticipated at the start of the accounting year, as such ‘excess returns’ would prompt market entry, thereby driving them back to a rate equal to the risk adjusted cost of capital\textsuperscript{16}. Thus supra-normal profitability has been associated with the extent to which these rates of return exceed the estimated risk adjusted cost of capital\textsuperscript{17}.

The need to estimate a firm’s risk adjusted cost of capital at the start of the accounting year in order to measure economics profitability highlights one of q’s inherent advantages - it requires no such estimate and is therefore independent of the particular method chosen to accomplish this.

Against this advantage may be set q’s unsuitability for measuring the economic profitability of a line of business within a firm\textsuperscript{18}. This is generally more practicable using rates of return, as these may be calculated from line of business accounting information published in accounts or obtainable from the firm’s management accounting information system\textsuperscript{19}. Some consideration of the suitability of such information is, however, called for.

Where there is less than complete separation of different lines of business, the methodology employed to arrive at line
of business information is the more or less arbitrary allocation of revenues, costs and book values to specific output. It is widely recognised that preparers of accounts have wide discretion over the choice of the method of allocation. Furthermore, such 'full absorption costing' techniques are closely associated with the 'cost plus' basis for setting prices which has been criticised for conflicting with incremental principles which underlie much micro-economic theory. Thus Baxter and Oxenfeldt (1961) suggested that the main attraction of cost plus pricing was that it offered a means by which plausible prices could be found with ease and speed. Its imposing computations looked factual and precise, and enables prices to be justified on moral grounds. This may explain why Coulthurst (1986) found that allocative techniques had even found their way into capital project appraisal, an area where incremental principles appeared to be indisputable. If the behavioral explanation for the widespread use of full absorption costing is correct, it suggests that the full cost methodology is specious and consequently cannot be relied on in estimating rates of return for a line of business. Full absorption costing and conventional accounting techniques of allocation may, however, be more soundly based than Baxter and Oxenfeldt suggest. Skinner (1987) argued that, while it had been long accepted that there was no economic justification for allocating shared costs to goods produced jointly, the cause-effect basis of allocating costs to separately produced goods would ensure that these cost allocations were not without significance. In Skinner's view, fully allocated cost was likely to be a good estimate of long run incremental cost. An objection to this view is that it assumes that the firm has certain knowledge of the demand schedule for its products in the forthcoming period. Whilst in these circumstances it could be argued that the budget represents an optimal plan for a particular, chosen level of demand, with overhead and other allocations reflecting economically efficient allocations and full cost corresponding to opportunity cost, in practice firms do not
know with certainty their demand schedules. Thus, when there are short term changes in demand, output rather than price is changed and overheads continue to be allocated to output according to the budgeted or standard rate\textsuperscript{21}. The incremental principle, under which profit maximisation requires price to equal marginal cost, has, however, not gone unchallenged. Baumol and Bradford (1970) drew attention to much prior economic literature which pointed out that systematic departure from pricing at marginal cost was required throughout an economy to balance the effect of government revenue\textsuperscript{22}.

It is also generally impossible to estimate directly the risk adjusted cost of capital of a line of business\textsuperscript{23}. This would not, however, preclude using a rate of return to estimate the economic profitability of a line of business provided an indirect estimate of the cost of capital was available\textsuperscript{24}.

The evidence above provides a less than comprehensive vindication of full absorption costing and conventional cost allocations employed in arriving at line of business information. Nevertheless, using these techniques, it is possible to estimate the rates of return earned in particular lines of business, something that cannot generally be used for.

Rates of return can only be measured by an analyst or other external observer 'ex post', that is after the end of the accounting year when a firm publishes its accounts and possibly makes available other information about its cash flow etc. These rates of return may be compared with the risk adjusted cost of capital anticipated at the start of the accounting year (ie the ex ante cost of capital), estimated using the Capital Asset Pricing Model (CAPM), the Dividend Growth Model (DGM) or in some other way. Whilst the various rates of return described below may also possess significance from an ex ante perspective (eg as management tools for investment appraisal), this aspect is not relevant to a study.
of q and is not addressed below.

It could be argued that q is fundamentally different from a rate of return measure which is compared with the firm's risk adjusted cost of capital. q relates to investment opportunities, whereas, as Luckett (1984) has observed, rates of return, especially those based on accruals based accounting information, are concerned with periodic assessment of on-going corporate activity.

If q and rates of return, whether based on cash flows or accruals, were seen to have nothing in common, the literature on rates of return would have little to contribute to this paper. It is certainly true that q and rates of return have different perspectives and cover different periods. q measures the anticipated economic profitability of a firm in all future periods; whilst the difference between the rate of return in an accounting year and the ex ante risk adjusted cost of capital at the start of that year measures the firm's economic profitability in a particular, past period. Both may, however, signal the exploitation of market power; and many of the problems that arise are common to both approaches. These problems include potential bias due to the omission of hidden capital, distortion due to taxation effects, and the extent to which capital markets are efficient. Furthermore, as argued in later chapters, there are structural similarities between measures, such as q, which are based on an input-output ratio and measures based on an internal rate of return. Finally, in many econometric studies the perspective for economic profitability is often irrelevant as the hypotheses being considered are concerned with steady states. In consequence, the literature on various rates of return is considered relevant.

Claims are made in the literature for four types of rate of return:
a. the Internal Rate of Return (CIRR);
b. the Accounting Rate of Return (ARR);
c. the Recovery Rate (RR); and
d. the Added Value Ratio (AVR).

The Return on Sales is also used in practical financial analysis and sometimes in empirical economic research, but the absence of any theoretical link with the internal rate of return and the susceptibility of this measure to the level of vertical integration means that it is not considered further in this paper.

The literature dealing with the four measures of economic profitability referred to above does not generally address their relationship to idealised measures such as those identified in Chapter 2.

3.91 The Corporate Internal Rate of Return Relative
One concept of the Internal Rate of Return (IRR) as it relates to the profitability of firms is to identify it with the average of the internal rates of return of the firm’s individual projects measured over their entire lives. This approach, adopted by Salamon (1973), avoids the need to determine how the initial and terminal values of a firm are arrived at. Salamon’s model of the firm comprises a perpetually growing collection of identical projects. He demonstrated that, when the rate of growth of investment is less than the IRR of the individual projects, the IRR earned on investing in the firm is the same as the IRR on the individual investments.

Salamon’s finding, rather than any similarity with an ideal
measure of a firm's economic profitability, represents the typical rationale for using the difference between the IRR on an investment in the entire firm, valuing initial and terminal capitals on some 'economic' basis, and the firm's risk adjusted cost of capital as a profitability measure. This internal rate of return is referred to in the literature as the Corporate Internal Rate of Return (CIRR). In the multi-period version, the firm's CIRR is the solution to the equation:

\[ V_0 = \sum_{t=1}^{n} (S_t - E_t - BI_t) (1 + CIRR)^{-t} + V_n (1 + CIRR)^{-n} \]  \hspace{1cm} (56)

where:
- \( V_0 \) is the initial 'value' of the firm at \( t = 0 \);
- \( V_n \) is the terminal 'value' of the firm at \( t = n \);
- \( S_t \) is the cash received from sales in the year \( t \);
- \( E_t \) is the cash expenditure of the firm that does not vary with output (ie, its 'fixed' expenditure); and
- \( BI_t \) is the cash expenditure of the firm that does vary with output (ie the 'variable' expenditure).

As previously, the division of all expenditure into two categories, \( E \) and \( BI \), is to facilitate later analysis and has no immediate significance. Abstracting from taxation, \( S_t - E_t - B_t \) corresponds to both the firm's net cash flow and the net cash flow accruing to shareholders and providers of loan capital.

In a single accounting year CIRR is the solution to
\[ V_0 = \frac{S-E-BI}{(1+CIRR)} + \frac{V_1}{(1+CIRR)} \]  

(57)

where \( S, E \), and \( BI \) are the cash flows in that year. Thus

\[
CIRR = \left( \frac{S-E-BI}{1+r} + \frac{V_1}{1+r} \right) \left( 1+r \right) - 1
\]  

(58)

The difference between the CIRR and the firm's risk adjusted cost of capital, \( r \), is considered to be a measure of the firm's economic profitability and can be expressed as the Corporate Internal Rate of Return Relative, \( CREL \), defined as

\[ CREL = \left( \frac{1+CIRR}{1+r} \right) \]  

(59)

Thus

\[
CREL = \frac{S - E - BI + V_1}{1+r - 1+r - 1+r + 1+r \frac{V_1}{V_0}}
\]  

(60)

Substituting continuously compounded interest rates, \( CREL \) is

\[
CREL = \frac{S.e^{-r} - E.e^{-r} - BI.e^{-r} + V_1.e^{-r}}{V_0}
\]  

(60A)
Unlike \( q \), CREL requires an estimate of the firm's risk adjusted cost of capital. This is most conveniently estimated before personal taxes. In consequence, the net cash flow \( S-E-BI \) and the capital values, where appropriate, are generally calculated either after mainstream corporation tax and before personal taxes or before all taxes. The cost of capital at a pre-personal tax level may be estimated using the Dividend Growth Model or by comparison with the cost of capital of other firms, but the most widely used method is the Capital Asset Pricing Model (CAPM). Despite the fact that, according to Levy and Sarnat (1986, page 345), the empirical results do not support CAPM in its purest form, it nevertheless provides a practical means of estimating a firm's risk adjusted cost of capital. According to the de-geared form of the CAPM:

\[
ru = r_0 + \text{Beta(Asset)} \left[ rm - r_0 \right] \tag{61}
\]

where: \( ru \) is the cost of capital of the (ungeared) firm;

\( r_0 \) is the risk free interest rate;

\( rm \) is the return on the universal or all-asset portfolio, generally taken to be proxied by the return on some diversified index such as the FTA All Share Index; and

\( \text{Beta(Asset)} \) is the Beta Coefficient associated with the firm's ungeared activities, which, ignoring the refinements described in 3.8 above, may be approximated by

\[
\text{Beta(Asset)} = \text{Beta} \frac{1}{1 + \frac{V_b}{V_e} \frac{1-T}{1-tp}} \tag{62}
\]
where: $V_b$ is the market value of the firm's loan capital (net of cash on deposit); $V_e$ is the market value of the firm's equity capital; $T$ is the corporation tax rate; $t$ is the income tax rate; and $p$ is the payout ratio - included in this analysis, even though this is not the generally accepted practice.

A number of valuation bases for $V_b$ and $V_e$ have been proposed. Steele (1986) used stock market values, but, as Franks and Harris (1986) observed, stock market values reflect both the current level and anticipated changes in a firm's profitability, making it difficult to untangle the two. It would be more accurate to say that stock market values reflect the cost of capital and anticipated changes in profitability. This may be illustrated by considering a firm operating in a world in which stock market prices reflect the Fundamental Model and, for simplicity, there is no taxation nor premium for risk. If the cost of capital is 10% per annum and the firm has a single investment which yields 20% per annum in perpetuity (i.e., it has an internal rate of return of 20%) which is paid out in dividends, the stock market value of the firm is £200. Employing this value in equation 57, in year 1:
\[ 200 = \frac{20}{1 + CIRR} + \frac{200}{1 + CIRR} \]  

Solving, \( CIRR = 10\% \).

Thus, if the stock market value is used, the cost of capital (10\%), not the internal rate of return on the single project (20\%) is revealed. Franks and Harris's concern is further illustrated if, at the start of the second year, the firm disposes of its existing project for its stock market value and invests the proceeds in a new project yielding £25 per annum in perpetuity. \( CIRR \) in the second year is:

\[ 200 = \frac{25}{1 + CIRR} + \frac{250}{1 + CIRR} \]  

Solving, \( CIRR = 37.5\% \).

This return is neither the cost of capital (10\%) nor the internal rate of return on the new project (25\%). Its true significance is revealed by considering \( CREL \). Abstracting from borrowing and tax, this as:

\[ CREL = \frac{S - E - BI + V_{e1}}{V_{e0}(1 + r)} \]  

where \( V_{e0} \) is the stock market value of equity at the beginning.
of the year; and

\( V_{e1} \) is the stock market value at the end of the year.

Assuming the stock market is efficient and subject to new information which arrives at the end of each accounting period

\[
V_{e0} = \frac{S-E-BI}{(1+r)(1+a)} + \frac{V_{e1}}{(1+r)(1+a)}
\]  

where: \( r \) is the risk adjusted cost of capital; and

\( a \) is the abnormal gain (ie at the start of the year \( E(a) = 0 \))

Therefore

\[
CREL = \frac{1}{1+a}
\]

Thus, when the CIRR employs stock market values, CREL simply measures the abnormal or unexpected share price market gain. Thus if CREL is to impart useful information, an alternative basis of valuing \( V_0 \) and \( V_1 \) is called for.

Rappaport (1986) proposed valuing a firm's initial and terminal capital in terms of the present value of the sustainable cash flow. There are two objections to this approach:

a. the sustainable cash flow is very subjective; and
b. $V_{e0}$ and $V_{e1}$ would include the capital value of any economic rents, so the resulting CREL would not indicate supra-normal profits generated by market power.

Realisable value might provide a basis for valuing $V_{e0}$ and $V_{e1}$. Whittington (1983) argued that this basis lacks relevance for a continuing business; but what is, in effect, exit price accounting has its advocates (eg Arnold and Wearing, 1988).

The suitability of the current cost basis for CIRR and related measures has received considerable attention. Kay and Mayer (1985), refuting Whittington's claim (1983) that current cost has no theoretical basis, demonstrated that CIRR with current cost values imparts the correct signals for market entry and exit. Their analysis assumed that current cost values included intangible assets and that economic depreciation had been charged in arriving at book values. Devereux (1986) demonstrated by simulation that, when the current cost valuation basis is employed, CIRR is a good indicator of the internal rate of return on a firm's projects. Net replacement cost provides a closer approximation to the concept of a firm's replication cost described in the previous chapter. In practice, however, hidden capital is often ignored and the net replacement cost of a firm's capital is taken to be synonymous with the net replacement cost of its tangible net assets. Thus, if hidden capital and other intangibles are included in the valuation, the current cost basis will approximate in many cases to the replication cost described in the previous chapter.

CREL is similar in form to the ideal profitability measure $EP_2$:

$$EP_2 = \frac{PV_{e1}(S) + PV_{e1}(K_{e})}{PV_{e1}(K_{e}) + PV_{e1}(E) + PV_{e1}(R)}$$

(9)
where: \( K_0 \) is the firm's replication cost at the start of the year; and

\( K_1 \) is the firm's replication cost at the end of the year.

Assuming the cash flows arise at the end of the accounting year, and that \( K_0 \) and \( K_1 \) can be represented as single payments, \( EP_2 \) takes the form

\[
EP_2 = \frac{S \cdot e^{-r_0} + K_1 \cdot e^{-r_1}}{K_0 + E \cdot e^{-r_2} + BI \cdot e^{-r_{bi}}} \tag{9A}
\]

where \( r_0, r_1, r_2, \) and \( r_{bi} \) are the discount rates appropriate for and specific to \( S, K_1, E, \) and \( BI. \)

CREL, on the other hand, may be expressed as

\[
CREL = \frac{S \cdot e^{-r} - E \cdot e^{-r} - BI \cdot e^{-r} + V_1 \cdot e^{-r}}{V_0} \tag{60A}
\]

Comparing the two measures, it is apparent that, provided \( V_0 \) and \( V_1 \) are the same as \( K_0 \) and \( K_1, \) CREL differs from \( EP_2 \) not only regarding the assumption that cash flows arise at the end of the year, but also in the following respects:

a. \( S, E, BI \) and \( K_1 \) are discounted by the firm's risk adjusted cost of capital \( r, \) whereas in \( EP_2 \) the discount factor is specific to each cash flow; and

b. In CREL the terms containing \( E \) and \( BI \) appear as deductions in the numerator rather than additions in the denominator.
The significance and implications of (a) and (b) and of the assumption that cash flows arise at the end of the accounting year are referred to again in the next section dealing with literature on the Accounting Rate of Return and are analysed in greater detail in the next chapter.

In practice, $V_0$ and $V_1$ are often taken to be the net replacement cost of the firm's net assets, $BV_0$ and $BV_1$, respectively, rather than the replication costs $K_0$ and $K_1$. As CREL can be computed in pre-tax terms provided the pre-tax cost of capital can be estimated, taxation effects can be abstracted and the difference between $BV_0$ and $K_0$ and between $BV_1$ and $K_1$ can, by definition, be identified with the firm's hidden capital. Literature describing hidden capital was summarised in 3.6. The potential for hidden capital to distort CREL and measures equivalent to CREL (eg ARR - see next section) is extensively described in the literature, although the term 'hidden capital' is not always employed. Hirschey (1985), for example, simply refers to 'accounting bias'. Egan, Higinbotham and Weston (1982), following Weiss, concluded that such accounting bias was eliminated when expenditure on hidden capital was constant. Their analysis employed the accounting rate of return, rather than CIRR, but appears to be mistaken as analyses by Telser (1969), Weiss (1969) and Demsetz's comparative study (1979) demonstrate. These analyses may be re-stated in terms of CIRR and CREL, as follows:

The 'true' CIRR, is defined by the equation:

$$BV_0 + HC_0 = \frac{S-E-BI}{1+CIRR} + \frac{BV_1}{1+CIRR} + \frac{HC_1}{1+CIRR}$$

(68)
where: $H_{Co}$ is the hidden capital at $t = 0$; 

$H_{C1}$ is the hidden capital at $t=1$;

$B_{Vo}$ is the net replacement cost of net assets, ie the tangible capital, at $t=0$;

$B_{V1}$ is the net replacement cost of net assets, ie tangible capital, at $t=1$; and

$S-E-BI$ is the firm's sales revenue, $S$, less cash expenditure, $E+BI$, in the year.

The apparent CIRR, $R_a$, is defined by the equation:

$$ BV_0 = \frac{S-E-BI}{1+R_a} + \frac{BV_1}{1+R_a} $$

(69)

The accounting bias, $BIAS_{CREL}$, in the CREL may be defined as

$$ BIAS_{CREL} = \frac{apparent\ CREL - 'true'\ CREL}{'true'\ CREL} $$

ie

$$ BIAS_{CREL} = \left( \frac{1+R_a}{1+r} \right) \left( \frac{1+CIRR}{1+r} \right) \left( \frac{1+R_a}{1+r} \right) $$

(70)

which reduces to
For any depreciation profile (straight line, constant exponential etc) that does not change over time:

\[ BIAS_{\text{CREL}} = \frac{R_s - \text{CIRR}}{1 + \text{CIRR}} \]  

(71)

For any depreciation profile (straight line, constant exponential etc) that does not change over time:

\[ HC_1 = (1 + g_{hc}) HC_0 \]  

(72)

where \( g_{hc} \) is the growth in expenditure on hidden capital, assuming this is constant.

Combining equations:

\[ BIAS_{\text{CREL}} = \frac{HC_0}{BV_0} \frac{\text{CIRR} - g_{hc}}{1 + \text{CIRR}} \]  

(73)

This indicates that the accounting bias in CREL eliminated when:

\[ \text{CIRR} = g_{hc}; \text{ or} \]

\[ HC_0 = 0. \]

As CIRR is not a risk adjusted internal rate of return, it has been assumed, in effect, that investment in hidden capital has
the same internal rate of return as investment in tangible assets. The first condition cannot therefore be satisfied as Salamon (ibid) demonstrated that growth must be less than the internal rate of return if the latter is defined. The second condition is satisfied when there is 100% first year depreciation, or when there is no expenditure on hidden capital. Thus only in these exceptional conditions is accounting bias not generated by hidden capital.

Hirschey (ibid) asserted that \( q \) is less subject to accounting bias than is the accounting rate of return (ARR). It is not completely clear that Hirschey confines the term 'accounting bias' to distortion caused by omission of hidden capital, but, assuming ARR and the CIRR are equivalent, this view can be tested, as follows:

The accounting bias, \( BIAS_q \), in Tobin's \( q \) arising from ignoring hidden capital may be defined as

\[
BIAS_q = \frac{\text{apparent } q - \text{'true'} q}{\text{'true'} q}
\]

But \( \text{apparent } q = \frac{Ve+Vb}{BVo} \)

and, abstracting from taxation,

\[
\text{'true'} q = \frac{Ve+Vb}{BVo+HC_0}
\]

where \( Ve+Vb \) is the market value of the firm's securities.

Thus:

\[
BIAS_q = \left[ \frac{Ve+Vb - Ve+Vb}{BV_0} \right] \left[ \frac{BV_0}{BV_0 + HC_0} \right] \left[ \frac{Ve+Vb}{BV_0 + HC_0} \right]
\]

(74)
Simplifying

\[ BIAS_q = \frac{HC_0}{TC_0} \]  \hspace{1cm} (75)

Comparing equations:

\[ \frac{HC_0}{BV_0} \cdot \frac{HC_0}{BV_0} \cdot \frac{CIRR-g_{hc}}{1+CIRR} \Rightarrow BIAS_q > BIAS_{CREL} \]  \hspace{1cm} (76)

This simplifies to:

\[ g_{hc} > -1 \Rightarrow A_q > A_x \]  \hspace{1cm} (77)

but, assuming hidden capital is positive, from equation 72:

\[ g_{hc} > -1 \]  \hspace{1cm} (78)

Therefore:

\[ BIAS_q > BIAS_{CREL} \]  \hspace{1cm} (79)

Thus, contrary to Hirschey's assertion, the accounting bias in \( q \) resulting from omitting or overlooking hidden capital is...
greater than that in the CIRR Relative. Given the equivalence of CIRR and the Accounting Rate of Return (ARR), discussed below, a similar finding applies to the ARR relative.

Other forms of accounting bias than that arising from the omission of hidden capital can be conceived. Consideration of these is, however, deferred to the next section dealing with the ARR.

3.92 Accounting Rate of Return Relative
The Accounting Rate of Return (ARR) consists of the annual profit divided by capital employed (corresponding to net tangible assets and, possibly, those intangible assets recognised in the accounts). It is widely used in day to day financial analysis. Reflecting the multitude of concepts of investment base and income generated from this investment, there exists a variety of views on how the return should be calculated, but there is a general recognition that the numerator and the denominator should be causally related (Bernstein, page 149).

In measuring the economic profitability of a firm, it is generally of no interest how the firm's activities are financed, i.e. whether by equity or loan capital. In consequence, ARR, like CIRR, is often calculated with long-term loans treated not as a deduction from net assets but as part of the capital employed. Profits are accordingly struck before interest on this loan capital. This corresponds to including $V_b$ in the numerator of $q$.

ARR is widely used for management control purposes and in comparative studies, but consideration here is confined to its use as a measure of a firm's economic profitability. The rationale for this is that it is similar, and may even be equivalent to, the CIRR.
Salamon (1982) observed that research in the late 1960s and early 1970s seeking to specify a relationship which would enable internal rates of return to be estimated from ARR had largely been abandoned when the goal proved elusive. Fisher and McGowan's claim (1983) that ARR was unrelated to economic profitability stimulated further work. While Martin (1988) argued that the relationship between ARR and internal rates of return was simply 'a red herring', others took up the challenge directly, useful insights being gained by Franks and Hodges (1983) and Kay and Mayer (1985). Salamon had, however, overlooked that a fundamental relationship between the CIRR and the ARR had already been demonstrated by Peasnell (1982). Abstracting from tax, Peasnell defined profit in a "clean surplus" manner so that, assuming that expenditure can be classified into fixed and variable elements:

\[ P_t = S - E - BI + BV_t - BV_{t-1} \]  

where: 

- \( P_t \) is the profit for the year;
- \( S \) is the firm's sales revenue in the year;
- \( E \) is the firm's fixed expenditure in cash terms in the year;
- \( BI \) is the variable expenditure in cash terms in the year; and
- \( BV_{t-1} \) and \( BV_t \) are the book values of net assets at the start and at the end of the accounting year, being net of depreciation and the firm's liabilities, other than its loan capital.

Assuming the variable expenditure, \( BI \), is the same on a cash or an accruals? basis, an alternative definition of the clean surplus profit is
\[ P_t = S - \text{Exp} - \text{BI} + \text{Revn} \]  

(81)

where: \( \text{Revn} \) is the surplus in the year on revaluing fixed assets; and

\( \text{Exp} \) is the fixed expenditure on a matching or accruals basis. This is, by definition

\[ \text{Exp} = E - \text{CAPEX} + \text{Depn} \]  

(82)

and results in the accounting identity

\[ \text{BV}_0 + \text{CAPEX} - \text{Depn} + \text{Revn} = \text{BV}_1 \]  

(83)

This definition of profit requires all extraordinary items, holding gains and other transfers to and from reserves to pass through the profit and loss account. \( \text{ARR}_t \), the Accounting Rate of Return in the year ending \( t \) is then defined as:

\[ \text{ARR}_t = \frac{P_t}{\text{BV}_{t-1}} \]  

(84)

Peasnell related \( \text{ARR} \) to \( \text{CIRR} \) by substituting \( \text{BV}_{t-1} \) above for \( V_t \) in equation 56. After algebraic manipulation this yields:
where $E$ is an error term such that:

$$
E = \frac{(C_n - BV_n)(1+CIRR)^{-n} - (C_0 - BV_0)}{\sum_{t=1}^{n} BV_{t-1} (1+CIRR)^{-t}}
$$

Peasnell's equation indicates that the CIRR is equivalent to a weighted average of the annual ARRs, where the weights are the corresponding net book values discounted by the CIRR, plus an error term, $E$, which depends on the divergence of accounting book values from the economic values used to calculate the CIRR. This error term vanishes when the opening and closing net book values are equal to the 'economic' values employed in the CIRR expression. When this condition is satisfied, the one-period version of equation 81 is simply

$$
CIRR = ARR_t
$$

Thus, when profit is calculated in a clean surplus manner, and book values of net assets correspond to the 'economic' values of the initial and terminal capitals in CIRR, ARR and CIRR are, in effect, equivalent. Subject to a need to establish a suitable basis for valuing book values, a measure of economic
profitability, the ARR Relative, AREL, can be defined\(^2\) as

\[
AREL = \frac{1 + \text{ARR}_t}{1 + r}
\]  \hspace{1cm} (88)

Given the equivalence of the one-period versions of CIRR and ARR when the basis of asset valuation is the same, it follows that the Corporate Internal Rate of Return Relative, CREL, and the Accounting Rate of Return Relative, AREL, are the same, i.e.

\[
AREL = CREL
\]  \hspace{1cm} (89)

It follows that the differences between AREL and EP\(_2\) are the same as those between CREL and EP\(_2\) identified in 3.91, i.e., in addition to the assumption for AREL that cash flows arise at the end of the year, and the possibility that BV\(_0\) and BV\(_1\) are not necessarily the same as the replication costs \(K_0\) and \(K_1\), AREL differs from EP\(_2\) and is therefore a biased measure of a firm's economic profitability in the following respects:

a. \(S, E, BI\) and BV\(_1\) are discounted by the firm's risk adjusted cost of capital \(r\), whereas in EP\(_2\) the discount factor is specific to each cash flow; and

b. in AREL the terms containing \(E\) and \(BI\) appear as deductions in the numerator rather than additions in the denominator.

The significance and implications of (a) and (b) and of the
assumption that cash flows arise at the end of the accounting year are analysed in greater detail in the next chapter. The literature on the significance of the difference between BV_0/BV_1 and K_0/K_1 was described in the 3.91.

In view of the equivalence of ARR and CIRR, Brealey and Myers claimed that, abstracting from the valuation basis, the only bias in clean surplus ARR is that resulting from failure to use economic depreciation^{29} (1984, page 254). This is inconsistent with the finding above that differences between AREL and EP_2 are not confined to differences in asset valuation. Furthermore, the Monopolies and Mergers Commission echo a widely held view when they commented in their report on the Supply of Cinema Advertising Services (1990, page 48) that ARR is "not the most appropriate basis to assess profitability" when the capital base of a firm is small in relation to its sales. As the capital base is reduced when a firm substitutes bought in goods and services for internally produced ones and when it rents property and other assets rather than owning them, even when the goods, services and property are obtained in competitive markets, this observation appears to conflict with Brealey and Myers's assertion.

Davis and Kay (1990) appear to share the MMC's misgivings. Without producing any empirical evidence to support their argument beyond a survey of a small selection of UK companies with different levels of buying in, they claimed that ARR is inflated or biased upwards when a firm substitutes bought in goods and services for internally produced ones. Davis and Kay considered the bias in ARR to be significant enough to undermine AREL as a measure of economic profitability.

As the bias identified by Davis and Kay appears superficially to be associated with Value Added, a profitability measure employing this variable might provide an obvious solution. Morley (1978) found that no such measures providing comparison of profitability across firms with different levels of buying
in are known. Davis and Kay proposed a new measure, the Added Value Ratio, as an alternative to ARR. This is described in the 3.94 below. The reason for the bias in ARR identified by Davis and Kay is analysed in the next chapter.

In much of the literature on ARR and CIRR, tax is abstracted. In practice, ARR is estimated using the pre-tax profit and values. Franks and Hodges (1983) adapted equations 85 and 86 to accommodate this, arriving at

\[
CIRR = (1-T) \frac{\sum_{t=1}^{n} ARR_t^* BV_{t-1} (1+CIRR)^{-t}}{\sum_{t=1}^{n} BV_{t-1} (1+CIRR)^{-t}} + E + E^* \quad (90)
\]

where: \(ARR^*_t\) is the pre-tax ARR;

\(T\) is the Corporation Tax rate; and

\(E^*\) is a second error term such that

\[
E^* = \frac{T \sum_{t=1}^{n} [D_t(tax) - D_t(acc)] (1+CIRR)^{-t}}{\sum_{t=1}^{n} BV_{t-1} (1+CIRR)^{-t}} \quad (91)
\]

where: \(D_t(tax)\) is the depreciation allowed for tax purposes; and

\(D_t(acc)\) is the depreciation charged in the accounts.
If returns are calculated, as elsewhere in this paper, on a pre-personal tax basis, equations 85 and 86 become:

\[
CIRR = \left( \frac{1-T}{1-tp} \right) \frac{\sum_{t=1}^{n} ARR* BV_{t-1} (1+CIRR)^{-t}}{\sum_{t=1}^{n} BV_{t-1} (1+CIRR)^{-t}} + E + E^* 
\]  

(92)

and

\[
E^* = \left( \frac{T-tp}{1-tp} \right) \frac{\sum_{t=1}^{n} [D_{t}(tax) - D_{t}(acc)] (1+CIRR)^{-t}}{\sum_{t=1}^{n} BV_{t-1} (1+CIRR)^{-t}}
\]  

(93)

where: \( t \) is the Income Tax rate; and \( p \) is the payout ratio.

The corresponding pre-tax ARR Relative is calculated using the estimated cost of capital on a pre-income tax basis.

An alternative way of using ARR to estimate economic profitability, much used in practice, is to calculate ARR using pre-tax 'operating profits', which exclude unrealised holding gains on assets, and compare this with some measure of average profitability, computed on the same basis. This technique is much favoured by the Monopolies and Mergers Commission, who typically use the average pre-tax ARR for commercial and industrial companies as a whole or for particular industries\(^3\) as a comparator. There is, however, no clear economic rationale for the technique and no objective way of assessing whether the difference between the ARR and the comparator is significantly large to indicate 'excessive' returns.
Given the close relationship between CIRR and the internal rate of return earned by a firm on its individual investments, the above relationships, particularly Peasnell's relationship between CIRR and ARR, yield valuable insight into the relationship between ARR and the internal rate of return - a relationship which had eluded the earlier work referred to by Salamon; but, as Steele (1986) observed, there is a paradox implicit in Peasnell's equation. ARR conveys no information about CIRR when nothing is known about the 'economic' valuation of capital by means of which CIRR is defined; yet this is precisely when ARR is needed to measure economic performance. To put it another way: if sufficient data is available to estimate Peasnell's error term, there is sufficient information to estimate CIRR directly without bothering with ARR.

Despite the equivalence of CIRR and ARR when the same basis of valuing initial and terminal values are used and the latter employs a 'clean surplus' profit, Devereux (1986) maintained that the two measures are fundamentally different in concept. This conclusion is disputed. Whilst the internal rate of return, on which CIRR is based, is essentially a measure that applies to the entire life of an investment, CIRR, like the theoretical measure EP₃, has been adapted to indicate a firm's return in a specific period, and when that period is a year and the basis of valuing the initial and terminal values are the same, ARR and CIRR are identical. This result does, however, depend on the condition that profit is calculated on a clean surplus basis. In a study using simulated data, Devereux (ibid) found that ARR was a poor measure of CIRR when the clean surplus profit concept was not adhered to. It should be noted that, in practice, reported profits do not generally comply with the clean surplus principle: under both the historical cost and current cost conventions, there may be prior year adjustments and transfers directly to reserves for items such as purchased goodwill and foreign exchange translation differences; and some profits and losses are
considered 'extraordinary' and taken 'below the line', ie after profit is struck. Under the current cost accounting convention specified in SSAP 16, holding gains and losses are not passed through the profit and loss account, although sufficient information is generally disclosed to permit clean surplus profits to be calculated.

Criticism is sometimes made of financial analysts that they are over-preoccupied with reported levels of profit. Beaver and Demski (1979), for example, argued that the process of reporting profits had little to do with informing financial markets about the economic profit earned in the last period. They suggested that reporting profits was simply a noisy but cost effective communication process. Converting reported profits to a clean surplus basis would seem unlikely, of itself, to undermine such a conclusion which has obvious implications for ARR. Furthermore, it is self-evident that in some situations, for example when a company is starting up, reported profits, and hence ARR, are of little significance. A similar criticism could, however, be made of the theoretical measures described in the previous chapter31.

Despite the theoretical significance of clean surplus profit, it is apparent that at many financial analysts attach importance to other definitions of profit, especially where these are thought to give a better indication of future sustainable profits, eg the reported operating profits before exceptional and extraordinary items - see, for example, the guidance in the standard text for financial analysts, Graham and Dodd (page 156, 1988). This suggests that ARR based on operating profit might have some value in measuring economic profitability, notwithstanding the literature described above.

Black (1980), in a radical reappraisal of what reported profits really represent, noted the relative stability of price earnings ratios compared with ratios of book value of net assets to market value and concluded, perhaps somewhat
mischievously, that accountants had achieved a remarkably good measure of value with their concept of profit. This idea is drawn on in the next chapter.

3.93 Recovery Rate

Ijiri (1980) pointed out that profit, and thus ARR, was a residual after all cash and non-cash items had been put together. The non-cash items were relatively "soft" and ambiguous, while the cash items were "hard" and objective. Ijiri proposed that the primary measure of profitability should be the 'recovery rate' (RR), defined in terms of a "hard" item, the annual cash recoveries of a firm, divided by another "hard" item, the gross, undepreciated book value of the assets employed in the business. Thus RR was defined as

\[
RR = \frac{S - E - BI}{GBV}
\]

where: 
- \( S \) is the sales receipts in cash terms;
- \( E \) is the fixed expenditure in cash terms;
- \( BI \) is the variable expenditure in cash terms; and
- \( GBV \) is the gross book value of the assets employed in the business, ie their book value before depreciation.

The recovery rate is indeed "hard" to the extent that no estimation of depreciation or net replacement cost is required. The computation of the book value of gross assets would, however, not completely avoid "soft" or subjective items: for example, any work in progress would still need to be valued in terms of conventional accounting concepts.

Observing that, for many firms, the recovery rate was

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"reasonably uniform over the years", Ijiri concluded, without formal proof, that the average value of RR over a number of years would correspond to:

\[
RR = \frac{R}{1-(1+R)^{-n}}
\]  

(95)

where: \( R \) is the internal rate of return on the firm's individual projects\(^2\); and

\( n \) is the average life of the firm's projects.

Ijiri recognised that the average life of the firm's projects could not be measured objectively but he provided no guidance as to how it might be measured subjectively. If project lives and fixed asset lives are assumed to be the same, it might be possible to estimate average project life from the lives of fixed assets disclosed in the accounts or from the disclosed total gross assets divided by the disclosed annual depreciation charge. The recovery rate is, however, intended to be an unambiguous or 'hard' measure: employing such subjective criteria would appear to defeat this objective.

Reflecting perhaps the low rate of inflation in the US economy at the time, Ijiri disregarded the effect of general and specific inflation and the difference between gross book values and gross replacement costs.

The Recovery Rate is neither an input-output ratio using present values nor an internal rate of return. It does not, therefore correspond to any of the ideal measures of economic profitability proposed in the previous chapter. Its validity depends exclusively on the link proposed with the internal rate of return on a firm's individual projects. Salamon (1982) examined this link by modelling the firm as an entity steadily
investing in a series of projects with the same life and internal rate of return. Expressed in nominal terms this model yields the following relationship:

\[ RR = \left( \frac{g_i}{(1+g_i)^n-1} \right) \left( \frac{(1+g_i)^n-(1+b)^n}{(g_i-b)} \right) \left( \frac{(1+R)^n(R-b)}{(1+R)^n-(1+b)^n} \right) \]  

(96)

where: \( g_i \) is the annual rate of growth in gross investment; and

\( b \) is a 'cash flow profile parameter' being the annual growth in cash flow for an individual project.

Salamon commented that when both \( b = 0 \), i.e., investment generates a constant income in notional terms, and \( g_i = R \), i.e., the annual growth rate of gross investment is equal to the common IRR, equation 96 collapses to equation 95. Salamon interpreted the second condition, \( g_i = R \), as requiring a firm to invest all its cash flow and pay no dividend. He concluded that this was not only an inappropriate assumption but also one that would make equation 95 redundant as, if cash flow was entirely reinvested, the firm's ARR would approach the IRR of firm projects. Salamon appears to have overlooked the fact that the condition \( b = 0 \), which is implicit in Ijiri's analysis, is sufficient, by itself, to collapse his equation. The condition \( b = 0 \) is not an unreasonable assumption. Furthermore, Salamon, himself, concluded that \( RR \) was not particularly sensitive to
b. This conclusion was supported by Gordon and Harmer’s (1988) extension of equation 96 to allow for concave cash flow patterns.

Some of the other assumptions behind equations 91 and 92 are cause for more serious concern. First, the analysis assumes that inflation has been constant over the period of the useful life of the projects. In the period 1972 to 1985, a period of 13 years which could be taken as representative of a typical project life, the annual rate of change in the Retail Price Index ranged from 3.6% to 26.1%. While CIRR and ARR suffer from similar weaknesses, this is probably even more damaging to the RR which depends on the observation of a long run stable rate to give it credibility. Second, to be a useful measure, the recovery rate must be observable. Ijiri suggested that the total of cash recoveries, $S-E-BI$, is not generally observable in company accounts, but could be estimated approximately as the total of:

- funds from operations before interest paid;
- proceeds from disposal of long term assets; and
- the annual decrease in total current assets.

Stark (1987) questioned whether Ijiri’s proposals represented a satisfactory proxy for the true RR. Lee and Stark (1987) concluded that they were fundamentally unsound because the cash recovery would be unsuitable for discounting.
examples demonstrated that Ijiri's proposed basis could result in a significant distortion in the time pattern of cash flow recognition, so that rankings according to the IRR of the firm's projects and according to its RR could diverge. They suggested that it would be better to estimate the recovery rate as the ratio of operating cash flow (i.e. profit before depreciation less increases in working capital) to gross fixed assets. This would assume that the initial project investment did not include an initial investment in current assets unmatched by liabilities, which might not be a realistic assumption in some industries. The conceptual problems over discounting would, however, be largely eliminated and the data required would be more readily observable from published accounts.

The advantage claimed for RR is that it is less prone than other measures to management manipulation. As noted above, the impact of inflation has not been addressed; and neither Ijiri nor other researchers have claimed that RR is effective in eliminating accounting bias arising from hidden capital. There has also been no consideration of how an RR relative might be calculated.

3.94 Added Value Ratio

As noted in 3.92, Davis and Kay considered there to be an upward bias in ARR, and in AREL, when a firm substitutes bought in goods and services for internally produced goods and services. They did not attribute this effect solely to a tendency for hidden capital to increase as buying in increases. Thus, notwithstanding its wide use in financial analysis and economic research, ARR was held to be an unsatisfactory profitability measure. Davis and Kay therefore proposed, as an alternative to ARR, the Added Value Ratio (AVR). A number of computational shortcuts of no theoretical significance were incorporated in the specification, together with a recommendation that the interest free rate rather than
the risk adjusted rate should be used. Abstracting these features, and assuming again that expenditure can be analysed into fixed and variable elements, AVR as proposed by Davis and Kay, takes the form:

\[ AVR = \frac{P_t - r \cdot BV_0}{r \cdot BV_0 + Exp} \quad (97) \]

where: \( P_t \) is clean surplus profit in the year, corresponding to

\[ P_t = S - Exp - BI + Revn = S - E - BI + BV_1 - BV_0 \quad ; \quad (98) \]

\( S \) is the sales in the year;

\( Revn \) is the surplus on revaluing fixed assets in the year;

\( Exp \) is the fixed revenue expenditure on an accruals basis in the year, corresponding to:

\[ Exp = E - CAPEX + Depn \quad ; \quad (99) \]

\( E \) is the fixed cash expenditure in the year;

\( CAPEX \) is expenditure on fixed assets in the year;

\( Depn \) is the depreciation of fixed assets in the year;

\( r \) is risk adjusted cost of capital on a pre-tax basis
anticipated at the start of the year;

BV₀ is the book value of net tangible assets on net current cost basis at the start of the year; and

BV₁ is the book value of net assets on a net current cost basis at the end of the year.

Substituting continuously compounded interest rates, and substituting for Pₜ and Exp

\[
AVR = \frac{S - E - BI + BV₁ - BV₀ - (e^r - 1) . BV₀}{(e^r - 1) . BV₀ + E - CAPEX + Depn}
\]  \hspace{1cm} (100)

Thus

\[
1 + AVR = \frac{S - BI + BV₁ - BV₀ - CAPEX + Depn}{(e^r - 1) . BV₀ + E - CAPEX + Depn}
\]  \hspace{1cm} (101)

Assuming the difference between capital expenditure and depreciation is small, ie

\[
S - BI + BV₁ - BV₀ >> CAPEX - Depn
\]  \hspace{1cm} (102)

and assuming the difference between the corporate internal rate of return and the cost of capital is small, so that

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\[(e^r-1) BV_0 + E = S + BI + BV_1 - BV_0 \]  

then, from the first two terms of the binomial expansion

\[1 + AVR = \frac{S + BV_1 - BV_0 - BI}{(e^r-1)BV_0 + E} \]  

Multiplying top and bottom by \(e^{-r}\) and re-arranging

\[1 + AVR = \frac{S + BV_1}{BV_0 + E} \cdot e^{-r} + BI \cdot e^{-r} - [(BV_0 + BI) e^{-r}] \]  

Davis and Kay viewed AVR as a ratio of outputs less inputs divided by inputs. Thus \(1 + AVR\) can be compared with one of the ideal measures of economic profitability proposed in Chapter 2. The most appropriate ideal is \(EP_2\), which, assuming cash flows arise at the end of the financial year, corresponds to

\[EP_2 = \frac{S \cdot e^{-rs} + K_1 \cdot e^{-rk}}{K_0 + E \cdot e^{-re} + BI \cdot e^{-rbi}} \]  

where: \(r_s, r_k, r_e\) and \(r_{bi}\) are the discount rates appropriate to \(S, E, BI\) and \(K_1\); and

\(K_0\) and \(K_1\) are the replication costs of the firm at the beginning and end of the year.

Comparing the two measures, it is apparent that, in addition
to the assumption that cash flows arise at the end of the year, and the possibility that BV_0 and BV_1 are not necessarily the same as K_0 and K_1, AVR differs from EP_2 and is therefore a biased measure of a firm's economic profitability in the following respects:

a. S, E, BI and BV_1 are discounted by the firm's risk adjusted cost of capital r, whereas in EP_2 the discount factor is specific to each cash flow; and

b. AVR contains an extra term in square brackets in both the numerator and denominator -(BV_0+BI)e^{-r}.

The extra term represents a bias in AVR. It may, however, be eliminated by re-defining AVR, using continuously compounded interest rates, as AVR_1, where

\[
AVR_1 = \frac{P_t - (e^r - 1)BV_0}{BV_0e^{-r} + Exp + BI - Revn}
\]  

Thus

\[
1 + AVR_1 = \frac{S + BV_0}{BV_0e^{-r} + Exp + BI - Revn}
\]  

Substituting the accounting identity

\[
BV_0 + CAPEX + Revn - Depn = BV_1
\]
results in

\[ 1 + AVR_1 = \frac{S + BV_1 - CAPEX - Revn + Depn}{BV_0 e^{-r} + Exp + BI - Revn} \]  

(108)

assuming the difference between capital expenditure and depreciation, net of any revaluation surplus, is small, ie

\[ S + BV_1 >> CAPEX + Revn - Depn \]  

(109)

and assuming the difference between clean surplus profit, \( S - Exp - BI + Revn \), and the capital charge represented by \( BV_0 e^{-r} - BV_1 \) is small, ie

\[ S + BV_1 = BV_0 e^{-r} + Exp + BI - Revn \]  

(110)

then, from the first two terms of the binomial expansion,

\[ 1 + AVR_1 = \frac{S + BV_1}{BV_0 e^{-r} + Exp + BI} \]  

(111)

Multiplying top and bottom by \( e^r \)
Thus, abstracting from the assumption that cash flows arise at the beginning and end of the year and the differences between $BV_0/BV_1$ and $K_0/K_1$, $AVR_1$ approximates to $EP_2$, except that a single discount rate $r$ is used for the various cash flows.

3.10 Estimating the Cost of Capital

The theoretical measures of a firm's economic profitability $EP_1$, $EP_2$ and $EP_3$ identified in the previous chapter all employ the present values of various corporate cash flows. As explained in Chapters 4 and 5, evaluation is only possible by reference to market values or by estimating the appropriate discount factor or cost of capital for the particular cash flow; and these discount factors can be estimated from the firm's overall risk adjusted cost of capital. The various rates of return described in this chapter are, on the other hand, compared directly with the firm's risk adjusted cost of capital. In every case, it is the anticipated cost of capital at the start of the accounting period that is the appropriate rate.

A review of the extensive literature on the estimation of a firm's risk adjusted cost of capital is beyond the scope of this paper. It is simply noted here that there are two principal methods:

a. the Capital Asset Pricing Model (CAPM); and

b. the Dividend Growth Model (DGM).

CAPM, in particular, has gained wide acceptance in both economics and business, the 1990 Nobel Prize Citation stating
that it remains "the premier model for the relation between risk and expected return". CAPM is described and employed in later chapters.

3.11 Survey of Subsequent Literature

Research published after 1989 has increased doubts over whether capital markets are efficient in a fundamental sense, and Shiller (1989 but available in the UK in 1990) has provided a convincing explanation in the form of a model in which investors comprise two groups, only one of which is 'smart'. The Capital Asset Pricing Model, employed throughout this paper, has, notwithstanding the endorsement referred to above, come under attack in a paper by Fama and French (1992).

In the area of the theoretical aspects of profitability measurement, an interesting development has been Stark's proposal (1991) for a new definition of deprival value based on optimal investment rules under uncertainty and the presence of genuine timing options. The analysis has not yet, however, been extended to ex post accounting rates of return. Davis, Flanders and Star published a further paper on AVR (1991), but this added little in the way of theory. Other research touching on profitability measurement published after 1989 has had few implications for this study. Except for such obvious experimentations as the substitution of cash flow for earnings, most empirical research requiring a measure of profitability has relied on reported profits or unadjusted values of $q$, causing Lev (1990) to comment on the surprising imbalance between the level of effort and sophistication that goes into statistical methodology and that goes into arriving at the profits measure used.
1. Lindenberg and Ross described $C_0$ as the cost of replacing the firm's 'capital stock'. This is equivalent to the replication cost of the firm provided 'capital stock' includes all intangible assets and is net of any liabilities (other than $V_b$) at the year end.

2. The possession of factors of production whose replacement cost does not reflect ordinary Ricardian rents was abstracted. Lindenberg and Ross also recognised that actual market entry was not essential to undermine market power. The mere absence of barriers to entry and the consequent threat of entry by another firm would generally be sufficient to eliminate the incumbent's supra-normal profits.

3. Strictly 'shareholders and providers of loan capital'. The latter are, however, seldom in a position to share in supra-normal profits.

4. ie, in a competitive market, price equals marginal cost. Langlois (1989) has proposed that firms will seek to maximise profit per unit of time, with the result that price in a competitive market would equal average variable cost, not marginal cost.

5. Sawyer defined the accounting rate of return as $P_t/K_t$ and then summed the series from $t=0$ rather than $t=1$. He therefore actually arrived at

$$q = \frac{(R-g)(1+r)}{(r-g)}$$

6. Lerner's Index is

$$\frac{1}{1-\frac{1}{e_d}}$$

where $e_d$ is the elasticity of demand. When estimating Lerner's Index it is a common practice to assume that marginal cost and unit variable cost are equal, so that

$$\frac{1}{e_d} = \frac{S-BI}{S}$$

where $S$ is the firm's sales; and

$BI$ is the firm's variable expenditure.
As described in Chapter 6, this practice is very questionable.

7. An exception may be found at page 578 of Corporate Finance by Brealey and Myers.

8. A secondary share issue is a sale of a large block of shares by a party other than the firm itself. Problems over simultaneous information release and other price sensitive information are thus minimised. In the sample studied by Scholes, issues ranged in size from 1% to 35% of the issued share capital and up to $100,000.

9. This equation assumes continuous capital expenditure and that $g$ and $d$ continuous rates.

10. Unwin and Simon were critical of this finding on the grounds that it assumed arbitrary parameters and depended on discounting present earnings in perpetuity at a rate equal to the inverse of the PE ratio, ignoring the fact that PE ratios reflected growth prospects as well as cost of capital.

11. In this paper, a post-corporation tax pre-income tax perspective is adopted throughout the analysis. This is a convenient approach, often used in the literature, as it accommodates the fact that post-income tax returns are not generally observable. It does not reflect a belief here that the Fundamental Model applies to pre-income tax returns.

12. This is not the inverse of the conventional Dividend Cover ratio, usually defined as profit after Corporation Tax, including ACT, to net dividends.

13. In an exchange offer, one or more classes of security is given the right to exchange part or all of the holding for a different class of security. Terms typically involve a package of new securities of greater value than the pre-offer original holding and little or no cash adjustment.

14. Bernier, for example rejected, at the 1% confidence level in two of the four years studied, the hypothesis that Tobin's $q$ and a firm's Beta Coefficient are inversely related.

15. Spiller's relationship was

$$q = 1 + \frac{S}{K} \frac{1}{\beta - e_d (1+r_o)}$$

where $e_d$ is the elasticity of demand.
16. Most literature ignores the option associated with sunk investment and the prior risk that the investment would prove abortive. These are referred to in Chapter 2.

17. An exception is the argument adopted in some of the industrial economics literature that economic profitability can be measured by the firm's Hicksian profit deflated by some functionally appropriate measure reflecting the scale of the firm. This argument was discussed in the previous chapter and rejected there as being based on an insufficiently rigorous definition of economic profitability.

18. In order to use q to measure the economic profitability of a line of business, it would be necessary to estimate the market value of the line of business. This would only be practicable when the line of business, or the balance of the firm's activities, represent a large proportion of the entire firm.

19. Although it might be necessary for, say, competition authorities and utility regulators to obtain the information on a confidential basis. Notwithstanding the disclosure requirements of the Companies Act 1985 and SSAP 25, issued in June 1990, the disclosure by companies of line of business information remains unsatisfactory due to the discretion afforded to directors in deciding what is a line of business. In this respect, it is notable that the Monopolies and Mergers Commission's recommendation (1980) that lines of business should be defined in terms of the Standard Industrial Classification was ignored by the government. Furthermore, there is nothing comparable in the UK to the PIMS data set or the Federal Trade Commission's Financial Reporting Program in the USA, although information in Monopolies and Mergers Commission's reports do provide a useful but limited set of data on the financial performance of firms in specific product-markets - see Utton (1986).

20. Coulthurst found that some firms made an adjustment to incremental cash flows in order to allow for non-income generating assets and expenses, especially those concerned with infrastructure.

21. To accommodate this criticism, Dorward (1986) suggested that budgeted overheads should be allocated in direct proportion to the rate of capital utilisation.

22. Baumol and Bradford went on to demonstrate that, in industries where, perhaps due to economies of scale, marginal costs were below average costs, the elimination of losses resulting from pricing at marginal cost would be achieved most efficiently by marking up prices in inverse proportion to their demand elasticities (so-called 'Ramsey pricing').
23. An exception might be when the line of business represented a large proportion of the business of the entire firm.

24. For example by using the cost of capital of a similar business which could be estimated directly from capital market information.

25. This may be less obvious for rates of return. In order, however, to estimate the risk adjusted cost of capital, assumptions are made about the efficiency of capital markets.

26. When, however, the growth in investment was equal to or greater than the common project IRR, IRR was not defined. As the present value of a perpetual cash stream growing at a rate in excess of the discount factor is, itself, not defined, this finding was a useful reminder of the principles of discounting but was not unexpected.

27. This assumption simplifies the subsequent analysis and would represent a reasonable approximation for most firms. It is not, however, essential for subsequent findings.

28. In practice, Edwards, Kay and Mayer and others identify economic profitability with ARR-r rather than (1+ARR)/(1+r). This is, however, a simple transformation of AREL.

29. Economic depreciation was defined by Brealey and Myers as the reduction in present value of an asset.

30. Utton (1986) formalised this approach in his study of MMC reports, noting that the MMC appeared to become concerned about excessive profits when ARR exceeded 'average ARR' by a factor of 2.

31. The theoretical measures would, however, provide useful information even in start up situations if account were taken of the option value of potential investments. Consideration of such a possibility is, however, beyond the scope of this paper.

32. Ijiri argued that, as cash flows normally occurred throughout the year, R could be replaced by the natural logarithm of 1+R.

33. Salamon's analysis and the resulting equation is in real terms with a constant inflation factor, but this does not effect his findings or conclusions.

34. This has been justified by Davis using some novel ideas about the nature of risk, but the use the risk free rate may, to some extent, have simply been an experimental ploy to overcome awkward results when AVR is calculated using the risk adjusted cost of capital estimated from the CAPM.
CHAPTER 4

EX ANTE MEASUREMENT OF THE ECONOMIC PROFITABILITY OF A FIRM:
RETURN ON TOTAL CAPITAL EMPLOYED

Introduction

As noted in the previous chapter, AREL, or, in practice, ARR-r, the difference between the Accounting Rate of Return, ARR, and the firm's risk adjusted cost of capital, r, is a widely used measure for the ex post economic profitability of a firm. Davis and Kay have, however, drawn attention to the inflation of ARR when bought in goods and services are substituted for those manufactured internally. In effect, Davis and Kay claim that ARR is biased by the operational gearing of the firm. Furthermore, there is a widespread belief, given expression by the Monopolies and Mergers Commission (MMC), that ARR is an unsuitable measure of profitability when the capital base is small in relation to sales. The literature contains no satisfactory explanation for such a bias. Without such an explanation, there can be no confidence that q would not also share the bias.

In this chapter, the bias identified by Davis and Kay is explained by the differences between ARR and a semi-operational form of the ideal measure, EP3, identified in Chapter 2. This semi-operational measure is called here the Return on Total Capital Employed (ROTCE). The difference between ARR and ROTCE is shown to conform to the pattern identified by Davis and Kay and by the MMC.

The chapter concludes with an analysis which derives a fully
operational form of ROTCE. Using data from a simple corporate model, this operational form is compared with ARR and measures proposed by Davis and Kay. The results demonstrate that the bias in ARR and the other measures can be significant.

4.1 The Bias in ARR identified by Davis and Kay
As the review of literature in the previous chapter confirms, it is widely recognised that ARR is biased if the denominator excludes hidden capital, and the numerator is net of expenditure on hidden capital rather than depreciation of hidden capital. Other biases identified in the literature are those that arise from the use of historical costs rather than current or net replacement costs and from the use of depreciation profiles that do not correspond to economic depreciation. Brealey and Myers (1984) assert, however, that there are no other biases in ARR. It is therefore somewhat surprising that Davis and Kay (1990) should claim, albeit with little hard empirical evidence, that ARR is inflated when a firm buys in goods and services. Identifying the bias as the difference between ARR and the ‘true’ rate of return, R*, that would be independent of the proportion bought in, it can be illustrated as follows:

Figure 4.1
Bias in ARR Described by Davis and Kay

Bias in
ARR = ARR-R*
Davis and Kay's bias may be associated with the omission of hidden capital but is not explained by this phenomenon, as hidden capital can be formed independently of buying in goods and services. Furthermore, it cannot be explained by the other forms of bias identified in the literature: those due to inappropriate valuation of assets and depreciation profiles. As buying in is associated with a decrease in the level of a firm's operational gearing, i.e., the extent to which expenditure is fixed, Davis and Kay were, in effect, claiming that ARR is biased by the firm's operational gearing. They offered no formal explanation for this effect nor statistical evidence to back up their claim, appearing to consider the existence of such a bias to be self-evident. A similar view may have found expression in the assertion in the MMC's report on the Supply of Cinema Advertising Services (1990) that ARR is not the most appropriate measure for service industries where capital employed is relatively low in relation to turnover.

No satisfactory explanation for ARR being biased by operational gearing is provided in the literature. Without such an explanation, the possibility that \( q \) could be similarly affected cannot be dismissed.

An unexplained bias in ARR is of great practical significance. In line with Edwards, Kay and Mayer's (1987) conclusion that ARR is 'directly relevant to economic analysis', it has become the accepted practice for government regulators, researchers and financial analysts to compare ARR, on a clean surplus, current cost basis, with the risk adjusted cost of capital, estimated using the Capital Asset Pricing Model (CAPM) in order to assess whether supra-normal profits have been earned. The biases in ARR due to the omission of hidden capital, the historical cost convention, and straight line depreciation are well understood and can, in theory, be allowed for. That identified by Davis and Kay cannot be eliminated until it is understood. An unexplained bias in ARR could result in the
mis-allocation of resources throughout the economy as regulated firms are set inappropriate price ceilings and the economic profitability of firms generally is mis-interpreted by researchers and financial analysts.

Despite the importance of the issue and the absence of a satisfactory explanation in the literature, it is relatively easy to demonstrate that ARR is indeed biased by operational gearing. A formal proof is provided in Appendix 3.

4.2 The Economic Rate of Return for a Firm

The failure of ARR-r to indicate in an unbiased way the ex post economic profitability of a firm can be explained by its divergence from an ideal measure of economic profitability. The analysis in this section therefore commences by partially operationalising the ideal profitability measure EP3 proposed in Chapter 2. The first step is to assume that \( K_0 \) and \( K_1 \) are single payments, so that

\[
EP_3 = \log \left( \frac{PV_{0,1}(S) + K_1 \cdot e^{-r_k}}{K_0 + PV_{0,1}(E) + PV_{0,1}(BI)} \right)
\]  

(18A)

where: 

- \( S \) is the sales in the year;
- \( K_0 \) is the replication cost of the firm at the start of the year;
- \( K_1 \) is the replication cost at the end of the year;
- \( r_k \) is the discount rate or cost of capital appropriate for \( K_1 \);
- \( E \) is the fixed expenditure in the year in cash terms; and
- \( BI \) is the variable expenditure in the year.
As previously, it is assumed for simplicity that $S$ and $BI$ are the same in cash terms and on an accruals basis, while, by definition, the accruals form of fixed expenditure, $\text{Exp}$, is

\[ \text{Exp} = E - \text{CAPEX} + \text{Depn} \]  

(82)

where: CAPEX is capital expenditure, ie expenditure on fixed assets in the year; and

Depn is depreciation on fixed assets in the year.

Thus, in effect, stocks, debtors, creditors and other working capital are abstracted. These may be allowed for by adjusting the period over which cash flows are discounted to reflect the period of credit given and taken, the time stocks are held, etc; but a good approximation would be achieved in most cases simply by including working capital in $K_0$ and $K_1$.

In separating expenditure into components $BI$ and $E$, it is assumed that expenditure can be classed as either variable or fixed. This basic distinction, though somewhat arbitrary, is one that has long been recognised by both economists and accountants. Fixed expenditure is typically associated with internal production and Value Added and variable expenditure is associated with bought in goods and services re-sold to provide the firm with a trading mark-up. The distinction therefore has much in common with that drawn by Davis and Kay between bought in expenditure and other expenditure.

Finally, there is an accounting identity such that

\[ K_0 + \text{CAPEX} - \text{Depn} + \text{Revn} = K_1 \]  

(83)

where Revn is the surplus in the year on revaluing fixed
Assuming $S$, $E$ and $BI$ are continuous, $EP_3$ may be expressed in the form

$$EP_3 = \log \left( \frac{\int_0^1 S \cdot e^{-r_s t} \, dt + K_1 \cdot e^{-r_k}}{K_0 + \int_0^1 E \cdot e^{-r_e t} \, dt + \int_0^1 BI \cdot e^{-r_{bi} t} \, dt} \right)$$

(18B)

where $r_s$, $r_k$, $r_e$, and $r_{bi}$ are the discount rates appropriate for $S$, $K_1$, $E$ and $BI$ respectively.

It is assumed that $S$, $E$ and $BI$ are constant in real terms within the year. This represents the most reasonable assumption an external analyst without knowledge of the actual profiles of a firm's annual cash flows in the year can make. It is a much better representation of reality than either of the other assumptions employed in the literature:

a. that cash flows arise at the end of the year; or

b. that the accounting period is instantaneous.

Whilst Peasnell (1982) defended these assumptions on the grounds an accounting period can, in theory, be made as short as one desires - "a year, a week, an hour", this ignored the fact that it is not the external analyst who determines the accounting period. The reality of the situation is that the normal duration for published accounts is one year.

With constant cash flows in the year, the integrals may be evaluated, as follows
Substituting for $K_1$ using equation 83

$$EP_3 = \log\left( \frac{(1-e^{-rs})S + K_1e^{-rk}}{K_0 + \left(\frac{1-e^{-re}}{r_e}\right)E + \left(\frac{1-e^{-rbi}}{r_{bi}}\right)BI} \right)$$  \hspace{1cm} (113)$$

Assuming that the difference between capital expenditure and depreciation is small in relation to sales and the initial capital, so that

$$\frac{1-e^{-rs}}{r_s}S + Revn\cdot e^{-rk} + K_0\cdot e^{-rk} + (CAPEX - Depn)\cdot e^{-rk} \gg (CAPEX - Depn)\cdot e^{-rk}$$  \hspace{1cm} (115)$$

and $EP_3$ is small so that

$$\frac{1-e^{-rs}}{r_s}S + Revn\cdot e^{-rk} + K_0\cdot e^{-rk} + (CAPEX - Depn)\cdot e^{-rk} \approx K_0 + \left(\frac{1-e^{-re}}{r_e}\right)E + \left(\frac{1-e^{-rbi}}{r_{bi}}\right)BI$$  \hspace{1cm} (116)$$

the Binomial Theorem can be used to approximate equation 114 as

$$EP_3 = \log\left( \frac{(1-e^{-rs})S + Revn\cdot e^{-rk} + K_0\cdot e^{-rk}}{K_0 + \left(\frac{1-e^{-re}}{r_e}\right)E + \left(\frac{1-e^{-rbi}}{r_{bi}}\right)BI - (CAPEX - Depn)\cdot e^{-rk}} \right)$$  \hspace{1cm} (117)$$
Substituting equation 82, this may be expressed as

\[ EP_3 = \log \left( \frac{\left(1 - e^{-r_k S}\right) + \text{Revn} \cdot e^{-r_k} + K_0 \cdot e^{-r_k}}{K_0 + \left(1 - e^{-r_e}\right) \text{Exp} + \left(1 - e^{-r_{bi}}\right) BI - \Delta} \right) \]  

(118)

where

\[ \Delta = (\text{CAPEX} - \text{Depn}) \left( e^{-r_k} - \frac{1 - e^{-r_e}}{r_e} \right) \]  

(119)

CAPEX-Depn has already been assumed to be relatively small. Assuming \( r_k \) and \( r_e \) are of a similar magnitude, it follows that \( \Delta \) is very small indeed and can therefore be ignored. Thus

\[ EP_3 = \log \left( \frac{\left(1 - e^{-r_k S}\right) + \text{Revn} \cdot e^{-r_k} + K_0 \cdot e^{-r_k}}{K_0 + \left(1 - e^{-r_e}\right) \text{Exp} + \left(1 - e^{-r_{bi}}\right) BI} \right) \]  

(120)

This semi-operational form of \( EP_3 \) can be expressed as the difference between a rate of return and the firm's risk adjusted cost of capital. This rate of return is called in this paper the Return on Total Capital Employed (ROTCE)\(^4\). Thus, by definition,
\[ \text{ROTCE} = r + \log \left( \frac{1-e^{-rs}}{r_e} S + \text{Revn}.e^{-rt} + K_0.e^{-rk} \right) \]  
\[ \frac{K_0 + \left( \frac{1-e^{-rs}}{r_e} \right) \text{Exp} + \left( \frac{1-e^{-rbI}}{r_{bl}} \right) \text{BI} }{ } \]  

(121)

where \( r \) is the firm's risk adjusted cost of capital\(^5\).

A shorthand form of this definition to facilitate subsequent manipulation is

\[ \text{ROTCE} = r + \log \left( \frac{\text{PV}(S) + \text{Revn}.e^{-rk} + K_0.e^{-rk}}{K_0 + \text{PV(Exp)} + \text{PV(BI)}} \right) \]  

(121A)

where the present value operator \( \text{PV}(\cdot) \) is implemented by multiplying the term by \( (1-e^{-rx})/r_x \).

A formal proof that ROTCE is unbiased by operational gearing is provided at Appendix 3.

4.3 The Davis and Kay Bias in ARR Explained

Assuming ROTCE is a good approximation of EP\(_3\), the bias in ARR can be specified as:

\[ \text{BIAS}_{\text{ARR}} = \text{ARR} - \text{ROTCE} \]  

(122)

Substituting equation 121A

\[ \text{BIAS}_{\text{ARR}} = (\text{ARR} - r) - \log \left( \frac{\text{PV}(S) + \text{Revn}.e^{-rk} + K_0.e^{-rk}}{K_0 + \text{PV(BI)} + \text{PV(Exp)}} \right) \]  

(123)
where ARR-r is the level of supra-normal profitability apparently indicated by ARR.

The reason for the bias identified by Davis and Kay can now be understood. Buying in is associated with variable expenditure, while internal production and manufacture is associated with fixed expenditure. Assuming this identification is 100%, the Bought In Ratio, BIR, can be defined in present value terms, as follows:

\[
BIR = \frac{PV(BI)}{K_0 + PV(BI)} + PV(Exp) = 1 - \frac{K_0 + PV(Exp)}{K_0 + PV(BI) + PV(Exp)} \quad (124)
\]

Thus the bias in ARR is

\[
BIAS_{ARR} = (ARR-r) - \log\left(\frac{PV(S) + Revn.e^{-rk} + K_0 e^{-x}}{K_0 + PV(Exp)}\right) - \log(1 - BIR) \quad (125)
\]

which may be expressed as

\[
BIAS_{ARR} = (ARR-r) - \log\left(\frac{PV(S) + Revn.e^{-rk} + K_0 e^{-x}}{K_0 + PV(Exp)}\right) + \log\left(\frac{PV(Exp)}{K_0}\right) - \log(1 - BIR) \quad (126)
\]

Sales Intensity, SI, and the Manufacturing Technology Ratio, MTR, are defined as follows:

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\[ SI = \frac{PV(S)}{K_0} \]  

and

\[ MTR = \frac{PV(Exp)}{K_0} \]  

The bias in ARR can therefore be expressed as:

\[ BIAS_{ARR} = (ARR - r) - \log(\alpha + SI) + \log(1 + MTR) - \log(1 - BIR) \]  

where

\[ \alpha = \left(1 + \frac{Revn}{K_0}\right)e^{-rk} \]  

Where the firm’s assets are not of a speculative nature, a reasonable approximation would be \( \alpha = 1 \). Thus

\[ BIAS_{ARR} = (ARR - r) - \log(1 + SI) + \log(1 + MTR) - \log(1 - BIR) \]  

This relationship can be illustrated as follows:
When there is no buying in, the bias in ARR is

$$BIAS_{ARR} = (ARR - r) - \log \left( \frac{1 + SI}{1 + MTR} \right)$$  \hspace{1cm} (132)$$

As SI > MTR for a profitable firm, the log term is positive. Thus the bias must be small, being less than \((ARR - r)^6\). As the proportion of goods and services measured by BIR increases, so does the bias. As BIR approaches 1, the bias becomes infinite. This corresponds well with the relationship described by Davis and Kay and illustrated in Figure 4.1. Furthermore, abstracting from buying in,

$$\lim_{K \to 0} (BIAS_{ARR}) = (ARR - r) - \log \left( \frac{PV(S)}{PV(Exp)} \right)$$

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The log term is likely to be small in this situation, but the bias could, nevertheless, be significant as high values of (ARR-r) are typically observed as $K_0$ approaches zero. These high values are explained by the bias. Thus the MMC’s mistrust of ARR when the capital base is small in relation to sales is shown to be well founded.

4.4 Translating the ROTCE into a Usable Profitability Measure
Given its derivation from EP3 and the failure of other measures such as ARR-r to correspond to this ideal, a fully operational version of ROTCE-r would be of considerable practical value. Such a measure is now derived.

ROTCE-r corresponds to

$$\text{ROTCE-r} = \log \left( \frac{\left(1 - e^{-rs}\right) S + \text{Revn}. e^{-rk} + K_0 . e^{-rk}}{K_0 + \left(1 - e^{-rs}\right) \text{Exp} + \left(1 - e^{-rb_i}\right)BI} \right)$$

(121A)

where: $S$ is the sales in the year;

$\text{Revn}$ is the surplus on revaluing fixed assets;

$K_0$ is the replication cost of the firm at the start of the year;

$\text{Exp}$ is fixed expenditure on an accruals basis;

$\text{BI}$ is variable expenditure; and

$r_i$ are the discount factors or costs of capital appropriate for each cash flow.

$S$ and ($\text{Exp+BI}$) are disclosed in published accounts. $\text{BI}$ can be represented by expenditure on Materials and Consumables which, as explained in Chapter 7, can be estimated from information in published accounts. Abstracting from the option value
associated with sunk investment, $K_0$ can be represented by the net replacement cost of net tangible and intangible assets, the latter being estimated by depreciating prior expenditure on such items as R&D and advertising. As noted in Chapter 2, an allowance is also required for the possibility that replicating the firm would prove unsuccessful, but, in many types of business it would be reasonable to assume that this adjustment was not significant. Thus, to operationalise ROTCE, it only remains to estimate the various costs of capital that appear in the equation above. This can be achieved using the Capital Asset Pricing Model (CAPM), according to which:

\[
\begin{align*}
    r &= r_0 + \beta \cdot (r_m - r_0) \\
    r_s &= r_0 + \beta_s \cdot (r_m - r_0) \\
    r_k &= r_0 + \beta_k \cdot (r_m - r_0) \\
    r_{b1} &= r_0 + \beta_{b1} \cdot (r_m - r_0) \\
    r_e &= r_0 + \beta_e \cdot (r_m - r_0)
\end{align*}
\]  

(134)

where: $r_0$ is the risk free rate of return; $r_m$ is the market return; $\beta$ is the firm's beta coefficient; $\beta_s$ is the beta coefficient of sales income; $\beta_k$ is the beta coefficient of the terminal value $K_1$; $\beta_{b1}$ is the beta coefficient for bought in expenditure; and $\beta_e$ is the beta coefficient for other expenditure.

Beta, the firm's beta coefficient, is the covariance of the
return on the firm's securities with the market return, deflated by the variance of the market return, ie

\[ \text{Beta} = \frac{\text{Cov}(r, r_m)}{\text{Var}(r_m)} \] (135)

where: \text{Cov}(\ ) signifies covariance; and

\text{Var}(\ ) signifies variance.

This may be expressed as

\[ \text{Beta} = \frac{\text{Cov}\left(\frac{\delta V}{V_0}, r_m\right)}{\text{Var}(r_m)} \] (136)

where: \( V_0 \) is the market value of the firm's securities at the start of the year; and

\( \delta V \) signifies change in the market value of the firm's securities, ie \( \delta V/V \) is the proportional change in \( V \).

Assuming dividend irrelevance and abstracting from taxation, it is assumed that

\[ \frac{\delta V}{V_0} = \frac{\delta Pr}{Pr_0} \]

where \( Pr_0 \) is the firm's clean surplus profit in the year and \( \delta Pr \) are changes in the profit. This assumption implies that changes in the return to shareholders correspond to the proportional changes in profits. This is a reasonable and
common assumption which underlies, for example, the use of the so-called accounting beta as a proxy for beta. In effect it is assumed that there are no systematic gains for shareholders unrelated to current profits.

By definition

\[ Pr_0 = P^* Q - b \cdot Q - \text{Exp} + \text{Revn} \]  \hspace{1cm} (137)

where: 
- \( P^* \) is price;
- \( Q \) is the quantity demanded;
- \( b \) is unit bought in cost;
- \( \text{Exp} \) is 'internal' cost, assumed to be fixed expenditure; and
- \( \text{Revn} \) is the surplus on revaluing fixed assets.

Treating demand \( Q \) as the only variable correlated with \( r_n \):

\[ \delta Pr = P^* \cdot \delta Q - b \cdot \delta Q \]  \hspace{1cm} (138)

Thus

\[ \text{Beta} = \frac{\text{Cov}(\frac{P^* \cdot \delta Q - b \cdot \delta Q - \text{Exp} + \text{Revn}}{Pr_0}, r_n)}{\text{Var}(r_n)} = \frac{P^* - b}{Pr_0} \cdot \frac{\text{Cov}(\delta Q, r_n)}{\text{Var}(r_n)} \]  \hspace{1cm} (139)

By definition

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where $S$ is sales

and

$$BI = b.Q$$

where $BI$ is the variable or bought in cost

Beta$_s$, Beta$_k$, Beta$_{bi}$ and Beta$_e$ are the respective covariances with the market return of the proportional changes in sales, bought in and other expenditure respectively, each deflated by the variance of the market return. They may be analysed in the same way:

$$Beta_s = \frac{Cov\left(\frac{P^- \cdot \delta Q}{S}, r_m\right)}{Var(r_m)} = \frac{P^-}{S} \frac{Cov(\delta Q, r_m)}{Var(r_m)}$$  \hspace{1cm} (140)$$

$$Beta_k = \frac{Cov(Revn , r_m)}{Var(r_m)} = 0$$  \hspace{1cm} (141)$$

$$Beta_{bi} = \frac{Cov(\frac{b \cdot \delta Q}{BI}, r_m)}{Var(r_m)} = \frac{b}{BI} \frac{Cov(\delta Q, r_m)}{Var(r_m)}$$  \hspace{1cm} (142)$$

$$Beta_e = \frac{Cov(Exp, r_m)}{Var(r_m)} = 0$$  \hspace{1cm} (143)$$

Rearranging to eliminate $Cov(\delta Q, r_m)/Var(r_m)$:
\[ r_s = r_{bl} = r_0 + \frac{Pr_0}{S-BI} \text{Beta}(r_m-r_0) \quad (144) \]

and

\[ r_k = r_e = r_0 \quad (145) \]

\( r_s, r_k, r_{bl} \) and \( r_e \) can now be eliminated from equation 121A to arrive at:

\[ \text{ROTCE-r} = \log \left[ \frac{S \cdot \alpha + (K_0 + \text{Revn}) e^{-r_0}}{K_0 + \text{Exp} \cdot \left( \frac{1-e^{-r_0}}{r_0} \right) + \text{Bl} \cdot \alpha} \right] \quad (146) \]

where

\[ \alpha = \frac{1-e^{-r_0} \frac{Pr_0}{S-BI} \text{Beta}(r_m-r_0)}{r_0 + \frac{Pr_0}{S-BI} \text{Beta}(r_m-r_0)} \quad (147) \]

Beta can be estimated from share price information and estimates are published by the London Business School Risk Management Service. It follows that all the variables needed to calculate \( \text{ROTCE-r} \) using the above equations can be estimated.

The conventional method of assessing supra-normal profitability is to estimate \( \text{ARR-r} \), where \( r \) is estimated using the CAPM. As information on Beta and \( K_0 \) is needed for such an evaluation, the additional information needed to estimate supra-normal profitability using \( \text{ROTCE-r} \) is modest and comprises any two of the three accounting variables sales, \( S \), variable expenditure, \( \text{Bl} \), and fixed expenditure, \( \text{Exp} \). As noted above, these variables can readily be estimated from published accounts.
In the preceding analysis, borrowing has been abstracted. In order to accommodate borrowing, it is simply necessary to exclude interest paid from Exp and substitute the asset Beta for the equity Beta.

4.5 Modelling ROTCE, ARR and Other Profitability Measures

In order to demonstrate the scale of the bias in ARR as the proportion of goods and services bought in increases, a simple model employing various realistic assumptions was constructed. The model, which is specified at Appendix 4, assumes that $K_o$, capital employed, is proportional to the quantity manufactured (ie, constant returns to scale) and sales price is constant as the proportion of buying in increases.

A wide variety of situations can be represented by this model. In the version reproduced at Appendix 5 the following illustrative variables were employed:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling price ($P_s$)</td>
<td>1.1</td>
</tr>
<tr>
<td>Manufacturing cost per unit ($\text{Exp}/Q_m$)</td>
<td>0.900</td>
</tr>
<tr>
<td>Bought in cost per unit ($\text{BI}/Q_{bi}$)</td>
<td>0.975</td>
</tr>
<tr>
<td>Capital employed per unit manufactured ($K_{m0}/Q_m$)</td>
<td>0.79</td>
</tr>
<tr>
<td>Capital employed per unit bought in ($K_{b10}/Q_{bi}$)</td>
<td>0.25</td>
</tr>
<tr>
<td>Risk free rate</td>
<td>3.0%</td>
</tr>
<tr>
<td>Risk premium</td>
<td>9.0%</td>
</tr>
<tr>
<td>Beta(sales)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

With these parameters, economic profitability, as measured by ROTCE-$r$, assuming it is indeed a good representation of $EP_3$, is constant and equal to 9.1%. In contrast, supra-normal profitability as measured by ARR-$r$ increases from 7.5% to 44.3% as the proportion bought in increases. The Bias in ARR, ARR-ROTCE, increases from -1.6% to +35.2% over the range modelled. The Added Value Ratio (AVR) proposed by Davis and Kay as a measure of economic profitability also increases,
reaching astronomical levels at high levels of buying in. The corresponding measure with bought in expenditure included in the denominator (AVR mk 1) also increases, but to a more modest extent. Return on Sales (ROS), which provides no signal by itself of supra-normal profitability, decreases as buying in increases.

The above results illustrate the extent to which ROTCE can eliminate bias that is present in ARR and other profitability measures.

4.6 Summary and Conclusions
An explanation for the bias in ARR associated with operational gearing, to which Davis and Kay drew attention, has been found. It is due to the mis-specification of ARR relative to the ideal profitability measure EP. By assuming that a firm’s cash flows are continuous and constant in real terms throughout the year, it was shown that ARR-r inflates relative to EP, as buying in increases. Support was also found for the MMC’s view that ARR is an inappropriate measure for non-capital intensive firms. Given the accepted practice of government regulators, researchers and financial analysts to compare ARR, on a clean surplus, current cost basis, with the estimated risk adjusted cost of capital, this is of some significance.

An operational form of EP was derived by applying the CAPM to each of the cash flows comprising the corporate cash flow. This measure is called here the Return on Total Capital Employed (ROTCE). It is proposed as a superior ex post measure of economic profitability to either ARR-r, the Corporate Internal Rate of Return Relative or Davis and Kay’s Added Value Ratio.

ROTCE was applied to data from a simple corporate model to confirm that the bias in ARR can be significant.
1. It should be noted that risk is a characteristic of a cash flow and can be defined independently of the business with which it is associated. Thus the risk associated with a firm's sales in a year can be defined in terms of, say, their variability (total risk) or by their correlation with the market return (systematic risk). While the nature of the business will determine the business risk and hence the magnitude of these statistics, it is possible in this analysis to abstract from such considerations. The means by which risk associated with a component cash flow can be quantified using the CAPM is dealt with later in the chapter.

2. An alternative assumption that expenditures grow at a rate sufficient to maintain a constant internal rate of return throughout the accounting period is rejected. It is considered that, in practice, expenditures on, for example, wages are not determined with such an objective in view. Abstracting from variations in volume within the year, separate types of expenditure will typically represent level cash flows in nominal terms with one or more discrete increases in the year to compensate for inflation. Assuming there is no correlation between the dates on which increases occur, the growth profile of expenditure in total will then correspond to zero growth in real terms.

3. All equations in this paper can, of course, be amended where necessary to reflect situations where firms publish accounts for periods other than one year.

4. An alternative approach is to define the Certainty Equivalent Rate of Return, CARR, as the risk free equivalent rate of return that can be compared with the risk free rate $r_0$, such that

$$CARR - r_0 = ROTCE - r = RPE$$

5. Throughout the analysis in this chapter, continuously compounded interest rates are employed. These may be replaced by the more familiar annual compound interest rate, $r_a$, by substituting $\log(1+r_a)$ for $r$. Thus equation ROTCE may be expressed as

$$ROTCE_a = r_a + (1+r_a) \left( \frac{PV_a(S) + \frac{Revn}{1+r_a} + \frac{K_0}{1+r_a}}{K_0 + PV_a(Exp) + PV_a(BI) - 1} \right)$$

where
\[ PV_a(X) = \frac{r_{xa}}{(1+r_{xa}) \log(1+r_{xa})} \]

Similar substitutions may be made elsewhere in this chapter.

6. The bias could even be negative, but large negative values are unlikely as the Sales Intensity will not be high when there is no buying in unless ARR-r is big.

7. The-Heip Nguyen and Bernier (1987) argued that a firm's systematic risk consists of two elements: one associated with its return on existing assets (a cash Beta) and the other associated with its growth opportunities (a revaluation Beta). This would suggest that there is a systematic return to shareholders correlate with current profits, but the authors were unable to suggest practical ways in which this might be estimated.

8. The same result can be arrived at by abstracting from the revaluation surplus and assuming that \( \beta_{s} = \beta_{b1} \), \( \beta_{S} = 0 \) and \( \beta_{s} \) is the one period weighted average of \( \beta_{s} \), \( \beta_{b1} \) and \( \beta_{s} \), i.e

\[
\beta_{s} = \frac{Pr}{S} \beta_{s} + \frac{BT}{S} \beta_{b1} + \frac{Exp}{S} \beta_{s}
\]

9. This is the definition of the Added Value Ratio employed by Davis and Kay in a subsequent paper 'Assessing Corporate Performance', Business Strategy Review, Summer 1990.
CHAPTER 5

EX ANTE MEASUREMENT OF THE ECONOMIC PROFITABILITY OF A FIRM:
MODIFIED TOBIN'S q

Introduction

The usual rationale for employing q as a measure of a firm's economic profitability derives from a consideration of a firm's behaviour when the capital market for its securities is efficient in a fundamental sense and the product market for its goods is less than fully competitive. In this chapter, a slightly different approach is taken. q is derived from EP1, the theoretical ex ante measure based on the ratio of a firm's inputs to its outputs identified in Chapter 2. This approach does not abandon the insight provided by the conventional approach, but it facilitates a more objective appraisal of q's strengths and weaknesses and suggests other ways in which EP1 might be estimated. One such alternative, arrived at by combining the Dividend Growth Model and the Capital Asset Pricing Model, is proposed as a practical ex ante measure of a firm's economic profitability. It is called in this paper Modified Tobin's q, or modq.

5.1 Rationale for q as a Measure of Economic Profitability

Whilst, as noted in Chapter 3, Salinger (1984) and Sawyer (1985) related q to the growth in demand, Salinger (ibid) related q to the elasticity of demand, and Chen, Cheng and Hite (1986) related q to Beta, the fundamental insight that q measures a firm's economic profitability is that
identified by Lindenberg and Ross (1981) and is broadly as follows. The cost of entering a market is $C_0$, the cost to the providers of the equity and loan capital of replicating their interest in a firm that has entered the market, ie the cost of re-creating the business in its existing state and potential (see Chapter 2). Provided the product market is competitive, ie there are no barriers to entry, the cost of entering will also equal the expected present value of future payments to the providers of loan and equity capital - if it were greater, there would be no incentive to enter and if it were less, more entrants would be induced to enter, depressing the return. According to the Fundamental Model of share value, the value of the firm's securities is also equal to the expected present value of these payments. It follows that, in a competitive product market,

$$V_e + V_b = PV_{0,0}(C_0)$$  \hspace{1cm} (148)

where: $V_e$ is the market value of the firm's equity securities;

$V_b$ is the market value of the firm's loan capital;

$PV_{0,0}(C_0)$ is the replication cost of the firm.

When, however, the market is uncompetitive, ie there are barriers to entry, it is the cost of entering the market and the cost of overcoming these barriers that equals the expected present value of future earnings. According to the Fundamental Model of share value, the value of the entered firm's securities remains equal to the expected present value of its earnings. Thus

$$V_e + V_b = PV_{0,0}(C_0) + B$$  \hspace{1cm} (149)

where $B$ is the present cost of overcoming barriers to entry.
Defining $q$ as

$$q = \frac{V_o + V_b}{PV_{0,0}(C_0)}$$

(23)

it follows that

$$q = 1 + \frac{B}{PV_{0,0}(C_0)}$$

(150)

The additional cost, $B$, that must be incurred by new entrants enables the firm to set prices above the level applying in a competitive market. For a profit maximising firm, the expected present value of these supra-normal profits is exactly equal to the present cost of the barriers to entry. Therefore

$$q = 1 + \frac{PV_{0,0}(SNP)}{PV_{0,0}(C_0)}$$

(25)

where $SNP$ are the firm's supra-normal profits. Thus the extent to which $q$ exceeds 1.0 signals the expected present value of supra-normal profits attributable to the firm's market power as a proportion of the replication cost of the firm.

The above analysis, which is widely accepted in the literature, suggests that, provided $PV_{0,0}(C_0)$ can be measured, $q$ is an unbiased measure from the ex ante perspective of a firm's economic profitability. As demonstrated in Appendix 3, $q$ is certainly free from the bias due to operational gearing which afflicts some ex post measures. The analysis does,
however, gloss over a number of problems. In practice, $q$ is measured as

$$q = \frac{V_e + V_b}{BV}$$  \hspace{1cm} (151)$$

where $BV$ is the book value of a firm’s net assets\(^1\) on a net replacement cost basis.

Abstracting from the prior risk that, on replication, the sunk investment would be lost, in a world without taxes, the difference between $PV_{0,0}(C_0)$, the replication cost of the business and the book value, on a net replacement cost basis, of the firm’s net assets is, by definition, its hidden capital, $HC$, ie

$$PV_{0,0}(C_0) = BV_0 + HC$$  \hspace{1cm} (152)$$

In a world with taxes, the values and cash flows in $EP_t$ are post tax, including personal taxes. As, however, returns after personal taxes cannot be observed, is necessary to abstract from personal taxes and consider cash flows after payment of corporation tax and before income tax. Thus $PV_{0,0}(C_0)$ is valued after mainstream corporation tax\(^2\). $BV$ is measured before deducting any provision for deferred taxation. Assuming the trapped equity model applies and the tax shield on borrowing is effectively an asset of the firm, it follows that

$$PV_{0,0}(C_0) = BV_0 - DT + TSB + HC$$  \hspace{1cm} (153)$$

where: $DT$ is the deferred tax liability described by Edwards,
Kay and Mayer, being the amount which, when deducted from BV, results in the net replacement cost of the firm's net assets on a post-mainstream corporation tax basis; and

TSB is the tax shield on borrowing, valued by discounting tax savings from borrowing at rates of interest applying at the pre-income tax level.

As DT, TSB and, especially, HC are difficult in practice to estimate, it is usual to estimate q using equation 152. This introduces a bias into q as, from equation 21

\[
\text{Bias} \% = \left(1 - \frac{EP_1}{EP_1} \right) = \frac{HC + TSB - DT}{PV_{0,0}(C_0)} \frac{1 - HC + TSB - DT}{PV_{0,0}(C_0)}
\]

(154)

Thus when HC+TSB-DT is significant in relation to PV_{0,0}(C_0) there is a significant bias in q.

5.2 Derivation of modg
As noted in the review of literature, Black commented that accountants have achieved, with their concept of profit, a remarkably good measure of value, but their measure of value, book value (BV in the above), is ineffective. Although the seriousness with which Black made these comments might be questioned, they have some force. Book values are arrived at by employing generally accepted accounting policies consistent with various fundamental accounting concepts. Even when the current cost convention is employed, the sum of book values is not intended to provide a measure of the value of the firm. One of the fundamental accounting concepts, that of prudence,
will generally result in the book value of intangible assets being stated at below their expected present value, contributing to hidden capital. Furthermore, book values do not reflect the tax shield on borrowing, the economic value of the deferred tax liability nor any value attributable to the possibility that sunk investment might have been abortive. The objective of the following section is therefore to derive from \( \bar{E}_P \) a variant of \( q \), called here modified Tobin’s \( q \), or ‘\( \text{modq} \)’, which employs profit and the estimated cost of capital of the firm rather than book value, thereby reducing or eliminating the distortion in \( q \) due to these shortcomings in book values.

\( \bar{E}_P \) correspond to

\[
\bar{E}_P = \frac{\sum_{i=1}^{\infty} [PV_{0,0}(Div_i) + PV_{0,0}(Int_i)]}{PV_{0,0}(C_0)}
\]

where: \( Div_i \) is the dividend in year \( i \);

\( Int_i \) is the interest in year \( i \); and

\( PV_{0,0}(C_0) \) is the replication cost of the business.

Assuming the Fundamental Model of capital market efficiency applies,

\[
V_e = \sum_{i=1}^{\infty} PV_{0,0}(Div_i)
\]

and

153
\[ V_b = \sum_{i=1}^{\infty} PV_{0,0}(Int_i) \]  

(156)

Substituting in equation 7 above and, for simplicity, writing \( C_0 \) for \( PV_{0,0}(C_0) \)

\[ EP_1 = \frac{V_o + V_b}{C_0} \]  

(7A)

Thus, on the assumptions made, \( EP_1 \) and \( q \) are the same. Next, however, \( C_0 \), which is difficult to estimate, is replaced with variables that can be observed. This is achieved as follows: -

Consider cash flows in the year immediately following \( t=0 \) when ex ante profitability is measured. Abstracting from personal taxation, from the definition of clean surplus profit,

\[ C_1 = C_0 + Pr_1 - Div_1 + Y_1 \]  

(158)

where: \( Pr_1 \) is the clean surplus profit or 'earnings' in the following year;

\( Div_1 \) is the gross dividend paid in that year;
\( Y_1 \) is the net proceeds from new borrowing in the following year;

\( C_0 \) is the replication cost or 'capital employed' at the end of the current financial year (corresponding to time \( t=0 \)); and

\( C_1 \) is the replication cost or 'capital employed' at the end of the following year.

This may be expressed as

\[
C_1 = C_0 + (1-p)Pr_1 + Y_1 \tag{159}
\]

where \( p \) is the payout ratio, defined as the ratio of gross dividends to clean surplus profit;

Four points should be noted:

i. cash flows are considered on a post corporate pre-personal tax basis;

ii. as \( C_0 \) and \( C_1 \) are the replication costs of the business, it follows that profit \( Pr_1 \) must be arrived at on a consistent basis - in practice this means charging depreciation on a net replacement cost basis;

iii. \( C_0 \) and \( C_1 \) include hidden capital, deferred tax, and the tax shield on borrowing; and

iv. the clean surplus profit includes any change, \( \delta V_b \), in the market value of borrowing in the next year.

The net proceeds from new borrowing is related to borrowing at the end of the year, \( V_{b0} \), and at the end of the next year, \( V_{b1} \),
by the following relationship:

\[ V_{b0} + Y_1 + \delta V_b = V_{b1} \]  \hspace{1cm} (160)

Assuming borrowing is at market rates, \( \delta V = 0 \). Therefore

\[ C_1 = C_0 + (1-p) Pr_1 + V_{b1} - V_{b0} \]  \hspace{1cm} (161)

Note the same result may be obtained by assuming that borrowing is not necessarily at market rates but the clean surplus profit excludes gains accruing to shareholders from changes in the market value of debt. This alternative assumption may be a better representation of data encountered in practice.

The rate of growth of equity share capital in the following year, \( g_1 \), is, by definition:

\[ 1 + g_1 = \frac{V_{e1}}{V_{e0}} \]  \hspace{1cm} (162)

where: \( V_{e0} \) is the market value of equity share capital at the end of the financial year; and

\( V_{e1} \) is the market value at the end of the next year.
The gearing ratio at \( t=0 \) is \( B_0 \), where:

\[
B_0 = \frac{V_{bo}}{V_{eo} + V_{bo}} \tag{163}
\]

where: \( V_{bo} \) is the market value of borrowing at the end of the financial year.

It is assumed that \( g_1, B_1 \) and \( p \) are constant in all periods after \( t=0 \) and equal respectively to \( g, B \) and \( p \), the levels at \( t=0 \) or derived from the year ending \( t=0 \). These assumptions are reviewed below. It follows that:

\[
1 + g = \frac{V_{bi}}{V_{bo}} \tag{164}
\]

and assuming capital markets are efficient in a fundamental sense:

\[
1 + g = \frac{Pr_1}{Pr_0} = \frac{C_1}{C_0} \tag{165}
\]

Substituting these identities into (161) and rearranging:
This result is similar to the familiar substitution commonly employed in the Dividend Growth Model

\[
g = (1-p)ARR
\]

where ARR is the Accounting Rate of Return, except that allowance is made for loan capital.

Substituting equation 166 into equation 7:

\[
EP_1 = \sum_{i=1}^{\infty} \left[ PV_{t,0}(Div_i) + PV_{t,0}(Int_i) \right]
\]

Assuming capital markets are efficient in a fundamental sense and substituting equations 154 and 155

\[
EP_1 = \frac{V_{e0} + B_{b0}}{(1-p)Pr_0 \frac{(1+g)}{g} + B_{b0}}
\]

Substituting from equation 163

\[
V_{b0} = \frac{B}{1-B}V_{e0}
\]
and substituting the following definition of the Price Earnings ratio based on profits in the current year

\[ \text{PER} = \frac{V_{eq}}{E_0} \]  \hspace{1cm} (171)

results in

\[ EP_1 = \frac{\text{PER} + \frac{B}{1-B} \text{PER}}{(1-p)\left(\frac{\text{PER} \cdot (r+\text{PER})}{\text{PER} \cdot (r-p)}\right) + \frac{B}{1-B} \text{PER}} \]  \hspace{1cm} (172)

Substituting for \( r \) using the Capital Asset Pricing Model

\[ r = r_0 + \text{Beta}(r_m-r_0) \]  \hspace{1cm} (173)

where: \( r_0 \) is the risk free rate;

Beta is the equity Beta Coefficient; and

\( (r_m-r_0) \) is the risk premium.

and re-arranging results in

\[ EP_1 = \left[ \frac{(1-p)(1-B)(1+r_0+\text{Beta}(r_m-r_0))}{\text{PER}(r_0+\text{Beta}(r_m-r_0)) - p} + B \right]^{-1} \]  \hspace{1cm} (174)
Each of the variables on the right hand side of the above equation can be observed or estimated. This side of the equation can therefore be used to estimate EP\(_i\). It is called in this paper 'Modified Tobin's q' or 'modq'. Thus modq is defined as:

\[
\text{modq} = \left[ \frac{(1-p)(1-B)(1+r_0 + \beta(r_m-r_0))}{\frac{\text{PER}(r_0 + \beta(r_m-r_0)) - p}{\text{PER}} + B} \right]^{-1} \tag{175}
\]

Given the reciprocal structure of modq and the need, described in later chapters, to use \(1/\text{modq}\), rather than modq, to test the measure, a case could be made to use \(1/\text{modq}\) as the measure of profitability. This option is not, however, taken as it could reduce the measure's acceptability to users familiar with q and the convention that profitability measures are directly related to profitability.

5.3 Significance of Assumptions Employed in the Derivation of modq

The Fundamental Model of share price assumes expectations to be homogenous, so that, in continuous time,

\[
V_e = E_0 \left( \int_0^\infty \text{Div}(t) \cdot e^{-r(t) \cdot t} \, dt \right) \tag{176}
\]

where: \(E_0(.)\) is expectations at time \(t=0\);

\(r(t)\) is a unique discount rate; and

\(g(t)\) is a unique expected growth rate.

The assumption of a constant growth rate assumes that there is a constant \(g_{aw}\) that is the solution to
where $D_{iv_0}$ is the current level of dividends.

There may well be such a solution, but it could diverge from what would be seen as the long term growth rate. This might be acute when $E_0(Div(t))$ has discontinuities, such as when statutory controls of dividends are in place. Similar considerations apply to the assumptions that $B$ and $p$ are constant.

The future levels of $B$ and $p$ are assumed to be indicated by current levels, and, in effect, growth is estimated from the perceived long term growth rate implied by the historic Price Earnings ratio, i.e.

$$g = \frac{PER\cdot r - p}{PER + p} \quad (178)$$

In order to avoid bias in modq, these need not be the 'best' estimates of $B$, $p$ and $g$ available, but they should themselves be unbiased. In practice, better estimates may be available from other sources - for example, in the summary of brokers' estimates published each month as Earnings Guide. There will certainly be particular situations where current levels would be a poor predictors of future levels, for example when earnings are depressed below the long term level as a result of short term factors. High values of the payout ratio, $p$, might signal such situations and thereby indicate when modq should not be used. Another situation when modq would be unreliable would be when tax rates were known to be subject to future change. This situation arose immediately after the 1984 Budget. There is no reason why such factors cannot be built
into the above analysis. When, however, such estimates are not available, for example when a large number of companies are being studied and it is impracticable to obtain information other than that in the accounts, the use of actual values for \( p, \) \( \text{PER} \) and \( B \) may introduce 'noise' but should not introduce a systematic bias into the estimate of \( \text{mod}q. \)

Whilst, as stated above, no explicit assumption has been made about how the tax shield on borrowing is valued, the assumption that \( B \) is constant has implications for its valuation. This matter is discussed in the next chapter.

5.4 \( \text{mod}q \) and \( q \) Compared
Like \( q, \) \( \text{mod}q \) is free from bias due to operational gearing as, according to the analysis in the previous chapter, this bias is due to divergence from the form of theoretical input-output ratios for the firm. \( \text{mod}q \) was derived directly from \( \text{EP}_1 \) and therefore avoids this error.

The bias in \( q \) when the denominator employs the book value of net assets, \( \text{BV}, \) is given by equation 157. This bias is not present in \( \text{mod}q \) where, by construction,

\[
\text{BIAS} \% \text{mod}q = \frac{\text{mod}q - \text{EP}_1}{\text{EP}_1} = 0
\]

If, however, the assumption that the current, historic levels for the payout ratio, \( p, \) growth rate, \( g \) implied by the historic Price Earnings ratio, \( \text{PER}, \) and gearing ratio, \( B, \) are unbiased estimates of future levels is invalid, biases will be introduced into \( \text{mod}q. \) Furthermore, these estimates are not necessarily the best estimates available. It is therefore possible that \( \text{mod}q \) has a larger random error or 'noise' associated with it than has \( q. \)
Unlike q, modq requires an estimate of r, the company's risk adjusted cost of capital. This is arrived at using the CAPM. If the estimate is biased in the sense that there is a variable w for which

$$\frac{d}{dw} EP_i = 0$$  \hspace{1cm} (180)

and

$$\frac{d}{dw} r \neq 0$$  \hspace{1cm} (181)

it follows that modq will be biased as

$$\frac{d}{dw} modq \neq 0$$  \hspace{1cm} (182)

Possible variables w include the assumed levels for the risk premium and risk free rate of return. Thus if these estimates are significantly different from the true levels, or if the CAPM itself is flawed, modq will be systematically over or under-stated.

Estimation of modq requires that profits after a charge for the depreciation of hidden capital, are observable. As only the earnings after expenditure on related items can be observed, there is an implicit assumption that expenditure on hidden capital is equal to the depreciation charge accruing on this item. In effect, any changes in the year to the net replacement cost of hidden capital are ignored. In the light of the relatively long term nature of much hidden capital suggested by the literature, this assumption is not unreasonable. Furthermore, provided hidden capital is not volatile, any bias should be less than that in q when BV is
used to estimate $C$. In situations where hidden capital is known to have changed significantly in the period, for example when a competitor suddenly introduces a new technology which undermines that of the firm, modq would not be a reliable profitability measure and should be avoided.

As profits are calculated on a clean surplus basis, modq will contain an erratic element due to the presence of such items as currency translation differences and extraordinary items. This creates no problem when profitability is measured as the average modq over a relatively long period. modq, is, however, like $q$, an ex ante measure. When expectations have changed, modq in earlier periods may be of limited relevance; and even when this is not the case, a long series of modq may simply not be available. In this situation, it would be preferable to employ some measure of sustainable earnings instead of the clean surplus earnings. In the empirical work which follows, sustainable earnings are estimated as follows:

1. the current cost operating profit before tax and monetary working capital adjustment in the latest year;
2. (less) interest paid;
3. (less) tax at a rate $(T-tp)/(1-tp)$ on the corresponding historical cost profit after interest;
4. (plus) the holding gain on stock and fixed assets in the latest year.

By employing the net replacement cost basis of valuation, it is implicitly assumed that net replacement costs are observable, or at least estimatable. Estimates can be made by applying an appropriate index to capital expenditure. The best known technique for doing this by forward iteration, in which errors in the earliest estimate become less significant as
subsequent estimates are computed. Another approach is to employ the information disclosed in published Current Cost accounts. This approach is the one used in the empirical study and is discussed in Chapter 7. In using either technique, it is, however, necessary to assume that the net replacement cost of the firm's net assets as a whole are equal to the sum of the net replacement costs of the individual assets and liabilities.

A crucial assumption, not only in the derivation of modq but for q itself, is that the capital markets for the firm's shares and loan capital are efficient in the fundamental sense. A possible way of allowing for some limited departure from this form of capital market efficiency is discussed below.

5.5 Modifications for Possible Inefficiency in Capital Markets

If capital markets fail to reflect rational expectations about future cash flows, modq will fail to indicate the profitability of a firm. Although the existing literature makes little of the point, capital market inefficiency can take two forms: Systematic Inefficiency and Unsystematic Inefficiency. Systematic Inefficiency occurs when a securities market is 'over-valued' as a whole in relation to the expected present value of future dividends. This form of inefficiency would appear as an apparent over or under-valuation of a comprehensive index such as the FTA Industrials Group relative to the present value of anticipated dividends and capital gains. Unsystematic Inefficiency, on the other hand, would take the form of 'noise' associated with an individual share price at a particular time and could be represented as an error term associated with an individual share price about its Fundamental Value, adjusted for Systematic Inefficiency. For a large portfolio and for the average for an individual share over an extended period, such an error term would have a zero
value.

Despite the evidence described in Chapter 3 that capital markets are efficient, estimates of Systematic Inefficiency have been made by Davies and Wadhwani (1988) and, on a regular basis, by County Nat West Wood Mac. The principles involved in such estimates are straightforward: yields on equities are compared with those on supposedly risk free gilt edged securities and the reverse yield gap is analysed in the light of historic returns and expectations of growth in dividends and inflation. Such estimates are primarily intended for investors seeking relatively short term investment opportunities by switching between equities and gilts, but Shiller's (1981) comparison between the Standard and Poor’s Composite Stock Price Index and the ex-post rational price suggests that so-called Rational Bubbles might persist for years. In order to adjust modq for Systematic Inefficiency, an estimate over a longer time scale than that employed by Davies and Wadhwani and County Nat West Wood Mac is therefore called for. In Appendix 6 a method of estimating the Systematic Inefficiency in UK share prices is suggested and an adapted version of modq (called modq*) is proposed. As noted in Appendix 6, the suitability of modq* as a profitability measure is, however, questioned as its derivation employs the Capital Asset Pricing Model which itself rests on an assumption that capital markets are efficient.

modq can only be adapted to Unsystematic Inefficiency by restricting its use to portfolios or to long run averages. The latter approach is only suitable when the underlying expectations determining profitability remain relatively constant. In view of Utton's finding that market power can persist for years, this restriction would not preclude the use of modq to assess market power.
5.6 Summary and Conclusions

While q has many advantages as a profitability measure, including an absence of the bias due to operational gearing present in ARR, it is difficult to measure because its denominator, the firm's capital employed, cannot be observed. The usual approach is to assume that the capital employed is equal to the net replacement cost of the firm's net assets, but this approximation ignores hidden capital and taxation effects and thus introduces a serious bias into q.

A modified form of Tobin's q for use as a profitability measure, called here 'modified Tobin's q' or 'modq', is derived, in effect by combining the Dividend Growth Model and the Capital Asset Pricing Model. In this way, the unobservable capital employed is eliminated and replaced with the firm's profit and the cost of capital. modq takes the form:

\[ modq = \left[ \frac{(1-p)(1-B)(1+r_0+\beta (r_m-r_0))}{PER(r_0+\beta (r_m-r_0)) - p} + B \right]^{-1} \]  

Like q, modq depends on the assumption that capital markets are efficient. Two forms of inefficiency are identified: Systematic Inefficiency and Unsystematic Inefficiency. Systematic Inefficiency corresponds to the extent to which the market as a whole is over or under-valued relative to the expected present value of future dividends. A possible method of adapting modq to compensate for this factor is suggested. Unsystematic Inefficiency corresponds to the noise associated with an individual share price. If it exists, it would be necessary to restrict the use of modq to portfolios or to averages over time.

In Chapter 4, it was possible to evaluate ROTCE by examining ex post data provided by a simple corporate model. This approach is less suitable for a measure such as modq which
measures profitability ex ante. A more effective evaluation can be made by employing real data incorporating the actual expectations of shareholders at the time. The next chapter describes how such tests to appraise modq were devised.
NOTES TO CHAPTER 5

1. Net assets here correspond to fixed assets plus stocks, debtors and prepayments, less creditors, liabilities other than loan capital and unpaid dividends, and provisions other than deferred taxation.

2. The term 'mainstream' corporation tax is used in this paper to refer to the corporation tax charge net of Advance Corporation Tax (ACT), which is assumed to be fully recoverable against the investors' Income Tax assessment.

3. This result could be deduced from the Dividend Growth Model, which is an application of the Fundamental Model of share price, but is more generalised.

4. This can be illustrated by re-arranging equation 166. Thus

\[ g = \frac{Pr_1(1-p)}{(C_0 - V'_{bo})} \]

5. In practice this might not be the case. It is my personal view, based on the experience of working in HM Treasury on dividend controls at the time, that dividend cover concessions granted in 1978 rendered the dividend controls then in operation largely cosmetic.

6. It would be preferable to exclude the profits of discontinued businesses, but these were not required by SSAP 16 to be disclosed separately in Current Cost accounts.

7. This is only a first order approximation as no allowance is taken of initial allowances, timing differences and tax exhaustion. As, however, a similar approximation is often used by financial analysts when estimating the long run tax charge, it is possible that there are market inefficiencies which would compensate for the error.

8. \( q \) would also be affected by an absence of capital market efficiency, as would the statistic ARR-\( r \) if the cost of capital, \( r \), were estimated using some method, such as CAPM, which depends on capital market efficiency.
CHAPTER 6

TESTS TO ESTABLISH WHETHER modq MEASURES PROFITABILITY

Introduction

In the previous chapter a modified form of Tobin's q, modq, was proposed as an unbiased measure of a firm's economic profitability. A new profitability measures can be appraised in two ways:

a. by using data from a corporate model and comparing the new and existing measures with the theoretically 'correct' result indicated by the model; and

b. by sampling the new measure using real data and examining whether the results are consistent with predictions.

The evaluation of ROTCE in Chapter 4 used the first method. This method is, however, unsuitable for modq as, in building the model, it would be necessary to make the same assumptions about the relationship between market values and current cash flows that were made in deriving modq. The only practicable way of appraising modq is therefore to sample real data.

The most straightforward way to use real sample data would be to compare modq with some unbiased profitability measure covering the same period. A test may be constructed by assuming that q is such a measure. This is a useful test, as modq might have some applications even if it were simply a noisy estimate of q. modq is, however, intended to eliminate
the bias in q due to hidden capital and taxation effects. A second test is therefore devised by making assumptions about the extent of these biases. A third test is devised by assuming that profitability is determined by market power and its appropriation by labour.

Tests such as these using real data drawn from samples cannot 'prove' that modq is a reliable profitability measure. They might, however, provide evidence that, for the sample selected, modq did not indicate profitability in the way intended and is not, therefore a credible profitability measure.

6.1 Using Sample Data: Testing 1/modq rather than modq
As noted in the previous chapter, modq is preferred to its reciprocal in order to build on the familiarity of users with q and to adhere to the convention that profitability measures are direct, not inverse, measures. The discussion of the appropriate statistical methodology is deferred to the next chapter, but in devising the tests, it is necessary to recognise that, as they will be subject to statistical analysis, it is necessary to invert modq. This imposes on each test a structure in which independent accounting variables are deflated by market values. Not only does this avoid the undefined variables which would arise if market values were divided by zero accounting variables, but it conforms with the principle expounded by Christie (1987) that, while there are no natural deflators and it was difficult to generalise, deflation by anything other than a function of the dependent variable could result in mis-specification. Christie was referring to equity valuation models, but, as the tests devised here are somewhat similar in form, inversion of modq for testing purposes would appear to be a called for.

6.2 Test 1: Is 1/modq positively correlated with 1/q?
The most straightforward way of evaluating modq would be to compare it with an unbiased measure of profitability. The review of the literature indicated that no such measure was available. Indeed, if such a measure existed, there would be
little need to propose new measures. In Chapter 3 a new measure, ROTCE, was proposed, but this relates to the ex post profit in a single accounting period, whilst modq relates to the expected profit in future periods. In the absence of exceptionally long series of data, ROTCE would therefore not provide a suitable comparator for modq.

As the review of literature confirms, q is, in theory, an unbiased measure, but, in practice, it is necessary to employ the net replacement cost of net tangible assets as the denominator. As a result, q is distorted by hidden capital and taxation effects. For the purposes of Test 1, these effects are assumed not to be material. Inverting both q and modq so that the former is deflated by market value, Test 1, referred to as T1 later, takes the form of a test of the null hypothesis that 1/modq and 1/q are not significantly and positively correlated.

Consideration of test methodology, including statistical considerations, is deferred to the next chapter.

6.3 Test 2: Do Hidden Capital and Taxation Effects explain any of the difference between 1/modq and 1/q?

Test 1, is a useful test in that modq would have a some interest and application even if it were no more than a noisy estimate of 1/q. modq is, however, intended to overcome the bias in q as conventionally measured arising from hidden capital and taxation effects.

The assumption in the first test that q is an unbiased measure of profitability is now relaxed. q is in practice measured as

\[ q = \frac{V}{BV} \]

where: V is the market value of the firm; and

\[ BV \] is the net replacement cost of the net tangible assets.

If 1/modq is simply a noisy estimate of 1/q
\[ \frac{1}{\text{mod}q} = \frac{1}{q} + e^- \]

where \(e^-\) is an error term.

Thus

\[ \frac{1}{\text{mod}q} - \frac{1}{q} = e^- \]

If, on the other hand, \(\text{mod}q\) measures profitability as intended

\[ \text{mod}q = \frac{V}{C} \]

where: \(C\) is the replication cost or 'capital' of the firm, such that

\[ C = BV + HC + TSB - DT \]

where: \(HC\) is the hidden capital;

\(TSB\) is the tax shield on borrowing; and

\(DT\) is the deferred tax liability.

It follows that

\[ \frac{1}{\text{mod}q} - \frac{1}{q} = \frac{HC}{V} + \frac{TSB}{V} - \frac{DT}{V} + e^- \]

Test 2, referred to as \(T2\), is an examination of the null hypothesis that the difference between \(1/\text{mod}q\) and \(1/q\) is unrelated to any of the factors \(HC/V\), \(TSB/V\) and \(DT/V\). Assuming the null hypothesis in \(T1\) has not been rejected, the null hypothesis in \(T2\) is consistent with \(1/\text{mod}q\) being simply a noisy estimate of \(1/q\).

In order to perform \(T2\), it is necessary to devise ways of estimating \(HC/V\), \(TSB/V\) and \(DT/V\). In the next sections of this chapter the ways in which, in principle, this can be done are explained. A consideration of test methodology is deferred to the following chapter.
6.31 Estimating Hidden Capital
The hidden capital of a firm, HC, is, by definition, the difference between the replication cost of the business and the net replacement cost of its net assets and Tax Shield on Borrowing, less the Deferred Tax liability. Thus

\[ HC = C - BV - TSB + DT \] (156A)

where: C is the replication cost of the business;

BV is the net replacement cost of net assets;

TSB is the Tax Shield on Borrowing; and

DT is the Deferred Tax liability.

Abstracting from any difference between the net replacement cost of net assets in their entirety and the sum of the net replacement costs of individual assets, and assuming that TSB and DT are valued in terms of their present value and present cost to the firm, hidden capital can be identified with the intangible assets represented by various types of past expenditure that would have to be incurred again if the firm were to be replicated in its entirety. The research reviewed in Chapter 3 identified four principal types of expenditure that might generate hidden capital in this way:

a. expenditure on advertising;

b. expenditure on R&D;

c. expenditure on creating human capital, including the cost of organisation; and

d. expenditure on infrastructure including investment in distribution networks, computer systems and supplier networks.
In addition, investment by third parties or 'stakeholders' in the firm can generate hidden capital, but, as there is no way in which this can be estimated without considerable firm-specific research, the estimate of hidden capital in this paper is confined to that generated by these four sources.

The hidden capital generated by the four sources above might be estimated by identifying the relevant expenditure incurred in the past and applying a policy of capitalisation, revaluation and depreciation on a net replacement cost basis. Approximations can, however, reduce the amount of data needed. Thus, in the case of advertising, if it is assumed that expenditure in previous years has grown in real terms, ie after indexation with a suitable cost index, at a rate \( g \), it is straightforward to show by summation of an infinite geometric series that

\[
HC = \frac{Adv}{d+g}
\]  

where: \( HC \) is the hidden capital generated by advertising;

\( Adv \) is the current level of expenditure on advertising;

\( d \) is the exponential rate of depreciation of this hidden capital; and

\( g \) is the rate of growth of expenditure on advertising.

Given the imperfect information available, it is not unreasonable to assume that the rate of growth in real terms is zero, so that the current level of spend is the best estimate of the spend in previous years. If it is also assumed that the rate of depreciation of hidden capital generated by advertising is common to all firms, it follows that
where $b_1$ is a coefficient common to all firms equal to $1/d$. This model also fits R&D where, as the review of literature confirms, the benefits of expenditure may be experienced only some years after the expenditure has been incurred. In the case of human capital and other investment in infrastructure and corporate organisation, a simple model does not emerge from the literature reviewed in Chapter 3. Furthermore, while expenditure by a firm on advertising and R&D can be observed, expenditure on human capital and infrastructure is difficult or, even impossible, to observe or estimate. It is, therefore, assumed that this expenditure is linearly related to the market value of the firm. A model of hidden capital is therefore proposed such that:

$$HC = b_0 V + b_1 \cdot Adv + b_2 \cdot R&D + e_-$$

where: $Adv$ is the current level of expenditure on advertising;

$R&D$ is the current level of expenditure on R&D;

$V$ is the market value of the firm;

$b_i$ are unknown positive coefficients; and

$e_-$ is an error term with zero mean.

Account must be taken of the fact that worldwide advertising cannot generally be observed. As explained in the next chapter, Advertising in the UK (UKADV), the corresponding sales (UKSL) can be observed. Thus, assuming UK advertising intensity is representative of worldwide advertising, hidden
capital, deflated by $V$, can be estimated as

$$\frac{HC}{V} = b_0 + b_1 \cdot \frac{UKADV}{UKSL} + b_2 \cdot \frac{R&D}{V} + e^-$$

This model represents a considerable simplification of reality. In the real world, the coefficients might well be different in different industries or vary over time. The former assumption could be dropped if the model was applied to a single industry. The latter assumption could lead to severe difficulties if the currently observed levels of expenditure on advertising and R&D is untypical of previous levels. Hidden capital may also have been generated independently of any input, for example by technological spill-over. No account is taken of factors, such as poor industrial relations and uncompetitive products, which could have a negative influence on hidden capital. Finally, to be useful in the work that follows, it is necessary for the error term, when divided by a suitable scalar, to have a zero mean and normal distribution.

6.32 Estimating Deferred Taxation

Edwards, Kay and Mayer identified the deferred tax liability of a firm with the present value of tax payments on the cash generated by the firm's assets. They were apparently able to estimate this present value, but, in the absence of a full explanation of their methodology, it is necessary to specify one. This now follows.

It is assumed that the (current cost) book value of a firm's assets is equal to the present value of the pre-tax cash flows generated by using those assets in the business, ie
where: \( BV \) is the book value;
\( n \) is the remaining useful life;
\( X_i \) is the pre-tax cash flow; and
\( r_u \) is the firm's (ungeared) cost of capital.

This may indeed approximate valuations used in current cost accounts, as SSAP 16 defined 'economic value' in such terms. The limitations of current cost asset values disclosed in Current Cost accounts are, however, appreciated and the approximation involved in using them in this way is recognised.

Consistent with the approach adopted elsewhere in the paper, \( r_u \) is the cost of capital after mainstream corporation tax. A case could be made for using a pre-tax rate when discounting tax payments, but this would be both complicated and possibly tautologous. As the objective is simply to arrive at a working estimate of the deferred tax liability, this complication is avoided, and \( r_u \) is used throughout, being estimated from the CAPM and the de-gearing equation:

\[
 r_u = r_0 + \frac{\text{Beta}}{V_b \frac{1-T_p}{1-tp}} (r_m - r_0) \tag{187} 
\]

According to Edward, Kay and Mayer's concept of deferred tax, amended only by employing the effective rate of mainstream corporation tax, the deferred tax liability, \( DT \), is
\[ DT = \frac{T - tp}{1 - tp} \left[ \sum_{i=1}^{n} \frac{X_i}{(1+ru)^i} - \frac{WDA_i}{1+ru} - \frac{IA \cdot GRC_n}{(1+ru)^n} \right] \]  

(188)

where: 
- \( T \) is the corporation tax rate;
- \( t \) is the income tax rate;
- \( p \) is the payout ratio;
- \( n \) is the remaining life of the assets;
- \( WDA_i \) is the annual allowance for tax purposes in year \( i \);
- \( 1A \) is the initial allowance on the eventual replacement in year \( n \); and
- \( GRC_n \) is the replacement cost in year \( n \).

Equations 185 and 187 enable the deferred tax liability for different classes of asset to be estimated as follows:

(a) Assets valued on a Open Market Basis.
There is no deferred tax liability as it can be assumed that the valuation takes into account this factor.

(b) Assets valued on a Current Cost Basis when there is an annual allowance or initial allowance.
It follows from equations 185 and 187 that

\[ DT = \frac{T - tp}{1 - tp} BV \]  

(189)

This equation is appropriate for estimating the deferred tax liability associated with investments in associated companies and non-industrial buildings, provided they are not stated at an open market value.

(c) Plant and machinery and some other classes of asset where an annual allowance is granted in perpetuity on a reducing balance basis.
Assuming such assets are held in perpetuity, so that \( n \) is infinite, Equations 185 and 187 become

\[
BV = \sum_{i=1}^{\infty} \frac{X_i}{(1+r_i)^i}
\]

(190)

\[
DT = \frac{T - tp}{1 + tp} \left[ \sum_{i=1}^{\infty} \frac{X_i}{(1+r_i)^i} - \frac{WDA_i}{(1+r_i)^i} \right]
\]

(191)

The presence of balancing charges for tax purposes enables the assumption of infinite retention to be relaxed. The annual allowance for plant and machinery is

\[
WDA_i = D GRC_i (1 - IA) (1 - D)^i - 1
\]

(192)

where: \( a \) is the age of the assets, assumed common for computational ease;
D is the rate of annual allowance; and
1A is the rate of initial allowance.

GRC\(_i\) rather than GRC0 is chosen, despite the fact that tax allowances are based on historical cost, not current or replacement cost because, although the expectation operator \( E(.) \) has been omitted, DT concerns expected tax liabilities and the perspective is ex-ante throughout. Thus

\[
BV = GRC_i (1 - d)^a
\]

(193)
where $d$ is the rate of economic depreciation. It is assumed, at least as a first order approximation, that

$$D = d$$

Therefore $BV = GRCI (1-D)^a$

Substituting into equation (190) and summing the geometric series.

$$DT = \frac{T-tp}{1-tp} BV \left[ 1 - \frac{D(1-IA)}{ru+D} \right]$$  \hspace{1cm} (194)

(d) Industrial buildings.

The annual allowance is given for a finite period on a straight line basis. In order to estimate this deferred tax liability, a different approach is needed. It is assumed that a replacement asset could be purchased at a cost net of tax equal to the book value less any initial allowance. The deferred tax liability is then

$$DT = \frac{T-tp}{1-tp} BV \left[ 1 - IA - \frac{D(1-IA)}{ru} \left( 1 - \left( \frac{1}{1+ru} \right)^{BV(1-IA)} \right) \right]$$  \hspace{1cm} (195)

As $D$ is small (no more than 0.04 in the period studied), a good approximation is

$$DT = \frac{T-tp}{1-tp} BV(1-IA)$$  \hspace{1cm} (196)
The above equations represent practical means of estimating the deferred tax liabilities associated with most classes of asset. There is, however, sufficient uncertainty over both the analysis and the effective tax rates to apply to include a coefficient in any estimate. Thus the deferred tax liability is estimated as

$$DT = \sum DT_i$$  \hspace{1cm} (197)

where $DT_i$ are the estimates of deferred tax liability for each class of asset.

6.33 Estimating the Tax Shield on Borrowing

The estimation of $TSB$, the tax shield on borrowing, must rely on theory about which previous literature is not agreed. Various conflicting models were described in Chapter 3. A slightly different approach is developed below which draws on several of the existing models while conforming to the assumption made in Chapter 3 that the gearing ratio is assumed by investors to be sustained.

The tax shield on borrowing is defined as the expected present value of the future tax savings each year, $S_t$. Assuming, as was done when modq was derived, that the expectation is that the debt/equity ratio is sustained, ignoring again taxes on personal income, and assuming borrowing is at the risk free rate $r_0$, the annual tax saving from cash flows in year $t$ is:

$$S_t = V_b r_0 \frac{T-t_P}{1-t_P} (1+g)^t$$ \hspace{1cm} (198)
Assuming the payout ratio is a measure, albeit approximate, of the proportion of cash flow paid out to satisfy equity shareholders, this saving may be analysed into three elements:

(1) a 'pure' equity element. This element contributes directly to the stockholders' return and is equal to

\[ p V_b r_0 \frac{T-tp}{1-tp} (1+g)^t \]  \hspace{1cm} (199)

As the riskiness of this element of the cash flow is the same as that of the returns to equity shareholders, the appropriate rate of discount is \( r \), the observed cost of equity capital.

(2) a 'pure' loan element. This corresponds to

\[ (1-p) V_b r_0 \frac{T-tp}{1-tp} \]  \hspace{1cm} (200)

and is assumed not to grow. Its riskiness is the same as that of the borrowing itself, which is assumed to be at the risk free rate, so it is discounted at the risk free interest rate, \( r_0 \).

(3) a mixed element. This corresponds to

\[ (1-p) V_b r_0 \frac{T-tp}{1-tp} ((1+g)^t-1) \]  \hspace{1cm} (201)
As this is dependent on the anticipated growth rate, it is held to be as risky as the 'pure' equity element and is, accordingly, also discounted at \( r \), the observed cost of equity capital.

Note that as borrowing is assumed to grow at rate \( g \), the rate of growth of the market value of equity, the gearing ratio, \( B \), will remain constant.

The Tax shield on Borrowing is the discounted sum of the entire cash flow discounted at the appropriate rates \( r_a \).

\[
TSB = \sum_{t=1}^{\infty} \frac{S_t}{(1+r_a)^t} \quad (202)
\]

Summing the three elements as geometric progressions

\[
TSB = V_b \left[ \frac{T}{1+r} - \frac{P}{1+r} \right] \left[ \frac{1}{g} + (1-p) \left( \frac{1}{r_0} + \frac{1}{r} \right) \right] \quad (203)
\]

The anticipated growth rate, \( g \), is not directly observable, but can be replaced by the PE ratio. From the Dividend Growth Model:

\[
V_{e0} = \frac{P}{r-g} = \frac{P}{r-g} \cdot \frac{(1+g)p}{r-g} \quad (204)
\]
where: \( V_e \) is the market value of equity.

\( Pr_0 \) is the clean surplus profit in the year ended; and

\( Pr_1 \) is the clean surplus profit in the next accounting year.

Substituting \( \text{PER} = \frac{V_e}{Pt_0} \) where \( \text{PER} \) is the Price Earnings ratio and rearranging:

\[
g = \frac{\text{PER} \cdot r - p}{\text{PER} + p} \quad (205)
\]

Using this expression to replace \( g \)

\[
\text{TSB} = V_b r_0 \frac{T - tp}{1 - tp} \left[ \frac{\text{PER} + p}{p(1+r)} + (1-p) \left( \frac{1}{r_0} - \frac{1}{r} \right) \right] \quad (206)
\]

As noted in Chapter 3, the theory underlying the expected present value of the tax shield is incomplete, and the above method is simply a refinement of the various methods proposed by prior researchers (and one that gives a result close to equation 49). For statistical analysis, some transformation may be needed to give less weight to high values, thereby taking some account of bankruptcy and tax exhaustion costs. Thus the Tax Shield is estimated as

\[
\text{TSB} = T \left( V_b r_0 \frac{T - tp}{1 - tp} \left[ \frac{\text{PER} + p}{p(1+r)} + (1-p) \left( \frac{1}{r_0} - \frac{1}{r} \right) \right] \right) \quad (207)
\]

where \( T(\cdot) \) is some suitable 'top slicing' transformation such as square root or \( \log(1+\cdot) \).
6.34 **Summary of Test 2**
Test 2 is an examination of the null hypothesis that the difference between $1/\text{modq}$ and $1/q$ are unrelated to $HC/V$, $TSB/V$ and $DT/V$. Rejection of the null hypothesis resulting from at least one of the explanatory variables being significant would be consistent with modq behaving as profitability measure that eliminates some of the bias present in q. Ways in which these dependent variables can, in principle, be estimated has been devised. Test methodology is considered in the next chapter.

6.4 **Test 3: Can some of the variability in $1/\text{modq}$ be explained by market power and its appropriation by labour?**
The first two tests employ assumptions about how q measures profitability and then construct testable hypotheses about the relationship between $1/\text{modq}$ and $1/q$. In the third and final test, T3, q is set aside and the question whether modq measures profitability is approached directly.

If modq functions in the way intended,

$$\text{modq} = \frac{V}{C} \quad (208)$$

and, assuming capital markets are efficient,

$$V = C + E(\text{PVSNP}) \quad (209)$$

where: PVSNP is the present value of supra-normal profits; and

$E(\quad)$ signifies expectation.

Thus
The connection between supra-normal profits and market power is well grounded in neo-classical economics. As noted in the literature review, many researchers have assumed that market power is the sole determinant of supra-normal profits; but theory suggests that economies of scale could also generate supra-normal profits and should not be ignored. In addition, as Salinger recognised, labour may be able to appropriate a significant proportion of supra-normal profits otherwise generated by market power. X-inefficiency, on the other hand might reasonably be ignored on the grounds that it is eroded too quickly by competitive pressures, particularly market entry, to significantly affect $E(PVSNP)$.

Following the above analysis, it is assumed that supra-normal profits are attributable to:

a. market power;

b. (less) the appropriation of this market power by labour; and;

c. other factors, including economies of scale, proportional to $V$.

In most empirical work involving the relationship between market power and profitability, market concentration and market share are used as proxies for market power. Using such structural variables to provide a firm-specific estimate of market power to test modq would, however, be unsatisfactory for the following reasons:

a. Most of the work using structural variables in this way has been concerned with establishing whether profitability and market structure are related. The absence of a statistically significant result could therefore be due to
the absence of a relationship between structural variables and market power rather than a failure of MOD to measure profitability.

b. In many of these studies, including the empirical research referred to in the review of literature, the relationship between structural variables and profitability has been found to be far from straightforward.

c. As numerous reports published by the Monopolies and Mergers Commission confirm, barriers to market entry are an essential condition if a firm is to translate a high market share or participation in concentrated markets into market power. The existence of such barriers can generally only be revealed by careful study of the particular market.

d. Firm-level estimates of the market share of UK firms are either unreliable or unavailable.

An alternative approach is therefore adopted. The market power of a firm with a single product-market can be represented by the reciprocal of the elasticity of demand it experiences, $1/e_d$, where $e_d$ is defined as:

$$e_d = -\left( \frac{\delta Q}{\frac{\delta P^-}{P^-}} \right)$$

where: $P^-$ is unit price; and
Q is quantity demanded

Thus market power is assumed to be proportional to $1/e_d$. The expected present value of supra-normal profits is then assumed to conform to the following linear relationship:
where: \( W \) is the staff costs; and

\[ c_i \text{ are positive coefficients.} \]

If \( \text{modq} \) measures profitability as intended

\[
\frac{1}{\text{modq}} = 1 - c_0 - c_1 \frac{1}{e_d} + c_2 \frac{W}{V} \quad (213)
\]

If, on the other hand, \( \text{modq} \) fails to measure profitability, a null hypothesis can be constructed that none of the variability of \( 1/\text{modq} \) can be explained by the variables \( 1/e_d \) and \( W/V \).

T3 is an examination of this null hypothesis. In order that it may be undertaken, it is necessary to devise a way of estimating \( 1/e_d \). In the following sections of this chapter a way in which this can be done is devised. A description of test methodology is deferred to the next chapter.

6.41 Estimating the Average Elasticity of Demand Experienced by a Firm

The literature provides no method by which the elasticity of demand experienced by a firm can be estimated. It is therefore necessary, for the purposes of this study, to devise a method using the type of data that might be obtained, i.e., cross-sectional accounting and financial data.

The market power of a firm operating in a single product-market can be represented by the reciprocal of the elasticity
of demand. \(1/e_d\), experienced, where \(e_d\) is defined as:

\[
ed = - \left( \frac{\delta Q}{\frac{\delta P}{P}} \right)
\]

where: \(P\) is unit price; and \(Q\) is quantity demanded

A firm without market power is a price taker and experiences a high elasticity. A firm with market power can set prices as a result of a low elasticity which gives it the opportunity of restricting output and increasing prices.

The definition of elasticity can be expressed in differential terms as

\[
\frac{1}{e_d} = - \frac{dP}{dQ} \frac{Q}{P}
\]

Changing price and output affects the risk to which the firm is exposed and hence its cost of capital. The firm with market power must take account of the change in its cost of capital when optimising its net worth. If this net worth is \(V\), its market value, the situation may be illustrated as follows:
where: $Q_c$ is the quantity supplied in a competitive market;

$Q_m$ is the restricted output of the firm with market power that maximises market value;

$V_c$ is the market value of the firm in the absence of market power; and

$V_m$ is the market value of the firm with market power.

To develop this model, consider a single product firm with no borrowing which experiences an anticipated demand for a single product. As has been demonstrated, assuming capital market efficiency,

$$modq = \frac{V}{C} = \frac{PER \cdot r - p}{(1-p)(1+r)}$$

where: $V$ is the market value of the firm's securities;

$C$ is the capital employed;
PER is the Price Earnings ratio;

r is the cost of capital; and

p is the payout ratio.

Abstracting for simplicity from any evaluation surplus, this may be expressed as

\[ V = \frac{C}{1-p} \cdot \frac{1}{1+r} \left[ \frac{V_r}{(P'Q - \text{Exp+BI})\left(\frac{1-T}{1-tp}\right)} - p \right] \]  (215)

where Exp+BI is the total expenditure incurred\(^3\).

The firm with market power seeks to maximise V by reducing Q. Differentiating by Q and setting \( \frac{dV}{dQ} = 0 \)

\[ \frac{V_r}{(P'Q - \text{Exp+BI})\left(\frac{1-T}{1-tp}\right)} - p \frac{d}{dQ}\left(\frac{1}{1+r}\right) + \frac{1}{(1+r)} \frac{d}{dQ}\left[ \frac{V_r}{(P'Q - \text{Exp+BI})\left(\frac{1-T}{1-tp}\right)} - p \right] = 0 \]  (216)

Completing the differentiation and rearranging
\[
\frac{(P,Q-\text{Exp-BI}) \left( \frac{dP}{dQ} \right) - \frac{V \cdot r}{1 + r} \left( \frac{1 - T}{1 - tp} \right) \left( \frac{1 - T}{1 - tp} \right) dP - d(\text{Exp+BI})}{(P,Q-\text{Exp-BI})^2}
\]

(217)

\[-\frac{1}{1 + r} \left[ \frac{V \cdot r}{P,Q-\text{Exp-BI}} - \frac{P \cdot 1 - T}{1 - tp} \right] dr = 0\]

Substituting the definitions:

\[
\frac{1}{e_d} = -\frac{Q}{P} \frac{dP}{dQ}
\]

\[
MC = \frac{d(\text{Exp+BI})}{dQ}
\]

\[
PER = \frac{V}{(P',Q-\text{Exp-BI}) \left( \frac{1 - T}{1 - tp} \right)}
\]

(218)

where: \(e_d\) is the elasticity of demand;

\(MC\) is the marginal cost; and

\(PER\) is the Price Earnings ratio.

results in:

\[
\frac{PER \cdot dr}{dQ} - \frac{1}{1 + r} \frac{dr}{dQ} (PER \cdot r - p) - \frac{PER \cdot r}{P',Q-\text{Exp-BI}} \left( \frac{P - P'}{e_d} \cdot MC \right) = 0
\]

(219)

\(dr/dQ\) may be substituted in the above equation as follows:

From the CAPM

\[
r = r_0 + \text{Beta}(rm - r_0)
\]

where: \(r_0\) is the risk free rate;

\(rm - r_0\) is the market risk premium; and

\(\text{Beta}\) is the beta coefficient, equal to
Cov(r, rm)/Var(rm), where Cov( ) signifies covariance and Var( ) signifies variance.

Assuming dividend irrelevance:
\[ r = \frac{\delta V}{V} = \frac{\delta PTP}{PTP} \]

where PTP is the pre-tax profit = P'.Q - Exp - BI.

The CAPM can therefore be expressed as

\[ r = r_0 + \frac{\text{Cov}\left(\frac{\delta PTP}{PTP}, r_m\right)}{\text{Var}(r_m)} (r_m - r_0) \]  \hspace{1cm} (220)

It is assumed that only proportional changes in demand, \( \delta Q/Q \), is correlated with rm. Defining marginal cost, MC, as

\[ MC = \frac{d(Exp+BI)}{dQ} \]  \hspace{1cm} (221)

it therefore follows that

\[ r = r_0 + \frac{P'.Q - MC.Q}{P'.Q - Exp - BI} \frac{\text{Cov}\left(\frac{\delta Q}{Q}, r_m\right)}{\text{Var}(r_m)} (r_m - r_0) \]  \hspace{1cm} (222)

\( dr/dQ \) is now be found by differentiating the above with respect to Q:
\[
\frac{d\gamma}{d\eta} = \frac{\text{Cov}(\frac{\delta \eta}{\eta}, r_n)}{\text{Var}(r_n)} (r_n - r_0).
\]

(223)

\[
\frac{(P^r \cdot Q - \text{Exp-BI}) (P + Q \frac{dP}{d\eta} - d(\text{Exp+BI})) - (P^r \cdot Q - \text{MC} \cdot Q) (P + Q \frac{dP}{d\eta} - d(\text{Exp+BI}))}{(P^r \cdot Q - \text{Exp-BI})^2}
\]

Substituting into 219 and reintroducing MC and \( e_d \) where appropriate results in

\[
(P^r - \frac{P^r}{e_d} - \text{MC}) \left[ (\text{PER}(r - r_0) \left( \frac{1}{P^r \cdot Q - \text{MC} \cdot Q} - \frac{1}{P^r \cdot Q - \text{Exp-BI}} \right) \right.

\[
- \frac{\text{PER} \cdot r}{P^r \cdot Q - \text{Exp-BI}} - \frac{1}{1 + r} (r - r_0) \left( \frac{1}{P^r \cdot Q - \text{MC} \cdot Q} - \frac{1}{P^r \cdot Q - \text{Exp-BI}} \right) \] = 0
\]

(224)

There are two solutions to the equation above:

\[
P^r - \frac{P^r}{e_d} - \text{MC} = 0
\]

(225)

and

\[
\frac{1}{P^r \cdot Q - \text{MC} \cdot Q} - \frac{1}{P^r \cdot Q - \text{Exp-BI}} \left[ \text{PER}(r - r_0) - \frac{1}{1 + r} (r - r_0) (\text{PER} \cdot r - p) \right] - \frac{\text{PER} \cdot r}{P^r \cdot Q - \text{Exp-BI}} = 0
\]

(226)

The second solution is not used in this analysis\(^5\).

The first solution may be expressed as
This is the familiar relationship that can be derived assuming single period profit maximisation and ignoring the cost of capital. It has now been derived assuming maximisation of the firm's market value with cost of capital dependent on price and demand. The significance of the relationship is that the reciprocal of the elasticity of demand of a firm supplying a single product-market is a measure of that firm's market power. In the case of a multi-product firm, the reciprocal of the elasticity of demand may still provide some indication of the firm's overall market power. Marginal cost is, however, difficult to observe and, without an estimate, the relationship is of limited practical use. How marginal cost can be achieved is now considered.

Two possibilities exist for estimating MC. First, it can be assumed that marginal cost equals average variable cost per unit, AVC, so that

$$\frac{1}{e_d} = \frac{P - MC}{P}$$

The right hand side is the Profit Volume ratio that, as explained in the next chapter, can be estimated from data in published accounts. While some researchers have used this technique, it is unsatisfactory as in practice the average variable cost per unit can be significantly different from marginal cost. An alternative approach is, therefore, adopted. Using the same analysis as that in equation 222,
Within a particular market, \( \text{Cov}(\delta Q/Q, \text{rm}) \) is constant. It therefore follows that

\[
\frac{P^* - \text{MC}}{P^*} = \frac{1}{\epsilon_d} = k \, \text{Beta} \frac{P^* - \text{Exp-BI}}{P^* \cdot Q}
\]  

(230)

where \( k \) is a constant. Therefore

\[
\frac{1}{\epsilon_d} = k \cdot \text{Beta} \cdot \text{ROS}
\]  

(231)

where \( \text{ROS} \) is the return on sales. Dropping the assumption that there is no borrowing, \( \text{ROS}_b \), the return on sales after interest, is substituted. Therefore

\[
\frac{1}{\epsilon_d} = k \cdot \text{Beta} \cdot \text{ROS}_b
\]  

(232)

Assuming that marginal cost and average variable cost are proportional, a simple test of this model can be performed by checking that \( \text{Beta} \cdot \text{ROS}_b \) and \( \text{PVR} \) are significantly and positively correlated.

6.42 Summary of Test 3

It has been shown that, if modq measures profitability as intended
\[
\frac{1}{\text{modq}} = 1 - c_0 - c_1 \frac{1}{e_d} + c_2 \frac{W}{V} \tag{212}
\]

where \( c_i \) are positive coefficients. In 6.41 above it was shown that

\[
\frac{1}{e_d} = k \cdot \text{Beta.ROS}_b \tag{232}
\]

where \( k \) is a positive constant.

Combining these relationships:

\[
\frac{1}{\text{modq}} = c_0 + c_1 \cdot \text{Beta.ROS}_b + c_2 \frac{W}{V} \tag{233}
\]

where \( c_1 \) is a negative coefficient and \( c_2 \) is a positive coefficient.

A null hypothesis can then be constructed that the variability in \( 1/\text{modq} \) is not related to \( \text{Beta.ROS}_b \) or \( W/V \). The examination of this hypothesis, which is consistent with \( \text{modq} \) not indicating profitability, forms T3.

The precise methodology for T3 is described in the next chapter.

6.5 Summary and Conclusions
In view of the difficulty in constructing a corporate model that does not use the same assumptions employed in arriving at \( \text{modq} \), the tests devised for \( \text{modq} \) use real data drawn from samples. The envisaged use of statistical analysis in the appraisal of the results prompts the use of \( 1/\text{modq} \) for testing
purposes.

Three tests for $1/\text{modq}$ are envisaged in principle, as follows:

Is $1/\text{modq}$ positively correlated with $1/q$?

Do Hidden Capital and Taxation Effects explain any of the difference between $1/\text{modq}$ and $1/q$?

Can some of the variability in $1/\text{modq}$ be explained by market power and its appropriation by labour?

In order to express the second test in an operational form, it is necessary to devise ways of estimating hidden capital and taxation effects. This was achieved by drawing on the existing literature. In order to express the third test in an operational form, it is necessary to estimate a firm's market power. In previous research this has typically been done by assuming that market power can be represented by structural variables such as market concentration. This approach is rejected. Instead, a relationship not found in the existing literature is employed: market power, as represented by the reciprocal of the elasticity of demand, is shown to be linearly related to the product of the Beta coefficient and the Return on Sales.

The operational forms of the tests are expressed as the following null hypotheses:

T1: $1/\text{modq}$ and $1/q$ are not significantly and positively correlated.

T2: The difference between $1/\text{modq}$ and $1/q$ is unrelated to

$\text{UKADV/UKSL, R&D/V, DT/V and TSB/V}$, where:

$\text{UKADV}$ is the current level of expenditure on advertising in the UK;

$\text{UKSL}$ is the current level of sales in the UK;
R&D is the current level of expenditure on R&D;

V is the market value of the firm;

DT is the deferred tax liability of the firm estimated as

\[ DT = \sum DT_i \] (196)

where DT\(_i\) are the estimates of deferred tax liability for each class of asset indicated by various equations; and

TSB is the Tax Shield on Borrowing estimated as

\[ TSB = T\left(\frac{V_b \times_0 \left(\frac{T-T_B}{T_B(1+r)}\right)}{P+R+P(1+r)} + (1-Tc)\left(\frac{1}{\times_0} - \frac{1}{r}\right)\right) \] (206)

where \(T(\ )\) is some suitable 'top slicing' transformation such as square root or \(\log(1+\ )\).

T3: The variability in \(1/\text{mod}q\) is unrelated to \(\text{Beta}, \text{ROS}_b\) and \(W/V\), where:

Beta is the firm's equity Beta coefficient;

ROS\(_b\) is the Return on Sales after interest; and

W is the salary and wage costs incurred.

Rejection of all three null hypotheses would not 'prove' that \(\text{mod}q\) is an effective profitability measure, but acceptance of any of the null hypotheses would not be consistent with \(\text{mod}q\) measuring profitability in the way intended.
Test methodology and statistical considerations are described in the next chapter.
NOTES TO CHAPTER 6

1. Comprehensive published data on market share and concentration in the UK is based on the Standard Industrial Classification (SIC). SIC relates to the type of goods produced, not the markets in which they are sold. Furthermore, these data are not analysed into shares of individual companies; and companies themselves are not required to disclose in their accounts the analysis of their turnover in terms of SIC.

2. This position is confirmed by Black (2) and Sawyer (page 15). There have, however, been occasional attempts to estimate elasticity at the firm level using serial data, eg by Baker and Bresnahan (1988), of a type unavailable in this study.

3. The notation is that used previously and has been adhered to for reasons of consistency. In this section, however, Exp+BI is, in effect, a single variable representing total expenditure and no significance should attached to the distinction between the fixed element Exp and the variable element BI.

4. This assumption was reviewed in Chapter 3.

5. This second solution is of interest as it suggests there is a relationship between Beta and financial and accounting variables. This would enable Beta to be estimated independently of the correlation between the company's share price and the market return. Subsequent analysis using Maple 5 to solve the differential equation suggests, however, that, when the condition that Beta is positive is included, no real solutions for Beta exist.

6. Market power is sometimes represented in econometric work by Lerner's Index, comprising

\[ \frac{1}{1 - \frac{1}{P^*Q - AVC.Q}} \]

\[ P^*Q \]

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CHAPTER 7

METHODOLOGY USED IN THE TESTS OF modq

Introduction
In the previous chapter, three tests of modq were described in outline. This chapter describes:

i. the basic methodology employed in performing these tests;

ii. the statistical criteria and software used;

iii. the principal sources of data used;

iv how the samples were chosen; and

v how each of the variables was defined and estimated.

7.1 The Basic Methodology
The three tests of modq formulated in the previous chapter are expressed as tests of the following null hypotheses:

T1: 1/modq and 1/q are not significantly and positively correlated.

T2: The difference between 1/modq and 1/q is unrelated to UKADV/UKSL, R&D/V, DT/V and TSB/V, where:

UKADV is the current level of expenditure on advertising in the UK;

UKSL is the current level of sales in the UK;
R&D is the current level of expenditure on R&D;

V is the market value of the firm;

DT is the deferred tax liability of the firm estimated as

\[ DT = \sum DT_i \]  

(196)

where DT\(_i\) are the estimates of deferred tax liability for each class of asset; and

TSB is the Tax Shield on Borrowing estimated as

\[ TSB = T \left( V_p r_0 \frac{T-tp}{1-tp} \frac{PER+p}{P(1+r)} + (1-p) \left( \frac{1}{r_0} - \frac{1}{r} \right) \right) \]  

(206)

where T( ) is some suitable 'top slicing' transformation such as square root or \( \log(1+ ) \).

T3: The variability in 1/modq is unrelated to Beta.ROS\(_b\) and W/V, where:

Beta is the firm's equity Beta coefficient;

ROS\(_b\) is the Return on Sales after interest; and

W is the salary and wage costs incurred.

Rejection of all three null hypotheses would not 'prove' that modq is an effective profitability measure, but acceptance of any of the null hypotheses would not be consistent with modq measuring profitability in the way intended.
Provided that in each case the explanatory terms, including any error term, are independent of each other and normally distributed, and provided random samples of the terms involving \( \text{modq} \) are taken, and these are also normally distributed, the tests may be performed using the methods of ordinary least square (OLS) linear regression.

It is impossible to obtain random samples of the dependent variable in this type of study. It is, however, a common failing and is assumed not to invalidate the OLS method.

The choice of OLS regression as the basic statistical tool is a natural one given the structure of the tests devised. Alternative statistical models to OLS linear regression exist in the form of generalised linear models and non-linear regression, but OLS was preferred because:

a. the model and the confidence tests associated with it are familiar and well understood;

b. it is possible to examine the data to assess their suitability for OLS linear regression; and

c. a user friendly computer package, Minitab, was available to perform the necessary calculations.

There is, however, a disadvantage in using any form of regression or correlation technique to evaluate \( 1/\text{modq} \). Regressions can be statistically significant even when the individual error terms are large relative to the dependent variables. The approach adopted is, therefore, better suited to evaluating \( 1/\text{modq} \) as a tool for econometric research than it is for evaluating \( \text{modq} \) as a tool for financial analysis. In the former, statistical inferences can drawn despite the
presence of a significant error term. In the latter, the value attaching to a single measurement may be crucial and the presence of an error term, even if it has an average value of zero, may undermine the utility of the measure. Further research is needed to investigate modq's suitability in the latter context.

As noted in the previous chapter, inversion of modq results in tests that are similar in structure to equity valuation models. Christie (1987) commented that, while there are no natural deflators in valuation studies and it was difficult to generalise, deflation by anything other than a function of the independent variable could result in mis-specification. In these tests, by inverting modq, V acts as the deflator for all the independent variables except UKADV. Christie's criterion is therefore largely satisfied. It should, however, be noted that Keenan (1970) argued that, as the great majority of the estimated parameters in equity valuation models are neither statistically significant nor stable, too much effort has been wasted on this type of study. Subsequent successful research such as that of Lindenberg and Ross, Hirschey and others referred to in Chapter 2 would appear to contradict this view. Thus, while Keenan's criticism may have some validity in respect of blind searches for independent variables to 'explain' equity prices, it has less relevance to studies which explore such topics as the Structure-Conduct-Performance paradigm, the existence of hidden capital, and, as in this case, the performance of a profitability measure.

Statistical tests can be applied to time series and cross-sectional data. Due, however, to the reliance, explained below, on data published in compliance with SSAP 16, there was insufficient data to construct a useful time series. It would have been possible to analyse separately a number of cross-sections taken from the data of each company, treating each as an independent sample, but this was considered inappropriate
as:

a. successive cross-sections would not result in truly independent sets of data;

b. all measures of profitability perform better when averaged over several years and there is no reason to believe that modq would be exempt from this principle;

c. the independent variables are subject to measurement error that would be reduced by taking averages; and

d. the DGM could not be expected to hold in situations where isolated profits were earned in a single year as such profits would often not reflect the anticipated long run level of profits assumed in the DGM.

The approach adopted was therefore to exclude from the samples companies for which it was not possible to construct two or more consecutive complete data sets. Values for the dependent and independent variables were then taken as the average of the two or more data sets derived from each cross-section.

7.2 Statistical Criteria and Software

The method of establishing whether the conditions for OLS were satisfied was inspection of data, examination of the correlation between independent variables, and review of plots of the error terms against the dependent variables.

In T1 the correlation coefficient was calculated and assessed at the 95% confidence level. In T2 and T3, the F test at 95% confidence was chosen to test the null hypothesis in each case and the significance of individual coefficients were assessed from their t ratios, using the same 95% confidence level. The overall explanatory power of the model was described and assessed using adjusted $R^2$. 

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The statistical software employed was Minitab, DOS Microcomputer Release 7. This choice reflected its availability, relatively low cost and the training available.

7.3 The Principal Sources of Data
Data published in compliance with SSAP 16 were employed in all three tests: in T1, the denominator of q, BV, the net current cost of net tangible assets, was extracted from such accounts; and in T2 and T3, modq was calculated using the clean surplus profits disclosed in them. As SSAP 16 only applied to accounting periods starting after 1 January 1980 and, following a period when many companies were failing to comply, was withdrawn in June 1985, most companies published at most five sets of Current Cost accounts. As a consequence, while Current Cost accounts represent a unique source of data on current values, the period they cover is limited.

It would have been possible to have estimated replacement costs from data in historical cost accounts by such techniques as the so-called 'standard perpetual inventory method' in which capital expenditure is indexed and depreciated. There are, however, three reasons for preferring current cost values disclosed in Current Cost accounts:

a. the values disclosed were audited and therefore represent reasonably objective and reliable source of information;

b. the information disclosed on asset values has been under-utilised by other researchers; and

c. estimates arrived at by indexing data in historical cost accounts are hampered by inadequate disclosure of information on asset disposals and deficiencies in representing replacement costs by indexed historical costs².
The decision to use Current Cost accounts foreclosed any possibility of choosing a period of relative economic stability in which to study modq. The first half of the 1980's was a period of recession followed by economic recovery. With possibly swiftly changing expectations, this is not an ideal period in which to study an ex ante measure of profitability. There are, however, few periods in recent years when economic expectations in the UK have been as stable as those in, say, Germany. Further research is needed to assess whether modq can indicate profitability in a different economic climate to that of the first half of the 1980s.

An alternative to iterative approaches for estimating the net current cost of a company's assets from historical cost book values might be provided by using a simple linear model similar to that used by Gray and Skerratt (1982) to predict current cost profits from historical cost profits.

The decision to use published Current Cost accounts as a principal source of data necessitated the use of micro fiches published by Companies House as the data were not available in any other form. Many of the fiches were indistinct and the process of transferring the data from fiche to spreadsheet was time consuming. This was a significant factor in the choice of sample size - see below.

Historical cost accounts were used for their disclosure of specific items. At the commencement of the study, no suitable computerised database of this information was available and, as the fiches needed to be accessed for the current cost data, this method was also used for the historical cost data. There were, however some advantages to be gained from this approach - information summarised on databases is never as complete as the original and contains an unquantifiable amount of categorisation and transcription error.
Other sources of data used included MEAL for advertising expenditure, a variety of sources for R&D expenditure, the London Business School Risk Management Service for estimates of Beta and the Extel Handbook of Market Leaders for share prices. These sources and the way in which they were used are detailed and discussed at 7.5 below.

7.4 Choice of Sample
The availability of stockmarket prices, Betas and Current Cost accounts represent essential criteria for inclusion in the sample. One possibility was to select a random sample of such companies, but this was rejected as:

a. T2 assumed common rates of depreciation of hidden capital;

b. T3 assumed a single product-market; and

c. a random sample would make it more difficult to obtain information on advertising and R&D as no industry-specific knowledge would be built up.

A sample comprising all the companies comprising a sector of the FTA All Share Index was then considered. The characteristics of the sector desired were:

a. a reasonable level of profits in the period (the models employed did not work with loss making companies);

b. a wide distribution of R&D and advertising intensities;

c. inclusion of at least a few firms thought likely, on a priori grounds, to possess market power; and

d. a high degree of adherence to SSAP 16.
No information on Betas prior to 1 January 1985 were available. FTA All Share sectors were therefore defined in terms of the sector constituents at that date. Two suitable sectors were identified: the 23 companies comprising the Buildings Materials sector and the 21 companies comprising the Food Manufacturers sector. A single combined sample was created from companies defined by these sectors which provided the necessary data. As two distinct industries and two separate markets were involved, a dummy variable was added to tests T2 and T3. No dummy variable was necessary for Test 1 as this test did not depend on an assumption that industries or markets were homogeneous.

It was also necessary to define the sample in terms of the period covered and the cross-sections taken. As noted above, SSAP 16 was withdrawn in June 1985. Current Cost accounts were published by a diminishing number of companies for periods ending between 14 March 1984 and June 1985, but these were excluded from the samples examined as, according to Devereux (1988), the changes to corporation tax announced by the Chancellor of the Exchequer on 13 March 1984 resulted in a massive short-term distortion of the post-tax cost of capital. This distortion could have impacted on T1, T2 and T3. It was therefore decided to take no cross-sections on or after this date.

Perfect cross sections are impossible using accounting data as companies adopt different financial year ends. Pseudo-cross sections may, however, be taken by aggregating data for which the financial year ends fall into suitable annual bands. The availability of Current Cost accounts and the Chancellor's statement on 13 March 1984 restrict the number of annual bands that can be constructed. Following Barron (1986), who proposed that, to minimise errors due to differing accounting year ends, mid-June was the best cut-off date for UK companies, five bands covering the following accounting periods were taken:-

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As explained in the next chapter, it was found that there were insufficient data to employ the first and last bands in statistical analysis.

7.5 How the Financial Variables Were Estimated

Despite the wide range of possibilities for defining and estimating many of the financial and accounting variables used, the existing literature provides little guidance on this important aspect of the work. A detailed specification of the various variables in T1, T2 and T3 is therefore provided below:

a. \[
\frac{1}{\text{modq}} = \frac{(1-p)(1-B)(1+r_0+\beta(r_m-r_0))}{\text{PER}.r-p} + B \quad (175A)
\]

b. q = V/BV

c. \frac{1}{\text{modq}} - \frac{1}{q} = \gamma

d. V = Ve + Vb.

e. Ve is the product of the number of equity shares issued and their price at the balance sheet date plus the book value of preference shares. Share prices were read from semi-log charts of adjusted price in the Extel Handbook of Market Leaders, corrected for any adjustment for prior rights or scrip issues by means of a share
price correction factor. The share price correction factor is equal to

\[
\text{Cash flow per Extel}
\]
\[
\text{Cash flow per share per Extel} \times \text{no of shares per accounts}
\]

In the case of volatile prices, the price at the balance sheet date was estimated from a straight line fitted by eye to the share price chart for some three months before and after the balance sheet date. No correction was made for systematic changes in share prices in this period as the necessary adjustments would not be material.

f. Vb is the book value of overdrafts and borrowing, net of cash on deposit. Negative Vb was taken to be zero.

g. B is defined as

\[ B = \frac{Vb}{Ve + Vb} \]

h. Beta is the company's equity Beta coefficient and was taken from estimates published by the London Business School Risk Management Service at 1 January 1985. This single date for Beta was necessitated by limited access to LBS data, but is not a serious shortcoming as the LBS estimate used was based on data for the period 1 January 1980 - 1 January 1985 which fits well with the period of the study.

i. \( r_0 \) was taken to be the 3 months' Treasury Bill rate at the balance sheet date as per the Annual Abstract of Statistics;
j. (rm-ro) is the risk premium in nominal terms (ie including inflation), before personal taxes. Analysts and researchers have generally used the longest period available to estimate this on the basis that the longer the period the smaller the standard deviation. The post-war volatility of the market return was, however, only some 35% of its pre-war level, and, as this was a backward-looking study of profitability in the period 1980-1985, it was felt more appropriate to base the estimate on market returns in the period 1946-1985. According to the BZW Equity Gilt Study 1988, the arithmetic average return before Income Tax on UK equities in this period was 16.5% and the return on Gilts was 5.9%, indicating a risk premium of 10.6%. As, however, the risk free rate employed in this study was the Treasury Bill rate, which, according to BZW yielded about a half percent less than Gilts, the risk premium was rounded down to 10%.

k. p, the Payout Ratio, is the ratio of gross dividends paid and payable in the year (net dividends per the accounts grossed up at the average income tax rate in the year) to ‘clean surplus profit’ for the year. p in excess of 1 or less than 0 is clearly invalid, but p greater than 0.8 was also considered invalid on the grounds that such high payout ratios could not be sustained and therefore could not be a reliable estimate of anticipated p.

l. The ‘clean surplus profit’ was the total the following items disclosed in the Current Cost accounts:

   CCA operating profit for the year ended;

   holding gains and monetary working capital adjustment arising in the year as per the Current Cost Reserve;
other net income;

the existing estimate of income tax deducted from dividends; less

corporation tax at the average nominal rate for the year applied to the historical cost profit before tax; and

net interest paid.

m. PER, the Price Earnings Ratio, is the ratio of Ve to the clean surplus profit in the year ended, where both items were estimated as above.

n. BV, the book value of net tangible assets, was taken from the Current Cost accounts. The following liabilities shown in the accounts were not, however, deducted:

   (1) net dividends outstanding - while these are shown as liabilities in the accounts, they do not effect the market value of the firm unless taxation and signalling effects are taken into account;

   (2) Vb as previously estimated; and

   (3) deferred taxation as stated in the accounts.

Intangible assets were disregarded unless they were completely separate from hidden capital items represented by the independent variables, in which case book values were included in BV.

o. DT was estimated for each class of asset disclosed in the Current Cost accounts as follows:-

   (1) Plant and machinery.

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DT_{PM} = \frac{T-t_D}{1-t_D} BV_{PM} \left[ 1 - \frac{D_{PM}(1-IA_{PM})}{ru+D_{PM}} \right] \quad (194)

where: \( BV_{PM} \) is the book value of plant and machinery disclosed in the Current Cost accounts;

\( IA_{PM} \) is the Annual Allowance for plant and machinery at the balance sheet date;

\( D_{PM} \) is the annual allowance for plant and machinery;

\( T \) is the corporation tax rate at the balance sheet date;

\( t \) is the income tax rate at the balance sheet date;

\( p \) is as previously estimated; and

\( ru \) is the ungeared cost of capital estimated using the CAPM and the ungeared Beta coefficient, all items being as previously estimated.

(ii) Buildings. Only industrial buildings qualify for an Initial Allowance, \( IA_{IB} \), and Annual Allowances, \( D_{IB} \), which are given on a straight line basis. The book value of land in Current Cost accounts is generally its open market value for existing use so there is no deferred tax liability associated with the land element in the book value of land and buildings. The deferred tax liability \( DT_B \) associated with buildings is therefore, from equations 189 and 196
\[
DT_B = \frac{T-tp}{1-tp} (BV_{NB} + BV_{IB} (1-IA_B)) 
\]

where: \(BV_{NB}\) is the book value of non-industrial building per the Current Cost Accounts; and

\(BV_{IB}\) is the book value of industrial buildings in Current Cost accounts.

This may be written in the form

\[
DT_B = \frac{T-tp}{1-tp} BV_{LB} \frac{m}{1+n} (1+n(1-IA_B)) 
\]

where: \(BV_{LB}\) is the book value of land and buildings;

\(m\) is the proportion of this value attributable to buildings; and

\(n\) is the proportion of industrial buildings to non-industrial buildings.

In the absence of any direct evidence in the account to be contrary, it was assumed that \(m = 0.5\).

For a non-manufacturing company, it was assumed \(n = 0\).

Following Devereux’s (1986/1) estimate, it was assumed that for a manufacturing company \(n = 0.65\).

(iii) Investment in associated companies. When investments in associated companies were valued at market value, there was assumed to be no deferred tax liability. When such investments were not valued at market value, it was assumed that the book value of the investment corresponded to the pre-tax cash flows anticipated, so that the deferred tax liability is, from equation 189:
\[
\text{DT(Ass)} = T_{-tp} \frac{BV(Ass)}{1-tp}
\]

where \(BV(Ass)\) is the book value of the investment shown in the Current Cost accounts.

(iv) Other classes of Asset. No Deferred Tax liability arises on other classes of asset unless book values correspond to anticipated pre-tax cash flows. In these circumstances, \(DT\) (other) was estimated as for plant and machinery. It should be noted that there is no deferred taxation liability for hidden capital as, in effect, 100% Initial Allowance is available.

p. The tax shield on borrowing, \(TSB\), is:

\[
\text{TSB} = T \left[ V_{b} T_{0} \frac{T_{-tp}}{1-tp} \left( \frac{PER+p}{P(1+r)} \right) + (1-p) \left( \frac{1}{r_{0}} - \frac{1}{r} \right) \right]
\]

where \(T(\ )\) is a suitable transformation reducing high values relative to lower values and all the elements are as previously specified.

q. The advertising expenditure, \(Adv\), for the year was taken from estimates by Media Expenditure Analysis Ltd (MEAL), and was found either by aggregating expenditure on the firm's leading brands published in Media Digest or from the corporate totals published annually in Campaign.
r. R&D was estimated from a number of sources. In descending order of preference they were:

(i) Company Accounts. Munson (1987) identified only 13 companies in the mid-1980s which disclosed R&D expenditure, and commented that it was likely but not certain that this small number included those companies with the highest expenditure. Following an amendment to SSAP 13, it has now mandatory for public companies, (together with certain other categories of no relevance here) to disclose their expenditure on R&D in accounts for periods commencing after 31 December 1988. Where, as a result of the amendment of SSAP 13 or through voluntary disclosure, R&D expenditure is disclosed for subsequent periods, the level of expenditure in the accounting year studied is inferred by assuming that the ratio of R&D to turnover has remained constant.

(ii) Monopolies and Merger Commission Reports. The Monopolies and Merger Commission have on many occasions disclosed the estimated R&D expenditure of firms dealt with in their reports. This source is used whenever possible.

(iii) Other Public Sources. R&D spend and/or the number of technically trained staff is occasionally referred to in the financial press, brokers' reports etc. This source was used when available, but only applied in a small number of cases.

(iv) DTI Statistics. Business Monitor MO14 provides 1981 medium and upper and lower quartile estimates of company financed R&D/Sales ratios for 14 groups of companies classified by their principal product and for 56 industries. In the absence of any other information, the R&D expenditure was estimated either
by applying the most appropriate R&D/Sales ratio to the company's sales, given its principal business and overall reputation for innovation, or by classifying turnover to the appropriate industry.

(v) US Patents. Patel and Pavitt (1987) argued that patenting by British companies in the USA is a useful proxy for technological activity. Their estimates of the number of patents registered by British companies in the years 1981-84 can therefore be used to rank companies according to their R&D spend or to classify them according to its R&D intensity - high, medium or low - for the particular industry. Very little use was made of this source.

Where it was necessary to estimate the R&D/Sales ratio, this was estimated for the entire period and the R&D spend arrived at by multiplying this by the sales in the period.

In each case the variable estimated was company financed R&D. Government funded R&D and spillover technology was disregarded even though it could be argued that these expenditures also contribute to R&D hidden capital.

s. Wages comprise staff costs taken from disclosures in the historical cost accounts. The Companies Act 1981 required world wide staff costs including NI and pension elements to be disclosed for the first time. Prior to this, only information on UK salaries were disclosed. To estimate world wide salary costs in periods before the Companies Act 1981 applied, UK salaries were grossed up by the earliest available ratio of world wide salaries/UK salaries. In order to estimate UK staff numbers (not used in the final analysis) a similar technique employing staff numbers was used.
t. ROSₜ is ratio of clean surplus profit to sales;

u. Sales is the turnover disclosed in the accounts;

v. PVR is the Profit-Volume ratio, estimated for each company as

\[
\frac{\text{Sales} - \text{Materials and consumables}}{\text{Sales}}
\]

where Materials and Consumables represent those costs which, a priori, change in the short-term in proportion to the volume of sales. This item is occasionally disclosed in Value Added Statements and, following the Companies Act 1981, in one format of the profit and loss account. Where Materials and Consumables was not so disclosed, it was estimated by deducting Depreciation on Plant and Machinery and Production Wages from Cost of Sales. Where Production Wages was not disclosed, this item was estimated from the proportion of costs, net of distribution and administration costs, to total costs applied to total Wages. For periods prior to implementation of the Companies Act 1981, when most of the necessary data were not disclosed, the earliest estimate of PVR was used.

w. The Dummy Variable was 1 for building materials companies and 0 for food manufacturing companies.

Direct entry of data extracted from micro fiche on to Lotus 123 Spreadsheet was found to be impracticable. Data were first recorded manually on data collection sheets and entered into the Lotus 123 Spreadsheet as a separate exercise. The data collection sheets are illustrated at Appendix 7. The formulae used on the Lotus 123 Spreadsheet are listed at Appendix 8.
NOTES TO CHAPTER 7

1. Auditors were not required by the accountancy bodies to state an opinion on whether the Current Cost accounts showed a true and fair view, only that they had been ‘properly prepared’ in accordance with SSAP 16. In practice, however, auditors would have examined the Current Cost accounts and in most cases would have ensured that the accounts were not misleading.

2. Bond and Devereux (1987) used analogous current costs values published by US corporations to examine the relationship between q and investment. In this context they concluded that these values performed no better than values estimated by the perpetual inventory method using historical cost data. This conclusion cannot, however, necessarily be extended to the use of q as a profitability measure.

3. Consider, for example, the hypothesis that:

\[ CC = HC \cdot \frac{RPI(O) - RPI(n)}{RPI(n)} \]

where: CC is the current cost of a firm’s fixed assets;

HC is the historical cost of firm’s fixed assets;

RPI(O) is the Retail Price Index at the balance sheet date;

RPI(n) is the Retail Price Index n years before the balance sheet date, where:

\[ n = \text{Accumulated depreciation carried forward} \]
\[ \text{Depreciation charged for the year.} \]

This hypothesis could be tested by examining the regression:

\[ CC = a_0 + a_1 \frac{RPI(0) - RPI(n)}{RPI(n)} + e_\sim \]

where: ao and a1, are coefficients; and

\( e_\sim \) is an error term.
4. Micro-Extat, providing a ten year series of summarised UK accounting data, but excluding current cost information published under SSAP 16, is now available at a cost of around £12,000 per annum.

5. Betas were published quarterly from April 1979 by the London Business School Risk Management Service, but the cost of acquiring these earlier data was in the order of £1000.
CHAPTER 8

RESULTS OF THE TESTS OF modq

Introduction

In this chapter the data collected to perform the three empirical tests of modq are described and the results of the tests are reported. The overall conclusion is that the tests provide no evidence that suggests that modq does not behave as intended.

8.1 Data

Using FTA Buildings Materials and Food Manufacturers sectors at 1 January 1985, 44 companies were selected for study, as follows:

<table>
<thead>
<tr>
<th>No of Companies in field</th>
<th>Potential No of Cross-sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building materials selection</td>
<td>23</td>
</tr>
<tr>
<td>Food manufacturing selection</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
</tr>
</tbody>
</table>

Cross-sections were excluded from the study if they failed to provide a complete set of data, or if the set of data they provided was isolated, i.e., a complete set of data could not be obtained from the previous or succeeding cross-section. The principal reasons for incomplete sets of data were:

a. failure to comply with the disclosure requirements of SSAP 16; and
b. contravention of assumptions underlying the Dividend Growth Model, i.e.

i. losses were reported; or

ii. Payout Ratios were unsustainable - as described in the previous chapter, Payout Ratios in excess of 0.8 were not considered sustainable.

Applying these criteria, 136 cross-sections were rejected and the remaining 84 sets of data were combined into a sample of 26, as follows:

<table>
<thead>
<tr>
<th></th>
<th>No of Companies in sample</th>
<th>No of Cross-sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building materials companies</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Food manufacturing companies</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>84</td>
</tr>
</tbody>
</table>

A sample of 26 is relatively small for an econometric study employing accounting and financial data; but such studies typically employ readily available accounting data. In this study, some 50 items of raw data were needed for each cross-section and each set of data in the final sample comprised the average of 3.4 cross-sections. Furthermore, before many of the cross-sections could be eliminated, it was first necessary to assemble and review the data. A considerable volume of unused data was therefore unavoidably gathered, both for the 18 companies eliminated from the final sample and for cross-sections of the 26 remaining companies.

8.2 Values of \( \text{mod}_q \)

For the 26 companies in the sample, the following values of \( \text{mod}_q \) were found:
<table>
<thead>
<tr>
<th>Building materials companies</th>
<th>modq</th>
<th>q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Circle Plc</td>
<td>0.77</td>
<td>0.45</td>
</tr>
<tr>
<td>BPB Industries Plc</td>
<td>2.11</td>
<td>0.98</td>
</tr>
<tr>
<td>John Carr Plc</td>
<td>2.42</td>
<td>1.08</td>
</tr>
<tr>
<td>Henderson Group Plc (The)</td>
<td>0.74</td>
<td>0.94</td>
</tr>
<tr>
<td>Ibstock Johnsen Plc</td>
<td>0.89</td>
<td>0.49</td>
</tr>
<tr>
<td>Johnston Group Plc</td>
<td>1.59</td>
<td>1.31</td>
</tr>
<tr>
<td>Manders (Holdings) Plc</td>
<td>2.65</td>
<td>0.63</td>
</tr>
<tr>
<td>Marley Plc</td>
<td>1.10</td>
<td>0.66</td>
</tr>
<tr>
<td>Marshalls Halifax Plc</td>
<td>1.10</td>
<td>0.70</td>
</tr>
<tr>
<td>Pilkington Brothers Plc</td>
<td>0.88</td>
<td>0.52</td>
</tr>
<tr>
<td>Redland Plc</td>
<td>2.00</td>
<td>0.96</td>
</tr>
<tr>
<td>Ruberoid Plc</td>
<td>1.91</td>
<td>0.78</td>
</tr>
<tr>
<td>Rugby Portland Cement Plc (The)</td>
<td>0.81</td>
<td>0.44</td>
</tr>
<tr>
<td>Tarmac Plc</td>
<td>1.73</td>
<td>1.37</td>
</tr>
<tr>
<td>Travis &amp; Arnold Plc</td>
<td>5.92</td>
<td>0.96</td>
</tr>
<tr>
<td>Average for building materials companies</td>
<td>1.77</td>
<td>0.82</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Food Manufacturing Companies</th>
<th>modq</th>
<th>q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated British Foods Plc</td>
<td>4.07</td>
<td>1.63</td>
</tr>
<tr>
<td>Avana Group Plc</td>
<td>6.76</td>
<td>2.66</td>
</tr>
<tr>
<td>Bibby &amp; Sons Plc</td>
<td>4.71</td>
<td>1.61</td>
</tr>
<tr>
<td>Cadbury Schweppes Plc</td>
<td>2.00</td>
<td>0.78</td>
</tr>
<tr>
<td>Hazelwood Foods Plc</td>
<td>1.77</td>
<td>2.06</td>
</tr>
<tr>
<td>J N Nichols (Vimto) Plc</td>
<td>1.75</td>
<td>1.92</td>
</tr>
<tr>
<td>Pauls Plc</td>
<td>1.12</td>
<td>0.61</td>
</tr>
<tr>
<td>Rowntree Mackintosh Plc</td>
<td>1.10</td>
<td>0.64</td>
</tr>
<tr>
<td>Tate &amp; Lyle Plc</td>
<td>1.14</td>
<td>0.51</td>
</tr>
<tr>
<td>Unilever Plc</td>
<td>1.54</td>
<td>0.51</td>
</tr>
<tr>
<td>United Biscuits (Holdings) Plc</td>
<td>1.91</td>
<td>1.10</td>
</tr>
<tr>
<td>Average for food manufacturing companies</td>
<td>2.53</td>
<td>1.27</td>
</tr>
</tbody>
</table>

Average for sample | 2.10 | 1.01 |

The theoretical value of modq for a firm selling in a competitive market is 1. The average value for the food manufactures was 2.53 and for the building materials companies was 1.77, suggesting that both industries are characterised by market power. This is not implausible given the market concentration and possible barriers to entry, but an alternative explanation is that the risk free rate and the risk premium assumed when calculating the risk adjusted cost of capital was too high. Further research is needed to establish whether modq in excess of 1 is typical of other sectors, including those for which market power is inherently implausible, and for longer periods than those considered here.
The standard deviation of \( \text{modq} \) for the entire sample was 75\%, compared with 56\% for \( q \). The variability of \( \text{modq} \) was therefore somewhat greater than that of \( q \), but, as the extra variability could result from an incremental information content, no conclusion can be drawn about the relative uncertainty or estimating error in each measure.

8.3 Results of Test 1

Test 1 was a test of the null hypothesis that \( 1/\text{modq} \) is not significantly and positively correlated with \( 1/q \). The correlation coefficient was found to be +0.71. The hypothesis could therefore be rejected at the chosen 95\% confidence level in favour of some non zero correlation.

Test 1 provided no evidence that, after inversion, \( \text{modq} \) was not at least a noisy estimate of \( q \). About half of the variability of \( 1/\text{modq} \) could be explained by \( 1/q \). Test 2, which concerns the possibility that \( \text{modq} \) improves on the measurement of profitability provided by \( q \), could then be proceeded with.

8.4 Results of Test 2

Test 2 was a test of the null hypothesis that \( \gamma \), the difference between \( 1/\text{modq} \) and \( 1/q \), is unrelated to UKADV/UKSL, R&D/V, DT/V and TSB/V, where:

- UKADV is UK advertising;
- UKSL is UK sales;
- R&D is research and development expenditure;
- DT is the sum of the estimates for deferred tax associated with each class of asset using the various equations in 4.32;
TSB is the tax shield on borrowing found from equation 55, including a suitable transformation; and

\( V \) is the market value of the firm.

A rather severe cube root transformation was found to be most conducive in the estimation of the Tax Shield using equation 55, suggesting that financial markets attach considerable weight to the cost of bankruptcy when placing a value on the tax shield.

A dummy variable, 1 for a building materials company and 0 for a food manufacturing company, was added to reflect any industry specific factors such as the average life of the hidden capital.

Regressing on UKADV/UKSL, R&D/V, DT/V, TSB/V and the dummy variable resulted in the following regression equation and statistics:

\[
\gamma = -0.3 + 0.2 \frac{UKADV}{UKSL} - 6.0 \frac{R&D}{V} - 1.1 \frac{DT}{V} + 5.1 \frac{TSB}{V} - 0.04 \text{Dummy}
\]

\( t \)  
-1.9  
0.04  
-1.0  
-3.0  
1.9  
-0.03

\( t \) probability  
93.1%  
2.9%  
67.2%  
99.3%  
92.6%  
2.1%

\( R^2 (adj) \)  
39.3%

F statistic  
4.24

F statistic probability  
99.1%

The F statistic indicated that collectively the independent
variables were significant, but only the coefficient of DT/V was significant at 95%. Eliminating variables in succession until only significant variables remained, the following regression equation and statistics were arrived at:

\[
y = -0.3 -1.2 \, DT/V + 5.2 \, TSB/V
\]

<table>
<thead>
<tr>
<th>t</th>
<th>-2.5</th>
<th>-4.1</th>
<th>+2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>t probability</td>
<td>98.0%</td>
<td>99.9%</td>
<td>95.3%</td>
</tr>
</tbody>
</table>

\[ R^2 (adj) \quad 44.4\% \]

\[ F \text{ statistic} \quad 11.0 \]

\[ F \text{ statistic probability} \quad 99.9\% \]

The above results indicate that the null hypothesis that difference between 1/modq and 1/q is due to DT/V and TSB/V cannot be dismissed at the 95% confidence level. Thus, on the evidence of this test, some 44% of the difference between 1/modq and 1/q is explained by taxation effects.

The influence of the variables UKADV/UKSL, R&D/V and the dummy variable on \( \gamma \) were examined individually and collectively and
the residuals were examined, but no evidence emerged that these variables could provide any explanatory power. Other variables not predicted by the model to be significant, such as Beta.ROS₇ and W/V (see below), were tried but no significant explanatory power was found.

In the case of the dummy variable, the absence of explanatory power not unexpected: there is no theoretical reason why the two industries should necessarily differ in this test. The finding that none of the difference between 1/modq and 1/q is explained by R&D and advertising intensity can be explained by the low levels of intensity observed:

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D/V</td>
<td>0.009</td>
<td>0.051</td>
</tr>
<tr>
<td>UK Advertising/UK Sales</td>
<td>0.007</td>
<td>0.054</td>
</tr>
</tbody>
</table>

Assuming an intangible asset life of, say, four years, the maximum R&D intensity observed of 0.51 would, for example, only increase 1/modq of 1.0 by about one percentage point to 1.1. Given the degree of variability in modq observed and the unavoidable estimating error in R&D and advertising spend, this effect would tend to be obliterated by other influences.

8.5 Results of Test 3
Test 3 was a test of the null hypothesis that none of the variability in 1/modq can be explained by market power and its appropriation by labour.

As an initial test of the model for market power, the relationship between the Profit Volume Ratio and Beta.ROS₇ was examined. For the sample this was found to be:
\[ \text{Beta.ROS_b} = d_1 + d_2 \text{PVR} + d_3 \text{Dummy} \]

where: Beta is the Beta Coefficient;
ROS<sub>b</sub> is the Return on Sales after interest;
PVR is the Profit Volume ratio;
Dummy is the dummy coefficient; and
d<sub>i</sub> are coefficients where d<sub>i</sub> is expected to be positive.

Dropping the dummy variable which was not significant at the 95% confidence level, the following result was obtained:

\[
\begin{align*}
\text{Beta.ROS_b} &= -0.0048 + 0.17 \text{PVR} \\
t &= -0.21 \quad 3.28 \\
t \text{ probability} &= 16.5\% \quad 99.7\% \\
\text{F statistic} &= 10.78 \\
\text{F statistic probability} &= 99.7\% 
\end{align*}
\]

Assuming the Profit Volume ratio is equal to the reciprocal of the elasticity of demand, this result is consistent with Beta.ROS<sub>b</sub> being, as the analysis indicates, a linear function of the inverse of the elasticity of demand. Thus the use of Beta.ROS<sub>b</sub> as a measure of market power was proceeded with.

Test 3 was a test of the null hypothesis that none of the variability in 1/\text{modq} could be significantly explained by Beta.ROS<sub>b</sub>, W/V and a dummy variable, where:

\[
\begin{align*}
W &\text{ is the staff costs; and} \\
V &\text{ is the market value of the firm.}
\end{align*}
\]

The dummy variable was found to be insignificant at the 95% confidence level and was dropped. Regressing 1/\text{modq} on
Beta, ROSb, and W/V resulted in the following regression equation and statistics:

\[
\frac{1}{\text{modq}} = 0.1 + 4.4 \text{Beta.ROSb} + 0.64 \text{Wages/V}
\]

\[
\begin{array}{ccc}
  t & 0.69 & 3.3 & 2.6 \\
  \text{t probability} & 50.2\% & 99.7\% & 98.4\%
\end{array}
\]

Thus the null hypothesis was rejected at the chosen 95\% confidence level. Some 37\% of the variability in \(1/\text{modq}\) was explained. A number of variables not indicated by the model, including those used in Test 2, were examined to see if the provided any explanatory power, but no significant results were obtained.

Although not constituted as a formal test of modq, the performance of \(1/q\) in Test 3 is not without interest. The dummy variable was again found not to be significant at the 95\% confidence level and was again dispensed with. The regression estimated was then:

\[
\frac{1}{q} = 0.51 + 4.9 \text{Beta.ROSb} + 0.96 \text{W/V}
\]

\[
\begin{array}{ccc}
  t & 1.7 & -2.0 & -2.1 \\
  \text{t probability} & 91.4\% & 94.4\% & 95.4\%
\end{array}
\]

Thus while the relative performance of \(q\) is close to that of modq, the fit is slightly less good and the market power term
just fails the 95% significant test.

8.6 Conclusion
The empirical evaluation of a profitability measure is a difficult task. The review of literature threw up no examples of it being attempted previously.

The three tests undertaken were incapable of 'proving' that modq is a satisfactory profitability measure. They are tests that can only provide evidence that modq does not perform in the way predicted by the theory. Working at the 95% confidence level, they provide no such evidence.

In Test 1 the null hypothesis that 1/modq is correlated with 1/q is rejected, suggesting that modq is at least a noisy estimate of q. In Test 2 the null hypothesis that the difference between 1/modq and 1/q is unrelated to estimates of taxation effects is rejected. This is consistent with modq being free from the taxation biases present in q. In Test 3 the null hypothesis that none of the variability in 1/modq is explained by terms representing the firm's market power and its appropriation by labour is rejected. This is consistent with modq indicating profitability.
1. Neither sub-set of the sample corresponds to a single homogeneous product market, but both contain companies that possess high market shares in specific markets, eg BPB Industries Plc share of the plasterboard market and Associated British Food's share of the sliced bread market. Potential barriers to entry include high transport costs associated with building products and branding strategies associated with food manufacturing.
CHAPTER 9

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

9.1 Conclusion
Despite the importance of the matter to competition authorities, utility regulators and economic researchers, relatively little effort has expended in determining how the economic profitability of a firm should be measured or even exactly what is meant by this term. In Chapter 2, three ideal forms of the economic profitability of a firm were identified: an ex ante measure, $EP_1$; and two ex post measures, $EP_2$ and $EP_3$. $EP_1$ and $EP_2$ were based on the concept that the economic profitability of a firm is measured by the ratio of its output to its inputs when both are expressed in present value terms. $EP_3$ was based on a different concept, the internal rate of return on inputs, but was shown to be a simple transformation of $EP_2$.

The review of literature relevant to using $q$ as a measure of a firm's economic profitability indicated that it could be biased by hidden capital and taxation effects. The literature on using ex post rates of return to measure a firm's economic profitability identified another form of bias, that due to the extent to which a firm buys in goods and services. This bias,
was identified but not convincingly explained by Davis and Kay.

Differences between ARR and EP₂ provide an explanation for the Davis and Kay bias. As no corresponding differences between q and EP₁ arise, q should be free from this form of bias.

A new operational ex post measure of a firm's economic profitability, called here the Return on Total Capital Employed (ROTCE), was derived in Chapter 4 from EP₂. ROTCE was shown to be free from the Davis and Kay bias. An operational form of ROTCE was derived by disaggregating Beta and was appraised using data from a simple corporate model.

In Chapter 5, a new operational ex ante measure of a firm's economic profitability, called here Modified Tobin's q (modq), was derived from EP₁. Compared with q, modq employs an estimate of the risk adjusted cost of capital, using CAPM, and the payout ratio in lieu of Capital Employed. This avoids the need to estimate hidden capital and taxation effects responsible for the principal biases in q. It was not deemed practicable to appraise modq in the same way as ROTCE using a data from a corporate model as many of the assumptions used to derive modq would have to be duplicated. An empirical study was therefore undertaken using real sample data. In the absence of a suitable unbiased profitability measure with which to compare modq, statistical tests were devised which incorporated assumptions about how q measures profitability and what are the underlying determinants of long run supra-normal profits. Whilst such statistical tests, by their nature, cannot 'prove' that modq is an useful measure, they are capable of providing evidence that modq does not perform as intended.

The three tests devised were tests of the following null hypotheses:

\[ T₁: \frac{1}{\text{modq}} \text{ and } \frac{1}{q} \text{ are not significantly and positively } \]
The difference between $1/\text{mod}q$ and $1/q$ is unrelated to UKADV/UKSL, R&D/V, DT/V and TSB/V, where:

- UKADV is the current level of expenditure on advertising in the UK;
- UKSL is the current level of sales in the UK;
- R&D is the current level of expenditure on R&D;
- $V$ is the market value of the firm;
- DT is the deferred tax liability of the firm; and
- TSB is the Tax Shield on Borrowing.

The variability in $1/\text{mod}q$ is unrelated to Beta, ROS$_b$, and W/V, where:

- Beta is the firm's equity Beta coefficient;
- ROS$_b$ is the Return on Sales after interest; and
- W is the salary and wage costs incurred.

T2 drew on the existing literature to devise ways of estimating hidden capital and taxation effects, but T3 employed a novel way of estimating the elasticity of demand experienced by a firm.

Real data drawn from a sample of companies in the buildings material and food manufacturing sectors was used. The R&D and advertising terms in T2 were not found to be significant in explaining the difference between $1/\text{mod}q$ and $1/q$. This may be due to the relatively low intensities observed. In other
respects, it was possible, using the OLS regression method, to dismiss at the 95% confidence level the null hypotheses. Thus the tests provide no evidence that modq does not perform as intended.

9.2 Suggestions for further Work
In deriving the theoretical measures EP$_1$, EP$_2$ and EP$_3$, the opportunity cost which Pindyck (1988) pointed out was associated with sunk investment was abstracted. In deriving ROTCE from EP$_3$ and in the empirical work to appraise modq, no allowance was made in the replication cost of the firm for the prior risk that the sunk investment would prove abortive. Further research is called for to establish whether Pindyck's effect is related to or the same as the abortive sunk cost effect and to identify practical methods of estimating them. One possibility is that the opportunity cost of sunk investment might be estimated by applying the Black-Scholes option pricing model to corporate cash flows. It is also conceivable that option pricing theory could be employed to estimate the prior risk of unsuccessful investment.

Also on a theoretical level, it should be noted that ROTCE was conceived in pre-corporation tax terms and modq was conceived in post corporate, pre-personal tax terms. Effective levels of corporate tax were assumed to be influenced by the payout ratio. Alternative assumptions about tax levels could be employed, and further work, both empirical and theoretical, could be undertaken to model taxation better. modq might also be re-specified with an Earnings Growth Model rather than a Dividend Growth Model. This approach might reduce the prominent role played by the Payout Ratio in the analysis and re-assert the Modigliani and Miller concept of Dividend Indifference in equity valuation when tax is abstracted.

Turning to the appraisal of modq, no empirical study can, as noted above, 'prove' that modq is a useful and reliable
measure of a firm's economic profitability. More extensive studies using a wider range of companies, longer and different periods and different explanatory variables would, however, be productive. These studies could be extended to consider whether modq is indeed free from bias due to operational gearing, as the theory indicates. Such studies could now employ financial databases such as MicroExtat that were unavailable when this study was commenced. It would be necessary to use iterative techniques to estimate net replacement costs of assets from historical cost data held on such databases. The possibility of estimating the net replacement cost of net assets from historical cost values using regression techniques could also be explored. The possibility of designing tests using data from a corporate model might also be re-evaluated. One approach here might be to aggregate investments with known internal rates of return.

In the empirical study, taxation effects explained only some 44% of the difference between $1/modq$ and $1/q$. Hidden capital arising from advertising and R&D appears incapable of explaining the difference in view of the low intensities observed. Further work is needed to find out what causes the difference between $1/modq$ and $1/q$.

As already noted, in order to undertake T3 a method of estimating the average elasticity of demand experienced by a firm was devised. It was demonstrated that, for a particular product market, the reciprocal of the elasticity of demand is proportional to the product of the Return on Sales and the Beta Coefficient. This conclusion, which is consistent with a finding of a positive and significant correlation between this compound variable and the Profit Volume ratio, contrasts with a widely held view that market power is, in general, inversely related to Beta. Further empirical work could be conducted to examine this hypothesised relationship, perhaps using structural variables such as market concentration and market entry to represent the presence of market power.
The bias in ARR demonstrated in Chapter 4 and the new ex post measure proposed, ROTCE, are important for competition authorities and utility regulators. Further analytical and empirical work is called for on ROTCE to establish whether it performs as intended.

At some point in future work, modq and ROTCE should be employed in a joint empirical study.

As noted in Chapter 8, the high average value for modq found in the companies sampled could be due to conventional over-estimation of the risk free return and/or the risk premium. Examination of modq for a large number of companies, including some where market power is implausible, would throw further light on this possibility.
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POSSIBLE WAYS OF ESTIMATING 'ECONOMIC' DEPRECIATION

Initially, a state of certainty with rational markets for second-hand assets but no innovation is assumed. Under these conditions

\[(1A1) \quad RC = \sum_{i=1}^{n} \frac{X_i}{(1+R)^i}\]

and

\[(2A1) \quad BV_m = \sum_{i=m+1}^{n} \frac{X_i}{(1+R)^{i-m}}\]

where: RC is the replacement cost of a new asset;

n is the life of the asset ie Xi = 0 for all i > n;

Xi is the cash flow generated by the asset - for algebraic simplicity, the terminal value of the asset is subsumed in Xn;

R is the internal rate of return on investment in a new asset and, through the assumed existence of rational markets for second-hand assets, the internal rate of return on investment in a used asset;

BVm is the (economic) book value of an asset used for m years ie its replacement cost less accumulated economic depreciation at rate dm, where, by definition:
From equation (2A1)

\[ BV_m = \frac{X_{m+1}}{(1+R)} + \frac{X_{m+2}}{(1+R)^2} + \cdots + \frac{X_n}{(1+R)^{n-m}} \]

and

\[ BV_{m-1} = \frac{X_m}{(1+R)} + \frac{X_{m+1}}{(1+R)^2} + \cdots + \frac{X_n}{(1+R)^{n-m+1}} \]

Thus

\[ BV_m = (1+R)BV_{m-1} - X_m \]

Substituting for BV_m in the definition of depreciation

\[ (3A1) \quad \frac{d_m}{BV_{m-1}} = \frac{X_m}{BV_{m-1}} - R \]

In addition, as
\[ BV_0 = RC \]

it follows that

\[ (4A1) \quad BV_m = RC \prod_{i=1}^{m} (1-d_i) \]

Note from equation (3A1) that when

\[ \frac{X_m}{BV_{m-1}} < R \]

dm is negative. Thus, unlike accounting depreciation, economic depreciation charged in a period may be negative. Under a policy of exponential depreciation, di is constant, d, for all \( i < m \). This implies that:

\[ \frac{X_i}{(1-d)^{i-1}} \]

is constant. The necessary condition for this is that Xi grows at a rate

\[ \frac{d}{1-d} \]

A1/3
throughout the life of the asset. This is a precise assumption but not one that is generally considered before exponential depreciation is employed. The employment of exponential depreciation by researchers may therefore have more to do with computational simplicity than with economic reality.

2. If assumptions that there is no uncertainty and no innovation are relaxed, equations (1A1) and (2A1) may be re-stated as follows:

\[
\begin{align*}
(5A1) \quad RCM_t &= \sum_{i=1}^{q} \frac{E_t(W_i)}{[1+E_t(R)]^i} \\
(6A1) \quad BV_{mt} &= \sum_{i=m+1}^{n} \frac{E_t(X_i)}{[1+E_t(R)]^{i-m}}
\end{align*}
\]

where: \( RCM_t \) is the replacement cost of a modern equivalent asset at time \( t \);

\( q \) is the life of such an asset;

\( W_i \) is the cash flow it generates, including, for simplicity, any terminal value;

\( E_t(\cdot) \) signifies expectation at time \( t \); and

\( BV_{mt} \) again signifies the "economic" book value of a used asset at time \( t \).

Again,
\[ BV_{0t} = RC_t \]

and

\[ d_{mt} = \frac{BV_{t(m-1)} - BV_{mt}}{BV_{t(m-1)}} \]

where \( RC_t \) signifies the replacement cost of an unused asset not incorporating the innovation incorporated in the modern equivalent asset.

Note that, while \( RCM_t \) and \( RC_t \) are not the same, the former defines the anticipated rate of return which is required to specify the latter. The ex post depreciation profile (\( d_{mt}, d_{m+1 t}, d_{m+2 t} \) etc) therefore reflects innovation: the greater the internal rate of return from a modern equivalent asset, the more severely the asset in place is written down. Results corresponding to equations (3A1) and (4A1) may be derived:

\[ \text{(7A1)} \quad d_{mt} = \frac{E_t(X_m)}{BV_{t(m-1)}} - E_t(R) \]

\[ \text{(8A1)} \quad BV_{mt} = RC_t \prod_{i=1}^{m} (1-d_{it}) \]
The reservations expressed over the assumptions implicit in exponential depreciation are unaltered.

3. A more generalised approach is possible which also allows for the fact that assets are depreciated in groups with difference ages. Dropping for simplicity the expectation operator and the \( t \) suffix, the 'economic' book value of a group of assets is given by:

\[
BV = \sum_{i=1}^{n} \sum_{j=1}^{n} I_{-i} \cdot b(-i; j) (1+R)^{-i-j}
\]

where: \( BV \) is the 'economic' book value of a group of assets;

\( I_{-i} \) is the expenditure on this group of assets \( i \) years previously;

\( R \) is the internal rate of return on investment in new modern equivalent assets; and

\( b(-i; j) \) is the recovery profile factor, ie the cash flow generated \( j \) years after \( £1 \) of investment \( i \) years.
The generalised equation at (9A1) may be simplified by assuming a constant rate of growth, \( g \), in expenditure and a common recovery profile such that:

\[
\begin{align*}
\text{\( b(-i;j) = b(j) \)} \\
\text{\( b(j) = 0 \); \( 1 \leq j \leq q \)} \\
\text{\( b(j) = k \); \( q < j \leq n \)}
\end{align*}
\]

where \( k \) is a constant, ie it is assumed that there is a fallow period of \( q \) years before a level recovery is made on the investment over the remaining \( n-q \) years.

With these simplifying assumptions:

\[
BV = I_{ok} \sum_{i=q+1}^{n} \sum_{j=1}^{n} (1+g)^{-i} (1+R)^{i-j}
\]

where \( I_{ok} \) is the current level of expenditure on this class of asset.

Replacing the second summation with the sum of a geometric progression:\(^1\)

\[
BV = \frac{I_{ok}(1+R)}{R} \left[ \sum_{i=q+1}^{n} (1+g)^{-i} (1-(1+R)^{i-n-1}) \right]
\]

\(^1\) being a series of \( i-n+1 \) terms compounded at \( 1/(1+r) \), with 1st term = 1
Rearranging:

\[ BV = \frac{I_0k(1+R)}{R} \left[ \sum_{i=q+1}^{n} (1+g)^{-i} \sum_{i=q+1}^{n} (1+g)^{-i} (1+k)^{i-n-1} \right] \]

The two summations may be replaced by the sums of geometric progressions. Following rearrangement:

\[(10A1) \quad BV = \frac{I_0k(1+R)}{R} \left[ \left( \frac{1}{g(1+g)} \right)^q \left( \frac{1}{1+g} \right)^n - \frac{1}{g-R} \left( \frac{1}{1+R} \right)^{n-q} \left( \frac{1}{1+g} \right)^q \left( \frac{1}{1+g} \right)^n \right] \]

The current rate of expenditure, \( I_0k \), on a group of assets and the growth in expenditure on them, \( g \), could be estimated from accounting data. The fallow period, \( q \), and the life of the asset, \( n \), could be estimated from accounting data or from industry-wide characteristics. The rate of return, \( R \), might be estimated in the light of knowledge about 'normal' returns or, alternatively, from estimates of the internal rate of return from investment in the overall capital of the firm. The value of \( k \), the constant recovery profile factor might be estimated a priori. Thus equation 10A1, could be used to estimate the 'economic' book value of a group of assets.
DOES THE TAX WEDGE EFFECT DISAPPEAR IF DEFERRED TAX IS ACCOUNTED FOR?

1. Consider the case of a one-asset firm without borrowing whose single asset is a risk free security with a replication cost of $k$ which generates income in perpetuity of $y$ per annum before tax. It follows that, assuming efficient capital markets, the cost of capital is $y/k$ and the market value of the firm, assuming an imputation tax system and all income is distributed, is the present value of the income received by shareholders, discounted at this cost of capital:

$$V_e = \frac{y}{k} \left( \frac{1-T}{1-t} \right) = k \left( \frac{1-T}{1-t} \right)$$

where: $T$ is the corporation tax rate; and $t$ is the income tax rate.

If deferred tax is ignored:

$$q = \frac{V_e}{k} = \frac{1-T}{1-t}$$

This is the result described by King. If, however, the liability for deferred tax, $DT$, is held to be the present value of the tax allowances available on re-investment in the
asset, ie

\[ DT = \frac{y}{k} \left( \frac{T-t}{1-t} \right) = k \left( \frac{T-t}{1-t} \right) \]

and this deferred tax liability is deducted from the replication cost in the denominator of \( q \), it follows that:

\[ q = \frac{k \left( \frac{1-T}{1-t} \right)}{k - k \left( \frac{T-t}{1-t} \right)} \]

which reduces to:

\[ q = 1 \]

Thus, when full distribution of profits is assumed, King's tax wedge effect can be ignored if the deferred tax liability is included in the denominator of \( q \) and is estimated in the manner proposed by Edwards, Kay and Mayer.

2. If the assumption about full distribution of profits is relaxed, the effective rate of tax under the imputation tax system is:

\[ \frac{T-tp}{1-tp} \]

A2/2
where $p$ is the payout ratio.

Returning to the one-asset firm model considered above, the market value of the firm is:

$$\frac{py}{y} \left( \frac{1-T}{1-tp} \right)$$

where $g$ is the rate of growth of gross dividends.

But:

$$g = (1-p) \frac{1}{k}$$

Therefore the market value of the firm is:

$$k \left( \frac{1-T}{1-tp} \right)$$

The present value of tax allowances available on re-investment in the asset is:

$A^{2/3}$
\[
\frac{y}{(\frac{y}{k})} \left(\frac{T - tp}{1 - tp}\right)
\]

which reduces to:

\[
k \left(\frac{T - tp}{1 - tp}\right)
\]

Tobin's q is therefore given by:

\[
q = \frac{k \left(\frac{1 - T}{1 - tp}\right)}{k - k \left(\frac{T - tp}{1 - tp}\right)}
\]

which reduces to

\[
q = 1
\]

Thus making allowance for the effective tax rate when a proportion of profits is retained does not affect the original conclusion: when allowance for deferred tax is made in the manner advocated by Edwards, Kay and Mayer, King's tax wedge is eliminated.

\[\text{A2/4}\]
FORMAL PROOFS CONCERNING THE BIAS IN VARIOUS PROFITABILITY MEASURES DUE TO THE LEVEL OF OPERATIONAL GEARING

Hypothesis 1
The first hypothesis is that the Accounting Rate of Return (ARR) is biased by operational gearing.

If ARR is biased by operational gearing, the rate of supra-normal profits represented by the difference between ARR and the firm's cost of capital will vary with a change in the level of operational gearing, other factors being held constant. The hypothesis may be therefore be expressed as:

\[
(H1) \quad \frac{d}{dw} (ARR - r) \neq 0
\]

where: ARR is the Accounting Rate of Return:
- \( r \) is the cost of capital; and
- \( w \) is the operational gearing.

Operational gearing is conventionally defined as

\[
\frac{\text{Exp}}{\text{BI} + \text{Exp}}
\]

where: BI is variable expenditure; and
- Exp is fixed expenditure.

This measure fails, however, to weigh expenditures, both revenue and capital, in present value terms; and the initial capital investment, which is in effect a 'fixed cost' as it does not vary with output, is ignored. Abstracting from the

A3 1
difference between cash flows and accounting costs, operational gearing, \( w \), should be defined as

\[
(3.1) \quad w = \frac{K_0 + PV(Exp)}{K_0 + PV(BI) + PV(Exp)}
\]

where: \( K_0 \) is the initial capital; and

\( \text{PV( )} \) is the present value operator - strictly \( \text{PV}_{0,1}(..) \).

Assuming level cash flows

\[
PV(Exp) = Exp \frac{1}{r_e} (1 - e^{-r_e})
\]

and

\[
PV(BI) = BI \frac{1}{r_{bi}} (1 - e^{-r_{bi}})
\]

where: \( r_{bi} \) is the cost of capital (discount rate) for BI; and

\( r_e \) is the cost of capital (discount rate) for fixed expenditure.

The condition that other factors are held constant may be expressed as follows:

i. A change in operational gearing does not affect sales, ie

A3 2
where $S$ is the firm's sales; and

ii. When operational gearing is changed, the present value of resources are held constant, ie

\[
\frac{d}{dw}(K_0 + PV(BI) + PV(Exp)) = 0
\]

Thus

\[
(3.3) \quad K_0 + PV(BI) + PV(Exp) = a
\]

where $a$ is a constant.

iii. $K_0$ is determined at the commencement of the accounting period,

\[
(3.4) \quad \frac{d}{dw}K_0 = 0
\]

Proof of Hypothesis 1

Assuming for simplicity that the revaluation surplus is zero, by definition
Abstracting from borrowing, the firm's cost of capital is, according to CAPM:

\[ r = r_0 + \beta (r_m - r_0) \]

From equations 139 and 140 of the main paper

\[ \beta = \frac{S-BI}{S-BI-Exp} \beta_2 \]

so that

\[ (3.6) \quad r = r_0 + \frac{S-BI}{S-BI-Exp} \beta_2 \]

Therefore

\[ \frac{d}{dw} (ARR - r) = \frac{d}{dw} \left( \frac{S-Exp-BI}{K_0} - r_0 - \frac{S-BI}{S-BI-Exp} \beta_2 \right) \]

We now evaluate this differential.

From equation 3.3

\[ BI = \frac{I_{bi}}{(1-e^{-I_{bi}})} (a - PV(Exp) - K_0) \]
Substituting for BI

\[ \frac{d}{dw}(ARR-r) = \frac{d}{dw} \left( \frac{S-Exp - \frac{R_e}{1-e^{-\omega}} (a-PV(Exp) - K_e)}{K_0} \right) \]

From equations 3.1 and 3.3

\[ (3.6) \quad w = \frac{K_0 + PV(Exp)}{a} \]

Differentiating with respect to w

\[ \frac{d}{dw}(PV(Exp)) = a \]

and

\[ \frac{d}{dw} Exp = \left( \frac{R_e}{1-e^{-\omega}} \right) a \]

These are the only non-zero differentials with respect to w in the above. Thus, completing the differentiation with respect to w

\[ \frac{d}{dw}(ARR-r) = \frac{a.b}{K_0} - \frac{(a.c.Beta_e (S-a.b + b.K_e))}{(S-a.b + b.PV(Exp) + b.K_0 - c.PV(Exp))^2} \]
where

\[ b = \left( \frac{z_{bi}}{1-e^{-z_{pi}}} \right) \]

and

\[ c = \left( \frac{z_{e}}{1-e^{-z_{r}}} \right) \]

The second term in the expression above includes \( PV(\text{Exp}) \) and therefore depends on \( \text{Exp} \). The first term does not contain \( \text{Exp} \). Therefore the expression cannot equal zero for all values of \( \text{Exp} \). Therefore

\[ \frac{d}{dw} (ARR - r) \neq 0 \]

and the hypothesis H1 is proved.

**Hypothesis 2**

The second hypothesis is that the Return on Total Capital Employed (ROTCE) is not biased by operational gearing.

The hypothesis may be expressed as:
From equation 121A of the main paper, assuming again, for simplicity, that \( \text{Revn} = 0 \), \( \text{ROTCE-r} \) is:

\[
\text{ROTCE-r} = \log \left[ \frac{\text{PV}(S) + K_0 e^{-r_t}}{K_0 + \text{PV(BI)} + \text{PV(Exp)}} \right]
\]

The conditions are as previously expressed:

\[
(3.2) \quad \frac{dS}{dw} = 0
\]

\[
(3.3) \quad K_0 + \text{PV(BI)} + \text{PV(Exp)} = a
\]

where \( a \) is a constant, and

\[
(3.4) \quad \frac{d}{dw} K_0 = 0
\]

**proof of Hypothesis 2**

Substituting equation 3.3 and replacing \( \text{PV}(S) \) with \( S \):
\[ \text{ROTCE}-r = \log \left[ \frac{S \left( \frac{1-e^{-rs}}{r_s} \right) + K_0 e^{-rk}}{a} \right] \]

Differentiating with respect to \( w \)

\[ \frac{d}{dw} (\text{ROTCE}-r) = \left[ \frac{S \left( \frac{1-e^{-rs}}{r_s} \right) + K_0 e^{-rk}}{a} \right]^{-1} \left[ \left( \frac{1-e^{-rs}}{r_s} \right) \frac{dS}{dw} + e^{-rk} \frac{dK_0}{dw} \right] \]

From 3.2 and 3.3

\[ \frac{dS}{dw} = \frac{dK_0}{dw} = 0 \]

Therefore

\[ \frac{d}{dw} (\text{ROTCE}-r) = 0 \]

and the hypothesis H2 is proved.

**Hypothesis 3**

The third hypothesis is that \( q \) is not biased by changes in the anticipated level of operational gearing.

The hypothesis may be expressed as

\[ A3 \ 8 \]
(H3) \[
\frac{dq}{dz} = 0
\]

where: \( z \) is the anticipated future level of operational gearing, ie

\[
z = \frac{C + PV(E_t)}{C + PV(E_t) + PV(BI_t)}
\]

\( C \) is the firm's capital at the time of measurement;

\( E_t \) is all future fixed expenditure, both revenue and capital, in cash terms;

\( BI_t \) is all future variable expenditure;

\( PV(\cdot) \) is the present value operator, strictly \( PV_{0,0}(\cdot) \); and, for simplicity, abstracting from loan capital,

\[
q = \frac{V_e}{C}
\]

where \( V_e \) is the market value of the equity of the firm.

The condition that other factors are held constant as \( z \) changes is expressed as follows:

i. A change in \( z \) does not effect the anticipated present value of all future sales, \( PV(S_t) \), ie
\[(3.5) \quad \frac{d}{dz} (PV(S_t)) = 0\]

ii. When \( z \) is changes, the anticipated present value of future resources expended remains constant, ie

\[(3.6) \quad C + PV(E_t) + PV(BI_t) = K_1\]

where \( K_1 \) is a constant.

iii. Capital is spent and therefore does not change with \( z \), ie

\[(3.7) \quad \frac{dC}{dz} = 0\]

Proof of Hypothesis 3
Assuming Capital Market Efficiency in the fundamental valuation sense

\[V_e = PV(S_t) - PV(BI_t) - PV(E_t)\]

Therefore

\[q = \frac{PV(S_t) - PV(BI_t) - PV(E_t)}{C}\]

Substituting equation 3.6
Differentiating with respect to $z$ and substituting (3.6) and (3.7)

$$\frac{dq}{dz} = 0$$

Thus the hypothesis is proved.
<table>
<thead>
<tr>
<th>Row</th>
<th>Column C</th>
<th>Column D+</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Percentage bought in</td>
<td>n%</td>
</tr>
<tr>
<td>5</td>
<td>Output sold</td>
<td>100.0</td>
</tr>
<tr>
<td>6</td>
<td>Sales price</td>
<td>Variable</td>
</tr>
<tr>
<td>7</td>
<td>Sales</td>
<td>C5*C6</td>
</tr>
<tr>
<td>9</td>
<td>Output manufactured</td>
<td>+C5*(1-C3)</td>
</tr>
<tr>
<td>10</td>
<td>Output bought in</td>
<td>Variable</td>
</tr>
<tr>
<td>12</td>
<td>Unit cost man goods</td>
<td>+C10*C13</td>
</tr>
<tr>
<td>13</td>
<td>Unit cost bought ins</td>
<td>+C13</td>
</tr>
<tr>
<td>15</td>
<td>Cost of bought ins</td>
<td>+C10*C13</td>
</tr>
<tr>
<td>17</td>
<td>Value Added</td>
<td>+C7-C15</td>
</tr>
<tr>
<td>19</td>
<td>Cost of man goods</td>
<td>+C9*C12</td>
</tr>
<tr>
<td>21</td>
<td>Profit</td>
<td>+C17-C19</td>
</tr>
<tr>
<td>23</td>
<td>Cap emp per unit mfg</td>
<td>Variable</td>
</tr>
<tr>
<td>24</td>
<td>Cap emp per unit RI</td>
<td>+C23</td>
</tr>
<tr>
<td>25</td>
<td>Capital employed</td>
<td>+C24</td>
</tr>
<tr>
<td>27</td>
<td>Operational Gearing</td>
<td>+C56</td>
</tr>
<tr>
<td>28</td>
<td>Bought In Ratio</td>
<td>+C57</td>
</tr>
<tr>
<td></td>
<td>Profitability:</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>ROTECE</td>
<td>+C55</td>
</tr>
<tr>
<td>32</td>
<td>ln(RITE-r)</td>
<td>+C54</td>
</tr>
<tr>
<td>33</td>
<td>ARG</td>
<td>+C21+C25</td>
</tr>
<tr>
<td>34</td>
<td>ARG-r</td>
<td>+C33-C49</td>
</tr>
<tr>
<td>35</td>
<td>HINS in ARG</td>
<td>+C33-C49</td>
</tr>
<tr>
<td>36</td>
<td>AVR</td>
<td>(C21-C49*C25)/(C19+C25+C49)</td>
</tr>
<tr>
<td>37</td>
<td>AVR mkt</td>
<td>(C21-C49*C25)/(C7-C21+C49+C25)</td>
</tr>
<tr>
<td>38</td>
<td>HINS</td>
<td>+C21+C7</td>
</tr>
</tbody>
</table>

| Parameters:                                                                 |
|                                                                           |
| 43  | Risk free rate                                                          | 3.0%                                                                    |
| 44  | Risk premium                                                            | 9.0%                                                                    |
| 45  | HETA(i) = RETA(i)                                                       | 0.30                                                                    |

| Calculated Values:                                                         |
|                                                                           |
| 41  | HETA                                                                    | +C45*C7*(C21*(1-C15)/C7)                                               |
| 42  | r                                                                        | +C43+C48*C44                                                            |
| 43  | rs                                                                       | +C43+C45*C44                                                            |
| 51  | IV(S)                                                                    | +C7*(1-EXP(-C50))/C50                                                  |
| 52  | LV(Exp)                                                                 | +C19*(1-EXP(-C45))/C43                                                |
| 57  | HINS                                                                     | +C15*(1-EXP(-C50))/C50                                                |
| 54  | ROTECE-r                                                                | 2*LN((C51+C25*(1+C43))/(C25+C52+C53))                                  |
| 56  | Operational gearing                                                     | +C54+C49                                                               |
| 57  | Bought In Ratio                                                         | (C25+C52)/(C25+C52+C53)                                                |

56  | Operational gearing                                                     | (C25+C52)/(C25+C52+C53)                                                |
57  | Bought In Ratio                                                         | 1-C56                                                                  |

APPENDIX 4
## Variations in Reported Profitability as Buying in Increases

<table>
<thead>
<tr>
<th>Percentage bought in</th>
<th>0.0%</th>
<th>10.0%</th>
<th>20.0%</th>
<th>30.0%</th>
<th>40.0%</th>
<th>50.0%</th>
<th>60.0%</th>
<th>70.0%</th>
<th>80.0%</th>
<th>90.0%</th>
<th>95.0%</th>
<th>99.0%</th>
<th>99.5%</th>
<th>100.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output sold</strong></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Sales price</strong></td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Sales</strong></td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
<td>110.0</td>
</tr>
<tr>
<td><strong>Output manufactured</strong></td>
<td>100.0</td>
<td>90.0</td>
<td>80.0</td>
<td>70.0</td>
<td>60.0</td>
<td>50.0</td>
<td>40.0</td>
<td>30.0</td>
<td>20.0</td>
<td>10.0</td>
<td>5.0</td>
<td>1.0</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Output bought in</strong></td>
<td>10.0</td>
<td>20.0</td>
<td>30.0</td>
<td>40.0</td>
<td>50.0</td>
<td>60.0</td>
<td>70.0</td>
<td>80.0</td>
<td>90.0</td>
<td>95.0</td>
<td>99.0</td>
<td>99.5</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td><strong>Unit cost man goods</strong></td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td>0.900</td>
<td></td>
</tr>
<tr>
<td><strong>Unit cost bought ins</strong></td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td>0.975</td>
<td></td>
</tr>
<tr>
<td><strong>Cost of bought ins</strong></td>
<td>0.0</td>
<td>9.8</td>
<td>19.3</td>
<td>29.3</td>
<td>39.0</td>
<td>48.0</td>
<td>58.5</td>
<td>68.3</td>
<td>78.0</td>
<td>87.8</td>
<td>96.5</td>
<td>97.0</td>
<td>97.5</td>
<td>97.5</td>
</tr>
<tr>
<td><strong>Value Added</strong></td>
<td>110.0</td>
<td>100.3</td>
<td>90.5</td>
<td>80.8</td>
<td>71.0</td>
<td>61.3</td>
<td>51.5</td>
<td>41.8</td>
<td>32.0</td>
<td>22.3</td>
<td>17.4</td>
<td>13.5</td>
<td>10.0</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Cost of man goods</strong></td>
<td>90.0</td>
<td>81.0</td>
<td>72.0</td>
<td>63.0</td>
<td>54.0</td>
<td>45.0</td>
<td>36.0</td>
<td>27.0</td>
<td>18.0</td>
<td>9.0</td>
<td>4.5</td>
<td>0.9</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Profit</strong></td>
<td>20.0</td>
<td>19.3</td>
<td>18.5</td>
<td>17.8</td>
<td>17.0</td>
<td>16.3</td>
<td>15.5</td>
<td>14.8</td>
<td>14.0</td>
<td>13.9</td>
<td>12.9</td>
<td>12.6</td>
<td>12.3</td>
<td>12.0</td>
</tr>
<tr>
<td><strong>Cap emp per unit mg</strong></td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
</tr>
<tr>
<td><strong>Cap emp per unit PL</strong></td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Capital employed</strong></td>
<td>79.0</td>
<td>73.6</td>
<td>68.2</td>
<td>62.8</td>
<td>57.4</td>
<td>52.0</td>
<td>46.6</td>
<td>41.2</td>
<td>35.8</td>
<td>30.4</td>
<td>27.7</td>
<td>25.5</td>
<td>24.3</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>Operational Gearing</strong></td>
<td>100.0</td>
<td>94.7%</td>
<td>88.0%</td>
<td>81.5%</td>
<td>74.5%</td>
<td>67.0%</td>
<td>59.1%</td>
<td>50.5%</td>
<td>41.4%</td>
<td>31.5%</td>
<td>23.6%</td>
<td>22.0%</td>
<td>21.4%</td>
<td>20.4%</td>
</tr>
<tr>
<td><strong>Bought In Ratio</strong></td>
<td>0.0</td>
<td>5.8%</td>
<td>12.0%</td>
<td>18.5%</td>
<td>25.3%</td>
<td>33.0%</td>
<td>40.9%</td>
<td>49.2%</td>
<td>56.6%</td>
<td>68.3%</td>
<td>73.7%</td>
<td>78.6%</td>
<td>84.6%</td>
<td>89.1%</td>
</tr>
</tbody>
</table>

## Profitability

- **ROTE**
  - 36.0%
  - 35.2%
  - 34.4%
  - 33.5%
  - 32.5%
  - 31.4%
  - 30.2%
  - 28.8%
  - 27.4%
  - 25.7%
  - 24.9%
  - 24.1%
  - 24.0%
  - 23.9%

- **ROTE-r**
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%
  - 18.2%

- **ARR**
  - 28.2%
  - 28.2%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%
  - 28.3%

- **ARR-r**
  - 7.9%
  - 9.1%
  - 10.9%
  - 13.0%
  - 13.5%
  - 18.1%
  - 21.5%
  - 27.5%
  - 29.9%
  - 36.1%
  - 39.8%
  - 43.3%
  - 47.3%

- **BIAS in ARR**
  - -10.7%
  - -9.1%
  - -7.3%
  - -5.2%
  - -2.9%
  - -0.1%
  - 3.1%
  - 7.6%
  - 11.7%
  - 17.0%
  - 21.6%
  - 25.8%
  - 29.8%

- **AVR**
  - 5.7%
  - 7.2%
  - 9.0%
  - 11.2%
  - 14.2%
  - 18.1%
  - 23.9%
  - 33.0%
  - 50.4%
  - 97.1%
  - 174.0%
  - 460.3%
  - 548.2%

- **AVR m-1**
  - 5.7%
  - 6.5%
  - 7.3%
  - 8.0%
  - 8.7%
  - 9.3%
  - 9.9%
  - 10.4%
  - 10.8%
  - 11.2%
  - 11.6%
  - 11.2%

- **RDS**
  - 18.2%
  - 17.5%
  - 16.8%
  - 16.1%
  - 15.5%
  - 14.8%
  - 14.1%
  - 13.4%
  - 12.7%
  - 12.0%
  - 11.7%
  - 11.4%
  - 11.4%
ESTIMATING THE SYSTEMATIC INEFFICIENCY OF UK SHARES AND 
ADJUSTING MODELS TO ACCOMMODATE THIS ESTIMATE

Systematic Inefficiency represents the proportional over-valuation of the market as a whole, and at time t is defined as X, where

\[(1A5) \quad M_t - (1 - X) M_t \]

where:

- \( M_t \) is the observed level of the FTA Industrials Index;
- and
- \( \bar{M}_t \) is the value of the FTA Industrials Index if valued rationally ie

\[(2A5) \quad \bar{M}_t = \sum_{t-1}^{\infty} \frac{E(D_t)}{(1 + E(r))^t} \]

where:

- \( D_t \) is the dividend paid on the FTA Industrial Index in year t;
- \( r \) is the return on the FTA Industrials Index;
- and
- \( E(\quad) \) signifies expectation.
If an expectation of constant long-term growth in dividends is assumed, equation 2A5 may be re-stated as

\[
N_t = \frac{E(D_1)}{1+E(g)} \sum_{t=1}^{\infty} \left[ \frac{1+E(g)}{1+E(r)} \right]^{t-1}.
\]

which, after summation of the geometric progression, reduces to:

\[(3A5) \quad N_t = \frac{E(D_1)}{E(r)-E(g)} \]

According to the Capital Asset Pricing Model:

\[(4A5) \quad E(r) = E(r_0) + \text{Beta}(FTA) [E(r_m) - E(r_0)] \]

where: \( r_0 \) is the risk free interest rate;  
\( r_m \) is the return on the comprehensive market portfolio;  
and  
Beta(FTA) is the Beta Coefficient of the FTA Industrials Group Index.

Let the observed 'real yield' on the FTA Industrials Index by \( y \), so that

\( A6/2 \)
Assuming \( E(D_1) = D_1 \), the equations above may be combined to give the systematic over-valuation of the market as a whole, in terms of variables which are measurable or estimatable in the light of long-run historical data:

\[
(5A5) \quad y = \frac{D_1}{M_t}
\]

\[
(6A5) \quad X = 1 - \frac{y}{E(r_0) + \text{Beta(FTA)}[E(r_m) - E(r_0) - E(g)]}
\]

Estimation is facilitated if rates of return are expressed in real terms. \( E(r_0) \) may then be represented by the current yield on indexed linked stock, say 2% Treasury 1996 or 3.5% before issue as per Plymen; and \( y \) can be taken to be the 'real yield' on the FTA Industrial Index as calculated by Plymen. Beta(FTA), the Beta Coefficient on the FTA Industrials Index, can be taken from data published by the London Business School Risk Management Service (1.02 in 1985). The term \( [E(r_m) - E(r_0)] \) represents the risk premium in real terms on the comprehensive market portfolio and was estimated by Franks and Hodges (1983) to be 7.7%. Finally, \( E(g) \), the anticipated real, long-term rate of growth in dividends, can be estimated from widely held expectations about the real long-term rate of growth in the UK economy (say 2% per annum) or from the historical real growth in dividends (1.5% per annum in the year 1919-1969 according to statistics provided by Plymen). A figure of 2% per annum is adopted. Employing these estimates in equation 6A5, the systematic over-valuation of the market as a whole in the period 1980-84 chosen for the empirical study is:
where \( R_o \) is the yield on 2% Treasury Index Linked Stock 1996, or 3.5%, as appropriate and \( y \) is the 'real yield' on the FTA industrials Index as calculated by Plymen.

Using the estimation of Systematic Inefficiency above, the adjusted or fundamental value of the firm's equity could be substituted for the 'over-valued' equity to arrive at a modified version of \( q \), \( q^* \), as follows:

\[
\text{mod}q^* = \frac{(1-X) V_o + V_b}{C}
\]

If the capital gearing ratio is redefined as \( B^* \), where

\[
B^* = \frac{V_b}{(1-X) V_o + V_b}
\]

and \( B^* \), rather than \( B \), is assumed to be held constant, the analysis leading to \( \text{mod}q \) may be repeated to arrive at an expression for \( \text{mod}q^* \), being \( \text{mod}q \) adjusted for Systematic Inefficiency:
where $\text{PER}^*$ is the Price Earnings ratio adjusted for Systematic Inefficiency, ie

\[
\text{PER}^* = \frac{(1-X)V_e}{E_i}
\]

Systematic Inefficiency contravenes an assumption underlying CAPM that capital markets are efficient. Use of CAPM when there is Systematic Inefficiency would presumably result in the cost of capital, $r$, being under-estimated, as no allowance would be made for the undiversifiable risk associated with volatility of $X$, the departure of the market as a whole from its fundamental value. Therefore, if Systematic Inefficiency exists, mod$q^*$ would tend to under-estimate profitability, at least for companies with modest capital gearing, and, if it did not exist, mod$q^*$ would represent a corrupted form of mod$q$. 

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<th>YEAR END</th>
<th>FILE NO</th>
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### APPENDIX 7

#### Data for Tables 1-3 only

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<th>I</th>
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**NOTES**

- File No:
- Date prepared:
- Date entered:

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**APPENDIX 7**

**Data For Tables 1-3 only**

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**Vertical Alignment**

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**Horizontal Alignment**
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