UNIVERSITY OF SOUTHAMPTON

Faculty of Social Sciences

Department of Management

EMPIRICAL MODELS OF ASSET PRICING
With particular reference to
THE MODELLING OF ZERO-DIVIDEND STOCKS

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A Thesis submitted in partial fulfilment of the requirements for
The degree of Doctor of Philosophy

September 2001

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ABSTRACT

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The appropriate pricing of financial assets is crucial to the proper allocation of capital to investment projects. This study examines theoretical models of asset pricing, commencing with portfolio theory (Markowitz (1952, 1959)) and the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965) and Mossin (1966), leading up to the multifactor models of Fama and French (1993).

In tracing this evolution of models, consideration is given to alternative schools of thought in relation to the efficiency of capital markets; the ideas of the 'Efficient Markets' adherents are discussed extensively, along with the contrasting views of those favouring a 'Behavioural' context to the process of price-setting.

Based upon empirical models developed with regard to the above body of theory, and also taking into account the influences of more recent approaches to model building and econometric techniques, the study makes use of a rich set of data related to the United Kingdom stock market over the period 1955-97. Data from the London Business School 'London Share Price Database' comprising over 800,000 monthly records, is used to construct portfolios. These are analysed with a view to ascertaining the determinants of stock returns, and the nature of the relationships involving, in particular, Dividend Yield and Payout Ratio; controlling for Covariance Risk, Seasonality and Market Capitalisation. With regard to the former, a unique class of stocks, those which pay *no* dividends, are studied in particular detail - with the justification that comparatively little prior research has been carried out in this area of study, and virtually none at all using UK data.

The empirical study is divided into three sections, which investigate, firstly, the hypothesised determinants listed above, in the context of an extended 'CAPM' form of model. The model, in addition, invokes indicator variables to separately identify non-dividend-paying stocks. Special attention is given to the criteria by which stocks are included / excluded from portfolios, in order to obviate 'survival' bias. Parameter stability is examined directly through the use of rolling regression analyses.

Secondly, a section is devoted to examining the migration patterns of stocks as they evolve and diffuse among the different fractiles, or 'strata', of Yield levels. This, together with the distribution of firm sizes within strata, is aimed at characterising the nature of, in particular, Zero-Dividend stocks as a distinct group. This type of study appears to have few antecedents in the finance literature.

Thirdly, the categorisation of 'Expanding' versus 'Contracting' stocks, as measured by year-on-year market capitalisation changes, is examined for its relevance in connection with Zero-Dividend stocks, which are known to comprise a heterogeneous mix of rising, dynamic firms and older, established companies, many of which are in decline. Stratification along this dimension is compared to that of Fama and French (2001), which classifies according to 'Former Payers' and 'Never Paid'.

The study finds there to be a significant, though declining (in recent periods) role for firm size; and a significant role for Dividend Yield in explaining Returns behaviour. The influence of Zero-Dividend status has been, during and since the 1970's, predominantly expressed through its seasonal interaction coefficients (for January and April), indicating that the

abnormal performance of this group has largely shifted to these 'milestone' months, at least in more recent times.

Later in the first empirical chapter, earnings information is introduced as an adjunct to the model, but carried out in a way which minimises the effects of its collinearity with Dividend Yield as an explanator. This is effected by the use of Payout Ratio in the model, which presents itself as being largely orthogonal to the above two variables. Payout Ratio is not restricted to the 'normal' range 0-1, but includes negative ratios (loss-making firms) and firms whose dividend payout exceeds earnings (Payout Ratio >1). It is observed that (in certain periods within the full sample) Payout Ratio emerges as a significant explanator of 'abnormal' returns, and indeed appears to diminish the significance of Dividend Yield in those instances.

At the close of this chapter, joint estimations using a variation of the Seemingly Unrelated Regression technique of Zellner (1962), together with selectively imposed restrictions, examines the Returns performance with a demonstrated greater precision.

A year-on-year portfolio migration study shows that, second only to the number of migration samples to and from the 'Low-Yield' category, the movement into and out of the Zero-Dividend group is toward the 'High-Yield' category. This evidence combines with the Firm Size distribution (within the Dividend-Yield categories) to indicate that there is greater 'similarity' between firms in the two 'extreme' Yield subdivisions than is suggested by the usual references to a 'U' shaped 'Returns versus Yield' characteristic, which places these groups at opposite ends of a Yield continuum.

In the final empirical chapter, the stratification of stocks into 'Expanding' and 'Contracting' categories is shown to be useful in terms of such a characteristic adding explanatory power to a Returns-determining equation. The same is not true, however, of the payment-history distinction between 'Former Payers' and those who have never paid a dividend.

Acknowledgements

I should like to record the greatest possible appreciation for the encouragement and support that I have received from my PhD supervisors, Professor Steve Thomas and Dr. Owain ap Gwilym, throughout the period of my study. Each in their own individual way, they have provided inspiration and encouragement in equal measure; and they have spent many hours studying the evolving drafts, as the project has progressed toward completion. In the process, they have become good friends, both inside and outside the professional and academic environment. I am indeed fortunate.

I should also like to thank both the teaching and the administrative staff within the department of Economics, who allowed me to 'sit in' on various of the MSc modules in order to develop the new and very necessary skills required to pursue this endeavour.

My family, and the home environment which they have created around me, have made possible something which I could not have envisaged, even just a few short years ago. A new interest has been kindled, and the sheer satisfaction gained from a challenging involvement with new and fascinating subject matter is something to be savoured. Of course, it has meant some compromises and adjustments to 'normal' family life, as I have spent hours in front of a computer screen long into the many evenings; for that tolerance, love and support, I cannot thank enough my dear wife Lynne, who has worked so hard in her own career to make it all possible.

This work is dedicated to Lynne, Bruce and Duncan, and most especially to the memory of Stuart, all of the members of my family, with the utmost love.

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1. Introduction

Investors are incentivised to defer consumption and to incur risk by the prospect of financial gain, which is measured as Total Return. Returns arise in two principal ways, by way of regular dividend payments generated from firms' earnings, and by way of capital gains as the ongoing market process prices stocks according to their perceived future prospects. Pricing proceeds in a way governed by the supply of, and demand for, financial instruments backed by 'real' projects. Central to this process is the determination of the most 'advantageous' allocation of scarce (financial) resources to the projects most deserving of those same resources.

The universe of 'real' projects covers all conceivable ways of adding value through economic endeavour. Firms vary widely in the nature of their activity, in the technologies utilised to produce their output, in their size and degree of maturity, and in the maturity of their products. The financing strategies of firms vary in matters such as equity versus debt financing, and in terms of dividend payout (versus retention for future investment). Investors themselves may have preferences for particular cash flow patterns, and have differing taxation circumstances.

The diversity of circumstances among both firms issuing stock, and investors trading stocks in the secondary marketplace, makes for potentially complex relationships between the variables involved. Since it is expected return, adjusted for risk[1], which arguably forms the principal metric for incentivisation, this is most frequently modelled as the dependent variable in financial models, against which is set a variety of candidate 'explanatory' factors or characteristics. Principal among these is the fundamental which determines Present Value; that is, discounted future prospective earnings; this is usually normalised against Price (as Price / Earnings Ratio) when viewed in the context of Returns generation. Since one of the main forms of dissemination of earnings from firms to investors is via the instrument of dividends, Dividend Yield potentially plays an important role also as a determining variable[2].

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[1] The principal measure of risk is taken to be the extent to which the volatility of individual stocks, when added to an investor's portfolio, contribute to the overall volatility of that portfolio. Risk-averse investors have an incentive to minimise portfolio volatility for any given level of return. This central issue is covered in greater detail in this and subsequent chapters of the thesis.

[2] This role is covered extensively, and indeed challenged, in the theoretical literature which is discussed in a later section of this thesis (Chapter 2).

Other influencing variables include firm size[3] (possibly presenting itself as a 'risk' factor) and also the frequency at which individual stocks are traded (The mechanism by which this latter effect operates may be by biasing the normal measurement of risk). In addition to all of the above, there would appear to be empirical evidence of seasonal influences at play in the determination of Returns. The effects of taxation policy need also to be considered. In the later empirical sections of this thesis, where attention is devoted exclusively to the properties of a class of stocks known as 'Zero-Dividend' stocks[4] the effects (on Returns) of (year-on-year) *changes* in firms' market capitalisation are measured. Similarly, the effects of the Dividend-Payment histories[5] of individual stocks are assessed, in order to determine whether there exists a substantive distinction (in terms of firms' characteristics) between these sub-classifications which would impact on Returns behaviour.

Notwithstanding the large range of possible explanatory variables related to returns performance of stocks, it is appropriate to view the investment problem initially from the perspective of the representative investor. This individual prefers *more return* to less, and *less risk* to more risk; accordingly, (s)he strikes a balance between the two factors according to preference, accepting greater returns only if the associated incremental degree of risk is deemed commensurate. The mapping of these factors into a 'Mean-Variance' space, incorporating both investor indifference curves and the limits of the opportunity set, is discussed in Chapter 2 as part of the development (within the literature) of Portfolio theory. From this point, models of portfolio formation such as the Capital Asset Pricing Model, and models deriving from the Arbitrage Pricing Theory, are discussed in detail.

Chapter 3 of this work discusses in detail the source of (UK) data for the study, and the manipulations required to present the data in a suitable form for statistical analysis, using the appropriate models as discussed in the preceding chapter.

The empirical work which follows will show that Dividend yield appears to have a role in 'explaining' returns (Chapter 4), and that Zero-Dividend-Paying stocks require to be treated as a distinct class in their own right, in order to develop the most meaningful relationships between the different types of investment vehicle. These relationships are further investigated

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[3] Firm 'Size' is defined by its Market Capitalisation, the total (current) value of its issued shares.

[4] Stocks which do not *currently* pay dividends.

[5] In terms of whether dividends had formerly been paid by the firm (and have now ceased) or whether dividends had never been paid. This form of classification was introduced by Fama and French (2001).

in terms of the way in which, through their evolution, stocks 'migrate' between yield classes over time (Chapter 5). Treating the historical migration frequencies of the different classes of stocks as estimates of future transition probabilities within a Markov process, leads to the conclusion that the population of Zero-Dividend stocks is increasing relative to dividend paying stocks. This conclusion is supported by anecdotal evidence, particularly from the United States, which indicates that firms, most frequently in the technology sector and among 'younger' companies, are electing preferentially to re-invest retained earnings in order to enhance shareholder value at minimum transactions costs; and to better match their cash flow characteristics in the formative years. Again, in an anecdotal context, this change appears to be facilitated by a relaxation in the 'stigma' associated with dividend curtailment.

Chapter 6 of this work examines exclusively the Returns performance of Zero-Dividend stocks, making the distinction (see above) between firms who have never paid a dividend versus 'Former' payers, and between firms whose year-on-year market capitalisation is increasing ('Expanding' stocks), versus those for which the converse is true ('Contracting' stocks). Chapter 7 Concludes.

Differences from previous studies centre around the fact that UK data is used rather than the majority of studies which use US data; secondly, even compared to UK studies, this work extends the period to include almost the entire data set period of the London Share Price Database (43 years). Thirdly, little prior work has been carried out in relation, specifically, to the Zero-Dividend class of stocks (particularly in the context of the UK market); and fourthly, the migration study appears to be largely without precedent in the finance literature, drawing instead from demographic-type studies.

2.0 An Overview of Asset Pricing Theory and Models

One of the most intriguing topics in modern finance concerns the magnitude of the Returns premium demanded by investors for holding risky assets such as equities, relative to those demanded in the case of less volatile Bonds. The issue is commonly referred to as 'The Equity Premium Puzzle', following the seminal paper by **Mehra and Prescott (1985).** The authors argue that "Over the ninety-year period 1889-1978 the average real annual yield on the Standard and Poor 500 index was seven percent, while the average return on short-term debt was less than one percent". Constructing economic models which accord to **Lucas' (1978)** pure exchange model, yet which are calibrated to reflect the elasticity of substitution and growth characteristics of an actual economy (that of the U.S) over the 90-year period, they find an inability within the models to generate risk premia which approach even *one order of magnitude less* than that actually observed.

Given the apparent failure of conventional (**von Neumann-Morgenstern (1947)**) utility theory to explain these outcomes, theory extensions are proposed which seek to incorporate novel parameter additions in order to explain certain investor behavioural characteristics. Thus **Yaari (1987)** proposes "The Dual Theory of Choice under Risk", and **Gul (1991)** "A Theory of Disappointment Aversion", each of which seek to question the validity of the Independence Axiom associated with the conventional expected utility theory. **Epstein and Zin (1990)** extend Yaari's Dual Theory into a multiperiod context, and conclude that they are thereby able only partially to 'explain' the Equity Risk Premium. A parallel, related strand of the literature is the "Prospect Theory" of **Kahnemann and Tversky (1979)**, which features the concept of "Loss Aversion", incorporating a value function which displays an asymmetric characteristic in terms of the incremental changes in Value perceived by individuals subjected to losses as opposed to gains. **Pemberton (1995)**, partially reconciles these two approaches by drawing an analogy between the neutral 'reference point' of the (atemporal) Prospect Theory with the Mean Expected Outcome (Certainty Equivalent) of the intertemporal gamble associated with Loss Aversion.

The emphasis upon investor behavioural characteristics implied by the above studies requires, however, to be viewed in a wider context which incorporates the concept of "Efficient Markets", **Fama (1970, 1976)**. A continuing subject for debate among financial economists is the question of whether investors, individually or collectively, implement decisions as if the Efficient Markets Hypothesis (EMH), in conjunction with Rational

Expectations[6], provides the 'hidden hand' which guides trading activity; or whether 'cognitive biases' and behavioural characteristics, such as those described above, play the more significant role in the decision making process.

Two distinct threads are apparent in the literature, reflecting the emergence of the different schools of thought on this crucial matter. The contrast is typified by **Fama (1998)**, supportive of EMH, and **Thaler (1999)**, supportive of the Behavioural Finance perspective. The dichotomy has relevance for the treatment of apparent 'Anomalies' in the characteristics and performance of financial assets, such as Market Size effects, e.g. **Banz (1981)**, and the effects of parameters such as Dividend Yield (**Brennan (1970)**), and the ratio Book value to Market Equity (**Fama and French (1992)**). These considerations are important in the context of the subject matter of this thesis, which identifies such 'anomalies' as evidence used in assessing the performance of the classes of stocks under scrutiny.

Closely linked with the above matters, is the question of how expectations are formed. Since expectations are in general unobservable (excepting for limited attempts to sample them using survey techniques), theory-based models have been proposed in order to generate expectations data. This raises the problem, however, of model validity, since without the 'true' model of expectations formation, any attempt to verify market efficiency is handicapped from the outset. Equally, without the certainty of being able to assume Market efficiency, no test of a candidate model can be fully convincing. For this reason, **Roll (1977)** argues that any tests involving Market efficiency and Expectations forming models must necessarily take the form of a joint test. Fama (1998) points out, however, that "bad model" problems inevitably "contaminate" attempts to verify the EMH.

The EMH holds that Prices (and therefore, by implication, Returns) are determined by supply / demand equilibrium in a competitive market, with traders behaving as rational agents utilising the current information set (Ω), which is fully and immediately incorporated into prices. Trading activity in this environment is such that any arbitrage opportunity which may arise, is rapidly dissipated by price adjustment; the opportunity to accumulate 'abnormal' profits is, on average, eliminated. The 'Rational Expectations' element of the EMH assumes that agents' subjective expectations are equated with the corresponding conditional mathematical expectations; these in turn are based upon the 'true' underlying probability distribution of outcomes, (**Muth (1961)**).

[6] Rational Expectations implies that forecast errors should be zero (on average) and should be uncorrelated with any information Ω_t that was available at the time the forecast was made (Cuthbertson (1996)).

For this reason, any subsequent analysis requires to replicate, or model as accurately as possible, the inherent expectations forming process *actually utilised* by agents in order to formulate prices. The modelling approach is generally preferred to alternatives based upon measuring subjective expectations by survey, owing to the risk of 'sample specific' bias in the case of the latter. The next section of this chapter will begin by reviewing the literature associated with the principal model types used in the analyses covered in subsequent chapters. As such, it will address the question of 'Anomalies', viewed either as departures from the EMH's holding, or as 'Behavioural Biases' such as is held to be the case by the 'Behavioural School'. (In the former case, this would be seen as indicative of a failure of the chosen model to capture a relevant Risk Factor); potential candidate factors are also discussed.

The following section (2.1) discusses the general aspects of models of portfolio formation; subsections 2.1.1 and 2.1.2 discuss two specific classes of model, the Capital Asset Pricing Model (2.1.1) and Arbitrage Pricing Theory (2.1.2). Later subsections address the effects (upon Returns) of stock characteristics such as Dividend Yield (also taking account of Taxation) (2.1.3), firm Size (2.1.4), Seasonality (2.1.5), Price / Earnings Ratio (2.1.6), Book to Market Ratio (2.1.7), Frequency of trading (2.1.8) and Payment History (2.1.9).

2.1 Models of Portfolio formation

The beginnings of Modern Portfolio Theory may be accredited to **Markowitz (1959)**, who framed the investor's portfolio decision problem in terms of Risk-Return space, with variance (or Standard Deviation) as an appropriate measure of Risk[7]. Hence the maximisation of the investor's expected end-of-period utility may be expressed as a (quadratic programming) variance-*minimisation* problem in which, for a given level of required Return, the target variable is adjusted to a minimum by setting the weightings of the individual stock components comprising the portfolio.

The work of Markowitz was extended independently by **Sharpe (1964), Lintner (1965) and Mossin (1966)**, who introduced the concept of the mean-variance 'efficient frontier', the locus

[7] This assumes the concave utility function of a risk-averse investor, who holds that the Expected utility of wealth E[U(W)], when faced with a gamble, is <u>less</u> than the Utility of the (certainty equivalent) expected wealth U[E(W)]. Under these conditions, the difference between the two increases with increasing variance.

of efficient portfolios plotted in mean-variance space. **Merton (1972)** derives the underlying algebra defining the efficient frontier. This locus represents the limits of the *opportunity set* available to the investor. With the effect of portfolio formation being to 'diversify away' the specific risk (of an individual stock), the systematic risk (of the portfolio) becomes a function of the covariance of the individual stocks with the market as a whole[8]. The Capital Asset Pricing Model (CAPM) asserts, moreover, that the expected return of an individual asset is a *linear* function of its covariance with the return of the Market Portfolio. The slope of this linear relationship has an economic interpretation as the 'Price of (covariance) Risk'. The availability of 'Risk Free' assets (e.g. short-term government bonds) has the effect of extending the boundary of the efficient frontier. **Black (1972)** shows that a similar effect may be generated by the formulation of a unique portfolio, lying on the efficient frontier, but having zero covariance with the Market portfolio. Linear combinations of the Market and Zero-beta (or Risk-Free) portfolios enable the investor to choose, optimally, any combination of Risk and Return desired, within the constraints of the opportunity set.

Empirical tests of the CAPM have been carried out by a large number of researchers, including **Friend and Blume (1970), Black, Jensen and Scholes (1972), Miller and Scholes (1972), Blume and Friend (1973)** and **Fama and MacBeth (1973)**. Later tests, which are covered in more detail below, incorporate additional 'candidate' explanatory variables, such as Price-Earnings ratio, **(Basu (1977)**) and firm size, (Banz (1981)); **Reinganum (1981)** examines these latter factors in combination. **Litzenberger and Ramaswamy (1979)** follow Brennan (1970) in examining the effects of Dividend Yield, and the taxation implications involved. Yet more tests are performed in a context which admits further factors in models which lean toward Arbitrage Pricing Theory as a basis for their consideration. These are covered further in the relevant sub-sections, below. Thus the remainder of this section proceeds as follows. Firstly, the CAPM-specific literature is reviewed, including those papers mentioned above. Secondly, the Arbitrage Pricing Theory (APT) and its associated literature is considered, both in a way which contrasts it with the CAPM, but which also includes the CAPM as a special (one-factor) case within the APT framework. Thirdly, the strands of the literature which deal with specific additional factors, such as those identified above, are considered.

[8] The implied simplification (relative to a 'linear programming' approach which optimises the portfolio by adjusting weightings) relies upon the assumption that the cross-covariance between any two securities may be largely expressed through the medium of their individual covariances with a common index.

2.1.1 The 'Pure' CAPM

The adoption of the terminology 'Pure' CAPM in this context implies a model which relates Expected Return to a single additional factor only; this being a measure of dispersion serving as a proxy for 'Risk' (see above). In this sense, it conforms to the 'two parameter' (mean / variance) models of **Tobin (1958),** Markowitz (1959) and **Fama (1965)**. Such a model should require no additional explanatory factors of the kind alluded to above.

In order to test this hypothesis, Fama and MacBeth (1973) use a two step regression analysis methodology, which firstly estimates individual securities' Beta over a prior holding period of 5 years in a series of time-series regressions. This is then followed by the formation of β-ranked portfolios, which are subjected to a cross-sectional analysis (on a rolling basis) to establish whether the covariance risk, or 'β- risk', is 'priced'[9]. At the same time, the intercept term is examined, which theory determines should be not significantly different to zero if the CAPM holds; and (similarly) the coefficient of a β^2 term, which again should be zero if the assertion of *linearity* holds. Finally, the coefficient of a generalised variable serving as a measure of non β- related risk is similarly assessed. That generalised measure is selected to be the standard deviation of the residuals from a market model regression, which in turn is an estimate of that part of the dispersion of the distribution of the return on security (i) that is not directly related to β_i. On the basis of these tests, Fama and MacBeth (1973) assert that the Capital Asset Pricing Model is a reasonable description of the data, by stating: "*the observed fair game properties of the coefficients and residuals of the risk return regressions are consistent with an efficient capital market - that is, a market where prices of securities fully reflect available information*".

Though not without critics of the way in which it was sometimes used by others (e.g. the critique of **Hess (1980)**), the Fama-MacBeth methodology was to become a standard technique in terms of research methodology within the literature for a decade or more. However, the question of non β- related risk (often termed 'anomalies'[10]) will be raised repeatedly in the literature to be discussed below.

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9 i.e. has a statistically significant coefficient.

10 Relative, that is, to the 'pure' two parameter CAPM model.

2.1.2 The Arbitrage Pricing Theory

The Arbitrage Pricing Theory was introduced by **Ross (1976)** as a testable alternative to the CAPM, given the contemporaneous work of Roll (1977) who pointed out certain of the drawbacks of attempts to test the latter. *Roll's critique* applied to cross-sectional performance assessment relative to an index that is ex-post efficient, which (by construction) is assured, subject only to that fact of efficiency. By contrast, relative to an inefficient index, *any* ranking of portfolio performance is possible, depending upon the nature of the particular index. Therefore, the only legitimate test of the CAPM is whether or not the 'market portfolio' (which strictly must include *all* assets[11]) is mean-variance efficient.

The Arbitrage Pricing Theory allows for a more general model construction, not limited to a single factor, such as covariance risk. However, the CAPM may usefully be regarded as being a special (single factor) case of the more general APT. Tests of the APT (e.g. **Roll and Ross (1980)** suggest that three or possibly four factors are 'priced'. A problem remains in terms of relating the factors so derived, to macroeconomic variables which may be correlated to those factors. **Chen, Roll and Ross (1983)** identify industrial production, unanticipated inflation, changes in bond default risk premium[12], and yield curve changes as being significant in this regard. Given the emphasis, later in this thesis, in relation to anomalies such as firm size, it is interesting that Reinganum (1981) rejects the APT on the basis that firm size does add explanatory power to an APT factor model; **Chen (1983)**, by contrast, fails to reject on the basis that it does not.

Clare and Thomas (1994), hereafter CT(1994), use UK stock market data to examine systematic factors as sources of risk, and carry out an empirical study which seeks to link fundamental economic variables with stock returns. They do so within an APT framework, using approximate factor models incorporating, initially, some 19 candidate factors which influence, to varying degrees, expected cash flows, discount rates, or both. These are subsequently reduced in number in smaller models embodying a core of significantly 'priced'

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[11] Logically, 'all assets' would include Human Capital (Mayers (1972)), which incorporates the education and skills base of the working population; along with physical capital, this represents a significant component of productivity and cash-generation potential. Through the concept of Net Present Value, this potential represents a valuable asset.

[12] Measured by the difference in yields to maturity of Aaa vs. Baa bonds.

determinants; the precise number of variables depending upon the prior methodology underlying the construction of their portfolios.

The critical role of the portfolio ordering methods chosen are discussed in detail, commencing with the need to effect a 'spread' of returns, while at the same time reducing the 'Errors-in-Variables' problem by 'grouping' individual stocks[13]. In both cases, this is done in the interests of providing an efficient parameter estimator; 'grouping' also provides a measure of diversification *within* each portfolio. CT(1994) utilise two distinct methods of forming portfolios, firstly sorting stocks according to their market betas; and in a second, separate exercise, sorting by firm size. Inevitably, the two 'competing' sort methodologies lead to differences in, but also to a degree of commonality between, outcomes.

Using beta sorted portfolios, a seven-factor model emerged; five of these factors, including two measures of default risk, inflation (measured by RPI), bank lending (to the private sector) and the Gilt-Equity Yield ratio were 'priced' positively and significantly at the 5% level. A (positive) significant intercept term provided some indication of mis-specification, however. With the size-sorted portfolios, only two of the above variables (RPI and Gilt / Equity Yield Ratio) survived into the final 'preferred' model, though the intercept term became insignificant. In a subsidiary series of tests, CT(1994) introduced 'excess return on the market' as an explanatory variable, in order to measure the effect, on each of the models, of the CAPM's single factor. In the 'beta-sorted' case, this was not significantly priced; however, in the size-sorted case, it did assume significance, thereby indicating that the reduction of the model to two variables had resulted in a loss of information, which required the inclusion of the 'market excess' parameter in order to re-instate.

CT(1994) conclude by highlighting the sensitivity of the results to the portfolio-ordering technique used, and suggest the use of non-linear estimation methods for future investigations involving the 'pricing' of factor risks.

2.1.3 Dividend Yield Relationships and Tax effects

Much of the theory base which underpins the determination of dividend policy stems from the early work of **Fisher (1930),** formalised by **Hirschliefer (1958).** Recommendations to managers stemming from these studies hold that their primary concern should be to maximise

[13] This problem arises because of the use of the 'two-step' (Time series / Cross-sectional) regression methodology of Fama MacBeth (1973).

the Net Present Value (NPV) available from the range of possible investment projects open to the firm. In this way, shareholder wealth is maximised, irrespective of individual shareholder preferences which relate to the *timing* of cash receipts. This arises since individual shareholder preferences may be accommodated (for any given stream of optimised NPV projects) by virtue of the individual's ability to borrow or lend in order to maximise the utility deriving from cash flows adjusted in this way.

From the standpoint of the firm, the method of financing investments, whether by equity (including retained earnings) or debt, should also be regarded as independent of the need to maximise NPV. Taken together, these considerations summarise the Fisher separation principle. An extension of this principle **(Modigliani and Miller, (1961)),** hereafter MM(1961), casts light additionally upon the considerations affecting the dividend payout policies of firms. Here, in addition to their ability to borrow or lend (in order to adjust cash flows to maximise utility), individuals may choose to re-invest dividends paid out by firms. Conversely, they may sell equity in order to (effectively) increase the current share of the firm's returns which are due to them[14].

Given the flexibility available to equity holders to regulate cash flows in the above manner, MM(1961) argue the illogicality of a capital market's attaching differential value to stocks on the basis of dividend policy alone. Again, in logic this extends to infinitely-lived Zero-Dividend firms, given only the existence of a viable secondary market to provide the necessary liquidity. However, simplifying assumptions which facilitate the visibility into the underlying logic may conspire, once they are relaxed, to dilute the emergent conclusions. Thus the relaxation of the assumption of frictionless markets with zero transactions costs focuses upon the (possible) non-equivalence of a cash dividend in the hands of an equity holder, versus the need to sell shares in a situation where fixed charges and/or bid-ask spreads may detract from the value of those instruments[15].

Similar considerations apply, on the other hand, to the case of firms incurring non-trivial legal and administrative costs in issuing shares to finance projects which might otherwise

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[14] This comparison reasonably postulates that a firm retaining reserves for investment, instead of paying out those same reserves by way of dividend, will in consequence maintain the value of its equity at a higher level (in a relative sense). This source of capital may potentially be harvested by shareholders who require a flow of cash equivalent to the 'missing' dividend.

[15] This effect is partially offset by the firm's administrative costs of distributing a dividend.

have been funded from retained reserves, had actual dividends *not* been paid. From the firm's perspective, financing via retained funds may well carry *lower* transaction costs.

Fama (1974) seeks to resolve these matters by examining, empirically, the interrelationships between firms' dividend and investment decisions, testing the data against the MM(1961) hypothesis of separability as between the two policies. Using a methodology which compares the results of a simultaneous equations estimation of dividend payout and investment (treating the two as being endogenously determined) - versus separate, single equation estimations, he finds no significant improvement in the explanatory power of the former over the latter; indeed, the converse is true. He concludes that the hypothesis of separability holds, and that *"there is a rather complete degree of independence between the dividend and investment decisions of firms"*.

Notwithstanding the above, it is likely that the *circumstances* of firms play a role in the determination of an appropriate (for the firm) dividend policy. Growing, finance-hungry firms embarking upon expansion programs requiring heavy investment may well tend to pay low or even Zero-Dividends. (Fama acknowledges this possibility in saying that: *"firms with high target ratios of capital stock to output may choose low target ratios of dividends to profits"*). In a later comment, he adds: *"perhaps there are upward shifts through time in target capital to output ratios as a consequence of increasingly capital-intensive technologies for the firms in the sample."* By contrast, mature companies with a high proportion of 'Cash cow' products in their sales portfolios, and possibly with a dearth of positive NPV projects in prospect, may tend to opt for higher dividend payout ratios[16]. Nevertheless, changing dividend payments, and in particular, dividend cuts, do engender significant market reactions in excess of what might be predicted from the logic as expounded above.

This is suggestive of a 'dividend signalling' effect[17], whereby managers set levels and, in particular, *changes* of dividends in order to convey information to markets. As in many walks of life, the avoidance of conveying negative information (or even the *impression* thereof), is at least as important as the conveyance of positive information (if and when available). As a result, according to the findings of **Lintner (1956)**[18], firms are reluctant to change dividend levels, in particular to reduce them or to increase them to levels unsustainable in the longer term. Accordingly, the norm is to set modest increases in dividends to levels which are

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[16] An alternative to dividend payments in these circumstances may be the repurchase of shares.

[17] See Ross (1977), Bhattacharya (1979).

[18] Lintner conducted interviews with financial managers of 28 firms.

undramatic, but which are expected to be maintainable into the future. Lintner's conclusions were broadly supported by **Fama and Babiak (1968),** in an analysis of over 200 firms during a 20-year span.

From the above discussion, it is clear that the effects of transactions costs, and their interplay with the particular circumstances of both individual shareholders and of firms, begin to motivate the hypothesis of an effect which is suggestive of a process of 'matching', in which particular investor cash flow timing preferences are reconciled to particular firms' dividend payout policies. Moreover, this effect is magnified when the 'absence of taxation' assumption is relaxed, and the question of differential taxation (as between dividends and capital gains) is taken into consideration. The process of hypothesis formation begins, however, with a rather simpler proposition. Ostensibly, High-Dividend paying stocks, whose Returns (in general) attract a higher level of taxation, should lead to a progressive reduction in demand from investors as the latter's marginal tax rates increase. Dependent on the mix of the aggregate investment community's tax situation, together with the differential tax treatment of the two forms of reward, it becomes feasible to conjecture that the equilibrium, market-clearing price of high dividend paying stocks may be depressed, relative to the stocks of otherwise 'identical' low yield firms. (i.e. those firms differing only in terms of having low dividend payout policies).

Brennan (1970) concludes that positive, non-zero values for (T), the *"market's effective tax rate"* will result in *"payment of dividends* [being] *detrimental to the interests of all investors"*. He argues, however, that market trading opportunities open to agents enable individual investors to choose stocks having dividend policies best suited to their circumstances; thereby obviating the need (on the part of corporations) to attempt to set policy in order to mediate potential *conflict of aims* between different investor groups.
Here then, is the notion of a 'matching' of firms' dividend policies to investor classes. This is perhaps best summarised by MM(1961, pp. 431) and quoted by **Black and Scholes (1974),** hereafter BS(1974), when they say:

> *"If, for example, the frequency distribution of corporate payout ratios happened to correspond exactly with the distribution of investor preferences for payout ratios, then the existence of these preferences would clearly lead ultimately to a situation where implications were different in no fundamental respect from the perfect market case. Each corporation would tend to attract to itself a 'clientele' consisting of those*

preferring its particular payout ratio, but one clientele would be entirely as good as another in terms of the valuation it would imply for the firm."

BS(1974) themselves outline the hypothetical ways in which, effectively, 'sub markets' may develop at each level of dividend yield, in which firms adjust dividend policy if they perceive a 'niche' to be open due to a shortage of supply of stock delivering a level of yield desired by a particular group of investors; they term this effect the "supply effect":

> *"If corporations are generally aware of the demands of some investors for high dividend yields, and the demand of other investors for low dividend yields, then they will adjust their dividend policies to supply the levels of yield that are most in demand at any particular time. As a result, the supply of shares at each level of yield will come to match the demand for shares at that level of yield, and investors as a group will be happy with the available range of yields. After equilibrium is reached, no corporation will be able to affect its share price by changing its dividend policy"*

Notwithstanding the 'clientele' effect as described above, BS(1974) point out an apparent imbalance between *"the number of companies with generous dividend policies"* and *"the number of investors who have logical reasons for preferring dividends to capital gains"*. Following up empirical evidence, they proceed to show that the coefficient associated with any possible dividend effect is *"statistically indistinguishable from zero"*.[19] Furthermore, they claim that, since portfolios specifically constructed from extremes of the yield spectrum are not mutually perfectly correlated, investors concentrating on specific portfolio types would suffer, as a result, from a lack of diversification. This disadvantage, they claim, more than offsets any advantage to be gained from tilting the portfolio (e.g. for reasons of tax), given the low (and insignificant) value of their dividend yield coefficient.

Elton and Gruber (1970), hereafter EG(1970), examine the MM(1961) 'clientele effect' from the perspective of determining marginal stockholder tax brackets, on the basis of the cost of retained earnings being determined by the *"rate which makes a firm's marginal stockholders indifferent between earnings being retained or paid out in the form of dividends"*. The point on the continuum at which the indifference occurs, given the

[19] BS(1974) claim that 'usual' regression methods produce misleading results, due to correlation between β (market risk coefficient) and δ (excess dividend yield coefficient). Their innovative methodology, claimed to "avoid many of the difficulties of cross-sectional regression" minimises the variance of portfolios constructed to have expected returns equal to the parameters of interest. However, Litzenberger and Ramaswamy (1979) claim, by contrast, that since one of the assumptions of the method holds the 'residual' risks of all securities to be equal ($s_{ii} = s^2$ for all i.), this estimator "reduces to OLS on the untransformed variables".

differential taxation of dividends and capital gains, is a function of the marginal stockholder tax bracket; knowledge of which is therefore a key determinant in formulating the firm's dividend policy. The methodology employed by EG(1970) examines the ex-dividend price movements engendered by the decision-making process (and ensuing trading activity) of those marginal stockholders.

EG(1970) find, on measuring the cum-dividend vs. ex-dividend prices of stocks relative to the dividend paid, that the implied tax bracket relating to the full sample chosen (daily data, 4/66 - 3/67) fell within credible bounds. Their result was close to comparable findings reported by others **(Jolivet (1966), Weston and Brigham (1966)).** When the full sample was ordered by dividend yield, a clear relationship emerged between the yield deciles and the corresponding implied tax brackets, thus lending support to the MM 'clientele' hypothesis.

Miller and Scholes (1978) (hereafter MS(1978)) question the logic of corporations failing to re-invest earnings, choosing instead to use after (corporation) tax earnings to fund dividend payments; these in turn creating a personal tax liability for their investors. In their introduction, they argue in favour of firms (with limited investment opportunities) either to invest in the shares of growing companies, or to engage in the re-purchase of their own stock.

Their paper proceeds with expressions of doubt that the 'clientele' effect (see above) fully mitigates the potential disadvantages (to investors) of receiving returns with a significant component of dividends, and queries *"the failure of the presumed large tax disadvantage of dividends to leave a more easily detected track in the prices or returns of shares"* (pp.334, note 3).

They conclude that provisions in the U.S. tax code allow strategies such as leverage and insurance to be successful in limiting or eliminating the tax penalty on dividends. Leverage works because the individual investor is permitted to claim tax relief on the interest on borrowings used to fund risky investments, up to the point where the interest on the loan just equals the income from the investment. Insurance functions by virtue of the fact that interest flows earned on insurance investments are relieved of tax. It is claimed that the ability deriving from these provisions enables investors to effectively convert income to capital gains, and thus relieves much of the pressure which might otherwise be placed on firms to revise their dividend policies.

The 'clientele' hypothesis is, however, supported by Litzenberger and Ramaswamy (1979), hereafter LR(1979); however, unlike BS(1974), they find in favour of a significant positive dividend yield coefficient. The value of their coefficient, however, is close to that of BS, the difference being in terms of the precision of the estimate. LR(1979) claim a superior methodology based upon a number of factors. They develop an after-tax version of the Capital Asset Pricing Model which accounts for both a progressive (rather than proportional) tax schedule, and place both wealth and income constraints upon investor borrowing.[20] Their approach to estimation builds upon the portfolio-construction methodology of BS(1974), but their estimator is based upon a Generalised Least Squares / Maximum Likelihood approach, for which they claim, justifiably, a lower variance. In contrast to BS, they address the 'errors in variables' problem associated with estimating (β) not by grouping[21], but by using the sample estimate of the variance of observed betas to arrive at maximum likelihood estimates of the coefficients.

A question remains as to the nature of the LR(1979) support for the 'clientele' effect. Whereas BS(1972) invoke this hypothesis to explain the lack of a decisive role for dividend yield, LR(1979) argue that *"If income related constraints are non-binding[22] and/or corporate supply adjustments are restricted[23], the before tax return on a security would be an increasing linear function of its dividend yield".* They find, empirically, that the (effective) coefficient of excess dividend yield is a positive value, but one which is declining with increasing yield; indicative of an increasing, but *nonlinear* function of yield[24]. The 'clientele' effect is present, but fails to completely suppress the yield coefficient for the reasons suggested by the quotation.

Litzenberger and Ramaswamy (1980) extends the work of the LR(1979) paper to focus specifically upon the tax-induced 'clientele' effect, extending the earlier work to include restrictions on short sales and to include a more complete treatment of marginal tax rates. Their results confirm the LR(1979) result stated earlier, cited in the LR(1980) paper as

[20] They impose a constraint upon the investors' ability to borrow in excess of their dividend income, and also impose a margin constraint based upon individual investor's wealth. This second constraint limits the fraction of security holdings that may be financed through borrowing.

[21] Nor by the use of instrumental variables, as in Rosenberg and Marathe (1978)

[22] The authors suggest the possibility that "the income constraint may be binding for no one, even when dividends are zero".

[23] Assumed by the action of regulatory authorities placing restrictions on firms' dividend policy.

[24] This would suggest that the implied tax rate is declining with increasing yield.

having been a preliminary result. However Hess (1980), in an ensuing discussion at the end of the paper, presents a critique of the LR(1980) methodology, claiming that the prior estimation of (β) over the previous 60-month period fails to take account of the fact that both (β) and (γ) - the coefficient of excess dividend yield - are parameters in the joint distribution of security returns, and should be estimated accordingly, rather than separately.

Blume (1980) begins by citing a survey of individual investors (**Blume and Friend (1978)**) which indicated strong preferences for dividend payments; these preferences were expressed in terms of the investors' likely future investment actions should dividend payout changes be implemented by firms. These actions (increasing (decreasing) holdings following increased (decreased) dividends), runs counter to the usual tax-based hypotheses relating to dividend payout. However, in the main body of the paper, Blume finds evidence of a positive relation between dividend yield and return, albeit one which is dependent on the period chosen. Importantly, however, he finds (in common with other studies) an interaction between dividend yield and beta, which he expresses as follows:-

"In the overall period, the average [cross-sectional regression] coefficient on beta is insignificant in the regressions in which it is the only variable, but significant in the regressions in which dividend yield is included."

In investigating the influence of Zero-Dividend stock returns, Blume (1980) finds that the effect of distinguishing this class of stocks (using a dummy variable approach) increases the significance of the dividend yield coefficients. The significance of the beta coefficient was, in contrast rendered slightly lower, thereby suggesting that *"beta may be in part a surrogate for the dummy variable"* (pp.572, note 14). The nature of this relationship is more fully developed in his empirical analysis, where he determines that there exists a tendency for higher (lower)- yielding stocks to have lesser (greater) subsequent betas[25].

Blume also highlights the non-linear nature of the relationship between Dividend Yield and Returns, with the returns on Zero-Dividend stocks being higher than all but the highest dividend-paying stocks. This alludes to the effect which later became known as the 'U - shaped' yield relationship. His further empirical analysis (examining an after-tax CAPM) concludes that the results are *"clearly inconsistent with a tax effect, but are consistent with the hypothesis that market participants often underestimated over this period* [1935-76] *the*

[25] Time-varying betas subsequent to the original estimation period.

subsequent growth of dividends for high-yielding stocks relative to low-yielding stocks". His note (21) reflects this conclusion as being at odds with LR(1979), but suggests that they fail to account for the non-linearity associated with Zero-Dividend stocks.

Having rejected the tax hypothesis, Blume concludes that the most plausible reason for the monotonic relationship linking risk-adjusted returns (on dividend-paying stocks) and anticipated dividend yields is the failure of the market to anticipate the greater relative growth of high-yielding stocks compared to low-yielding stocks. He argues against regarding this as the market acting in an irrational manner, since this does not imply that the market fails to act upon currently-known information.

Shiller (1981) poses the question in the title of his *paper "Do stock prices move too much to be justified by subsequent changes in dividends?"*. Here, he relates the actual sequence of movements of the S&P500 and NYSE indices to the sequence which would have been generated by a Net Present Value model using knowledge of the actual turnout of dividends up to the present time.

The primary value of this paper is that it demonstrates forcefully the large discrepancy between the volatility actually observed in terms of stock index movements, relative to that which is determined using a 'perfect foresight' NPV model. Shiller admits to being unable to explain this phenomenon either in terms of any reasonable prediction of the volatility of dividend streams, or of real discount rates, and therefore casts doubt, by implication, upon the Efficient Markets Hypothesis.

Shiller presents a useful proof (pp. 430, note 15) of the (theoretical) non-dependence of price (P_0) upon payout ratio (s), based on a continuous-time representation of the Net Present Value formula. This is valid for finite (non-zero) values of (s), and is applicable, in the limit, for Zero-Dividend stocks (s=0); in the latter case, the rate of growth would be (by assumption) equal to the discount rate.

Miller and Scholes (1982), hereafter MS(1982), examine the relationship between Returns and dividend yields in the context of taxation effects; they focus, however, upon short-term measures of dividend yield and show that the latter are inappropriate for deducing tax effects. They find that (apparently significant) yield effects are due to biases introduced by particular methodologies, and justify their assertion by stating (pp. 1119):-

"The cum-ex price differentials that maintain market equilibrium and keep such profit opportunities from arising obliterate the traces of the long-run tax differential that the tests with short-run yield definitions seek to measure."

The methodological issues noted by MS(1982) centre around the measures of market expectation of dividend yield used by candidate valuation models. In this context, the paper cites areas of difficulty such as the treatment of ex- and non-ex dividend months,[26] and the cross-influence, on returns, of unexpected changes in dividend payout.[27]

However, it should be noted that they utilise a variation of the 'two-step' Fama - MacBeth (1973) methodology, which is subject to the critique of Hess (1980). Hess points out that the initial estimates of covariance risk (beta) are carried out in the absence of a dividend yield regressor term;[28] whereas in the subsequent cross-sectional regression, dividend yield (which is potentially correlated with beta) is included jointly with the risk measure.

Rozeff (1982) examines the determinants of dividend payout ratio, proposing a model which considers both agency costs,[29] (which decrease with increasing payout ratio) and transactions costs, which increase with increasing payout ratio, since High-Dividend firms need to secure *ceteris paribus* relatively more equity finance from the market.

Rozeff postulates that the aggregate of the two costs will have a turning point (minimum) at some intermediate level of payout ratio, and that this level will depend upon the characteristics of the particular firm. Firms with growth opportunities, and consequently greater funding requirements, will have high transactions costs at high payout ratios. This will tend to move the optimum point to a lower level of payout ratio. The converse is true of firms with the higher agency costs, where the turning point is established at a higher level of payout ratio.

Rozeff (1982) also establishes a link between dividend payout ratio and risk. Firms with volatile cash flow patterns are more likely to require external financing from time to time. In

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[26] In the context of the normal (for U.S. stocks) quarterly dividend payment cycle.

[27] This, in essence, is a 'dividend signalling' effect.

[28] 'Missing variable' bias is therefore likely if the missing variable is correlated with the variable of interest.

[29] These relate largely to the cost (to shareholders) of gaining information about the firm; information is more freely available from higher dividend paying firms who subsequently go to the market for equity finance, and, in consequence, put more information into the public domain.

order to mitigate this, they are likely to establish a pattern of lower dividend payout ratios. Such firms, however, are almost certain to exhibit higher betas. These considerations would conspire to establish a correlation, as noted earlier, between dividend yield and beta.

Rozeff (1982) completes his paper with an empirical study of the relationship between dividend payout ratio (as dependent variable) and measures of transactions costs (two growth metrics and beta, as measures of likely funding requirements); and of agency costs (number of common stockholders and percentage of common stock held by 'insiders')[30]. Some 48% of the variance of the dependent variable is 'explained', and all of the selected regressors are highly significant, with negative coefficients associated with the transactions costs measures, and coefficients associated with the agency costs variables which have the expected sign as measures of the diversity of holdings.

The paper concludes by a recognition of the fact that dividend payout ratio variability is motivated by the twin market imperfections of transactions and agency costs, which are sufficient to give rise to the departure from the (idealised) indifference model of Modigliani and Miller (1961).

Litzenberger and Ramaswamy (1982), hereafter LR(1982), extend their earlier (1979,1980) papers by considering whether dividend effects (on Returns) may be explained by information effects, as well as, or instead of, (possible) tax influences. They find that information effects cannot explain the yield effects, but that the possibility remains of a tax-based explanation; they do not exclude the possibility that other (omitted) variables may hold the key to the dividend effects noted.

The methodology employed in order to isolate possible information effects is to run a comparison between two procedures used to estimate dividend yield. The first of these, and the one used in their earlier studies, assumes some prior knowledge on the part of the investor in relation to ex-dividend months. The second method uses, in turn, two alternative procedures for purging this effect. With reference to these, and quoting LR(1982) pp. 435/6:

"The first is to construct an expected dividend yield variable based on information the investor has prior to the test month, and the second is to use a sample of stocks known not to incorporate unavailable information for the cross-sectional regressions".

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[30] These purport to be measures of the diversity of stockholding, and closely related to Agency cost.

Several estimations are run, based upon a stratification of the data on the basis of dividend yield. From a starting point which treats the strata, or groups, as separate populations, restrictions are applied, firstly in terms of imposing a common coefficient on beta[31], subsequently by imposing a single coefficient on dividend yield across the sample. In a later test, a dummy variable is used to identify Zero-Dividend stocks as a separate sub-population (separate, that is, from stocks which are merely *low* dividend paying). Whilst the dummy variable coefficient itself is insignificant, the low-dividend group's dividend yield coefficient is increased both in magnitude and significance.

Prior to the imposition of a common coefficient for beta, the individual group coefficients exhibit a minimum value at intermediate values of dividend yield, with higher values obtaining at the high- and low-yield extremes[32]. The dividend-yield coefficients decrease monotonically with increasing yield, as would be predicted under the 'clientele' hypothesis[33]. The imposition of a global 'price of risk' has little effect on the yield coefficients of all except the lowest-yielding group. That group's dividend yield coefficient, however, drops markedly from being the highest to being the lowest value of all of the groups; this remains the case with the inclusion of the Zero-Dividend dummy variable, albeit with the increased coefficient highlighted above.

The paper is completed by a close replication of the Black and Scholes (1974) methodology providing a near- direct comparison to the results described above (quote, pp. 442):

"The coefficient of dividend yield is insignificant, implying that the Black - Scholes procedure as replicated here is not sufficiently powerful to pick up potential information effects."

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[31] This coefficient is sometimes referred to, especially in literature later than 1982, as the 'price' of (covariance) risk. It is most meaningful as such, therefore, when it can be applied as a unique value across the entire sample.

[32] There is a tendency for the larger firms to populate, disproportionately, the 'middle' yield groups; however, in 1982, the evidence for a 'size effect' was only just beginning to emerge (Banz, 1981).

[33] High (Low) 'excess' dividend yields (d_i - r_f) will normally call for higher (lower) pre-tax excess returns; however, the effect is offset by a lower (higher) coefficient, which is a function of the lower (higher) marginal tax rate of the clientele who favour high (low) yielding stocks.

LR(1982) conclude that the evidence supports the Tax-Clientele CAPM, and highlights the positive (but non-linear) association between stock returns and dividend yields; however, there exists little evidence that information effects have a role to play.

Elton, Gruber and Rentzler (1983), hereafter EGR(1983), conduct an empirical examination of deviations from the zero-beta form of the CAPM, and the extent to which dividend yields are capable of explaining such deviations. Their methodology hinges upon the calculation of excess returns on 20 portfolios formed from individual (β)- ranked securities; portfolio betas calculated for the preceding (5-year) period being used as estimates for the following one year in a cross-sectional regression of returns against the beta estimate. The resulting residuals, viewed as deviations from the empirical regression line, become the regressands in a second-stage procedure in which dividend yield, and subsequently a Zero-Dividend dummy variable, were set as explanatory variables. In this instance, EGR(1983) argued specifically in favour of treating the estimation of beta and that of dividend yield in separate regressions, on the basis that the ensuing bias was *against* finding a dividend yield effect. The fact that such an influence persisted, despite this direction of bias, lent support to the conclusion that the hypothesis (of a yield effect) was not rejected. EGR(1983) comment as follows:

> *"If betas are correlated with dividend yields, then our two step procedure would have a bias toward finding no dividend effect even when one was present".* They continue - *"there is considerable disagreement* [in the literature] *on the reasonableness of the procedures used for the joint estimation of dividend and beta effects".*

In relation to the effect of Zero-Dividend stocks within the analysis, EGR(1983) place great stress on the need to treat these securities, through the medium of the dummy variable, as a separate sub-population. The associated coefficient is positive and highly significant, even when low-priced stocks[34] (<$5) are eliminated from the sample. The linkage is also drawn, in the paper, with the small firms effect, which is examined as a factor in its own right elsewhere in this thesis.

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[34] Low priced stocks suffer from poor demand, for reasons including non-approval for margin requirement collateral, high relative transactions costs and perceived (non-covariance) risk. Their expected returns are, in consequence, elevated.

Shefrin and Statman (1984) examine the phenomenon of dividend-preference from a behavioural standpoint. It is suggested from anecdotal evidence[35] that individuals, unaware of the technicalities of motivating the substitutability of capital gains for dividends, react adversely to changes in dividend payment patterns. The reasons for this form of behaviour are analysed in terms of shareholder "self-control" over the matter of separating current consumption from the need to save for the future. Thus shareholders invoke a form of "rationality" which does not conform to the usual models of utility maximisation through the maximisation of expected wealth.

Keim (1985) finds a significant dividend yield effect, but finds it to be one which is highly seasonal in nature, with most of the effect confined to the month of January. Controlling for the firm size effect, the regression coefficients for Dividend Yield (including the seasonal effect noted above) are substantially reduced, but remain significant. The extent of the effects, coupled with their seasonal characteristics, causes Keim to reject a tax-based explanation.

Keim points out the contrast between the results obtained above, and those obtained by the use of methodologies (e.g. Litzenberger and Ramaswamy (1979) which employ alternative (short term) measures of Dividend Yield. (Miller and Scholes (1982) counsel against the use of short-term measures of dividend yield, as outlined above). Keim, in later versions of the paper, reverts to the long term yield measure[36].

Fama and French (1988) examine the question of whether autocorrelation in stock returns over longer horizons (3-5 years), and the attendant variation in (time varying) expected returns, implies a significant degree of predictability associated with these (low frequency) components[37]. Dividend yields are used to forecast Returns on NYSE stocks for return horizons (holding periods) from one month to four years, on the basis that dividend yield varies with expected returns. FF(1988) argue that, due to positive autocorrelation, the variation of expected returns becomes a larger fraction of the total variation of returns as the returns horizon increases.

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[35] Examples are presented of instances of firms attempting to alter patterns of dividend payments, and the resulting shareholder adverse reactions, which (it is implicitly suggested) are not untypical.

[36] It is this long-term measure which is used in the empirical work detailed in Chapter 4.

[37] Fama and French (1987) present evidence that time-varying expected returns explain 25-40% of 3-5 year return variances.

Using value- and equal- weighted portfolios to represent, preferentially, large and small firms respectively, FF(1998) measure continuously-compounded returns over selected horizons, over the period 1927-1986. These are then regressed on to dividend yield. In spite of the fact that changes in dividend policy may conspire to produce a variation in yield which partially obscures the relationship implicit in the regression (potentially reducing its efficiency), FF(1998) conclude that dividend yield remains a significant explanator of expected returns, increasingly so as return horizon increases. They conclude thus:-

"The persistence (high positive autocorrelation) of expected returns causes the variance of expected returns, measured by the fitted values in the regressions of returns on dividend yields, to grow more than in proportion to the return horizon. On the other hand, the growth of the variance of the regression residuals is attenuated by a discount-rate effect: shocks to expected returns are associated with opposite shocks to current prices. The cumulative price effect of an expected return shock and the associated price shock is roughly zero. On average, the expected future price increases implied by higher expected returns are just offset by the immediate decline in the current price. Thus the time variation of expected returns gives rise to mean-reverting or temporary components of prices".

Levis (1989), provides a perspective on the UK Stock Market, using data from the London Share Price Database (LSPD)[38] in order to draw comparisons with the results determined from US data; such a comparison is potentially capable of isolating any effects which may be (US) market specific. He finds that the size effect ceases to be dominant, and that Dividend Yield, Price to Earnings Ratio and Price itself have a role to play in 'explaining' abnormal returns. Using beta estimation techniques which appear to be those of Fama and MacBeth (1973)[39], and also invoking the **Dimson (1979)** aggregated beta coefficients approach, he finds that, notwithstanding the evidential interdependence of the listed effects, it is the Dividend Yield effect which dominates.

Rao, Aggarwal and Hiraki (1992) confirm a similar picture for the Tokyo Stock Exchange, with a significant Dividend Yield effect, but one which possesses a marked seasonal interaction, in that the effect is noted only for the four months of January, March, June and December, with the effect being most apparent in January. This conclusion holds even when

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[38] This database is (later) utilised by this author (see Chapter 3).

[39] Though not specifically acknowledged as such (Levis pp. 680).

controlling for the firm size effect, and is claimed to be inconsistent with a tax-based explanation. In drawing comparison with broadly similar 'anomalies' in the context of the US market, they suggest a linkage due either to the operation of global capital markets (i.e. international arbitrage), or to the omission of common elements in the pricing process (or a combination of both).

Christie (1990) examines the linkage between dividend yield and expected returns, but with particular emphasis on what he terms " the Zero-Dividend Puzzle". This is a reference to the non-linear "U-shaped"[40] characteristic whereby the otherwise monotonic yield / return relationship is breached by the higher expected returns generated by the Zero-Dividend stock population[41]. Christie (1990) makes reference to the Brennan (1970) after-tax CAPM, and the influence of augmenting that model with the Zero-Dividend dummy variable[42] discussed earlier in this section (see also references to Blume (1980), LR(1979) and EGR(1983)).

Christie's (1990) methodology is innovative in that it determines Zero-Dividend status by way of a firm's announcements[43], rather than by scanning its payment history (other than that from initial listing to first dividend payment). The advantage ascribed to this approach is that the (Zero-Dividend) status is attributed *earlier* to firms ceasing payment, compared to the alternative approach whereby, following cessation of dividend payments, a rolling annual total of those payments eventually subsides to zero. Newly-listed stocks, many of which are Zero-Dividend payers, are immediately included in the test samples, since they do not require a (minimum) 12-month qualification period[44]. This in turn means that a higher proportion of the group of primary interest in this study (i.e. Zero-Dividend stocks) appear in the samples, relative to studies which employ the alternative methodology.

Christie's (1990) other major innovation is the way in which he calculates excess returns; instead of using a model-based approach (e.g. CAPM), he defines excess returns as the difference between the realised return and the mean return of all firms of similar size but

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[40] The 'U-shaped' relationship is referred to by Blume (1980) and Keim (1985).

[41] Christie (1990) points out that Zero-Dividend stocks earn "equilibrium returns exceeding all but the highest-yielding corporations".

[42] Not only is the coefficient of the dummy variable significant, but the coefficient of the dividend yield term is increased both in magnitude and significance.

[43] Announcements, that is, of dividend initiation, omission and resumption of payments.

[44] In most studies, the qualification period is longer, e.g. Keim (1985) - 60 months.

dissimilar dividend yield. This form of expectations-generating model, he points out, serves to control for the 'size effect'.

The paper finds that, with the exception of the month of January, the excess returns performance of Zero-Dividend firms is inferior to that of dividend-paying firms of similar size[45]. This contrasts with the findings of **Keim (1983a)**. Approximately two thirds of the discrepancy between the two findings is reconciled by restricting the sample period in such a way as to exclude the years prior to and during the 2nd world war (1931-45), and to add the 'update' years 1979-85. The remaining one third is due to the methodological differences, in particular the elimination of the qualifying period. The effect of changing to the size-based model is to add just under 0.1% to the mean excess return over the period 1931-78 *ceteris paribus*. Christie (1990) holds that the period (1931-45) includes extreme positive 'recovery' returns, some as high as 500-700 %, in the wake of the Great Depression. Much of this effect was associated with low-priced shares; however, the effect did not persist into the post-war period.

The effect of the period and methodological changes introduced by Christie (1990) neutralises the 'U-shaped' characteristic for non-January months, restoring the monotonic relationship (subject to the seasonal qualification, above) between Returns and dividend yield for all except the highest-yielding portfolio. (The excess return of the latter is some 0.11% less than that of the second highest-yielding portfolio). The implication of this is that the tax-based hypothesis is once again motivated; however, this is rejected on the basis that the implied marginal tax rates exceed those which would lend support to the hypothesis.

In the light of the above, and giving regard to the intertemporal pattern of Zero-Dividend excess returns, Christie opts for a dividend-expectations explanation of excess returns. Here, the market bids up the prices of those recently-listed firms which it expects may initiate dividends in the near future: *"Market participants may view these newcomers with a heightened expectation of a forthcoming cash dividend program."* (pp. 118).

Christie and Huang (1994) once again examine the Dividend Yield effect as it relates to the question of differential taxation, but do widen the discussion to include any potentially exploitable systematic relation between dividend yields and expected returns. Using a non-parametric kernel estimation technique to allow for the possibility of nonlinear relationships

[45] January returns of Zero-Dividend stocks outperform dividend-paying stocks across all size deciles.

among the variables[46], they find scarce evidence in favour of a tax-based hypothesis; often, the anticipated yield effects which might be driven by changing taxation regimes contrast with those actually measured. They further find that the lack of consistency in yield-return patterns "*lend support to no particular hypothesis*".

Naranjo, Nimalendran and Ryngaert (1998), henceforth NNR(1998), claiming an improved methodology for measuring annualised dividend yield[47], find a positive relationship between risk-adjusted returns and dividend yield. The effect is said to be too large to be explained by taxation effects, and is "*primarily driven by smaller market capitalisation stocks and zero yield stocks*". The consistent positive relation is robust to model specifications which utilise **Fama and French (1996)** factors.

NNR(1998) find that their Zero-Dividend portfolio has a higher mean return than the four lowest (out of ten) positive-yield portfolios, and that the standard deviation of Returns declines monotonically with increasing yield, suggesting that "*higher yield stocks might be less risky*". They also document that, with the exception of the highest yield portfolio, "*firm size is for the most part increasing with yield*", indicating that larger, more mature firms are the ones paying non-trivial dividends.

Reference is made in NNR(1998) to the Miller and Scholes (1982) argument that dividend yield may proxy for risk, with (say) the 'riskier' (of two firms) trading at a lower price (*ceteris paribus*, in relation to cash flows) and, in consequence, having the higher yield. In this context, they quote the **Chen, Grundy and Stambaugh (1990)** finding that while a yield effect obtains when solely controlling for covariance risk, the yield effect becomes insignificant upon implementing a default risk factor into their analysis. Using nonlinear SUR[48] estimation techniques operating on APT-based models with a variety of imposed restrictions, they nevertheless do find the positive yield relationship described earlier.

[46] This technique is designed to avoid "mere correlations of the variables with residuals induced by the misrepresentation of functional form" providing indications of apparent economic relationships.

[47] The methodology utilises the firms' most recent regular dividend payment and last share price to infer anticipated, long-run dividend yield, which is claimed to provide a "less stale measure" of yield. However, the study is necessarily "[restricted] to firms with an established track record of quarterly dividend payments".

[48] This acronym relates to the Seemingly Unrelated Regression approach of Zellner (1962).

2.1.4 The effects of Market Size

There is a large body of literature which covers the 'Size Effect' in great detail, though by the very nature of the phenomenon, the coverage is frequently in the form of a joint survey with other factors, most notably those of seasonality. (**Keim (1983b), Reinganum (1983), Kato and Schallheim (1985)** and **Lamoureux and Sanger (1989)** are examples); and Price / Earnings effects (e.g. Reinganum (1981) and **Cook and Rozeff (1984)**). These contributions, with the exception of Reinganum (1981), are covered in sections 2.1.5 and 2.1.6 respectively. The following section examines papers whose prime thrust is that of the Size Effect itself.

Banz (1981) is credited with having made a seminal contribution to the literature in terms of his examination of the relationship between firm size and risk-adjusted excess returns - the 'size effect'. The paper does not attempt to develop a theoretical equilibrium model, but instead develops an empirical approach aimed at isolating the effect. The question therefore remains open as to whether *"market value per se matters or whether it is only a proxy for unknown true additional factors correlated with market value."* (pp. 4).

Banz (1981) proposes an extension to the Black (1972) zero-beta CAPM incorporating a term which may be described as the proportionate excess size of the firm (relative to average market value). He opts not to utilise the LR(1979) methodology[49], on the grounds of the latter's susceptibility to bias when multiple factors (here, the addition of the 'size' variable) are involved. Portfolio formation follows BS(1974), but with the use of three market indices in the regressions, in response to Roll's (1977) critique of empirical tests of the CAPM.

The 'size effect' is noted in terms of significant negative values for the coefficient of the excess size variable, and Banz (1981) concludes that the CAPM is mis-specified, with small firms having larger risk-adjusted Returns, compared to those of large firms. The effect is not linear, however, even using the logarithm of the excess size variable; and is most pronounced for the smallest firms in the sample. Neither is it stable with time, with large differences in the coefficients for different (10-year) sub-sample periods. However, the persistence and longevity of the size effect suggests that *"it is not likely that it is due to a market inefficiency but it is rather evidence of a pricing model misspecification"* (pp. 17).
In seeking possible explanations for the effect, Banz (1981) offers the **Klein and Bawa (1977)** model based upon information effects. This suggests that the investor community

[49] i.e. using the standard errors of the security betas as estimates of the measurement errors, in a correction for the 'errors in variables' problem.

limits its demand for stocks for which only limited information is available, due to 'estimation risk'[50] - this state of affairs is more likely to obtain with smaller stocks.

Banz (1981), closes with the suggestion that *"further research should consider the relationship between size and other factors such as the dividend yield effect."*

Reinganum (1981) also examines 'anomalies' related to size, though his paper concentrates initially on earnings' yields. He finds that risk-adjusted Returns are greater for high earnings' yield stocks relative to low earnings' yield stocks; and that the same is true for small firms relative to large firms. In determining whether these effects are separate or related (i.e. a single effect for which one of (E/P) or size is a proxy for the other[51]), he finds that, controlling for (E/P), a strong size effect remains; the opposite, however, was not the case.

He therefore concludes that the size effect is the dominant one, and subsumes the earnings' yield effect. He proceeds by saying: *"the two anomalies seem to be related to the same set of missing factors, and these factors seem to be more closely associated with firm size than E/P ratios.........at least for portfolios based on firm size or E/P ratios, the simple one-period capital asset pricing model is an inadequate empirical representation of capital market equilibrium."* In reaching the above conclusion, he asserts consistency with the proposition of **Ball (1978)**, that the alternative hypothesis, that of capital market informational inefficiency, is not supported[52].

Brown, Kleidon and Marsh (1983) find that the size effect is linear in the logarithm of size itself, but find temporal instability in its coefficients. Using Kalman filter techniques, they investigate the stationarity of the excess returns. Using the sample of firms investigated by Reinganum (1981), they find that risk-adjusted excess returns do not always conform to the pattern whereby those of smaller firms exceed those of larger firms. During the period 1969-74, for example[53], larger firms exhibited higher excess returns than smaller firms.

Stoll and Whaley (1983) find at least a partial explanation for the 'size effect' in terms of the disproportionate impact of transactions costs on the trading of small firm stocks. Market

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[50] Defined as "uncertainty about the true parameters of the return distribution".

[51] Or for some other determinant of equilibrium omitted from the two-parameter model.

[52] Reinganum's evidence for this conjecture is the persistence of 'abnormal' returns.

[53] The effect described was relatively stable over this period.

makers' proportionate spread applied to this class of security is greater by virtue of infrequent trading in small stocks (so that inventory costs require to be amortised over a fewer number of trades), and the higher risk associated with small stocks. Brokers' commission rates are an inverse function of the price per share, which in turn is found to be correlated with market value.

Before reaching its conclusion, the paper looks at whether downward-biased risk estimates for infrequently traded stocks are sufficient in themselves to give rise to the size effect (after **Roll (1981)**). Applying the Dimson (1979) aggregate coefficients correction to account for this bias, they find that the magnitude of the post-correction difference in results is too small to be of consequence in this regard.

Since transactions costs impact upon net effective period returns in a way which is dependent upon the number of periods for which stocks are held, Stoll and Whaley (1983) examine the issue in terms of Investment Horizon. They conclude that, for investment horizons within the range of three months to one year, abnormal returns (net of transactions costs) are not significantly different from zero - *"Thus, the data are consistent with the CAPM applied to after-transaction-cost returns defined over these longer investment horizons".* (pp. 78).

Chan, Chen and Hsieh (1985) investigate the size effect within an Arbitrage Pricing Theory framework, and find that the variable most influential in the analysis is the changing risk premium, defined as the return difference between low-grade bonds and long-term government bonds. This variable is postulated to capture the effects of changing business conditions, as evidenced by the fact that it is also correlated with net business formations, the latter serving as an indicator of the phase of the business cycle. The qualitative significance of this linkage is viewed in terms of a risk factor associated with small firms, whose fortunes tend to fluctuate in a more extreme fashion (compared to those of larger firms) as the business cycle plays out. As such, the small firms premium reflects the additional risk borne, in an efficient market, by holders of the stock of small firms.

2.1.5 Seasonality influences

There now exists a substantial body of literature associated with the study of seasonality in stock market prices, stemming largely from the 1970's. Given the fact that the empirical studies featured in Chapters 4 - 6 are based upon monthly data, the primary focus here is that of monthly Seasonality, as opposed to 'day of the week' effects. Although **Officer (1975)** had carried out some investigation in the context of the Australian stock market, it is **Rozeff and Kinney (1976)** who are generally credited with the earliest substantive discovery of significant effects. Using equally weighted[54] NYSE data, they determined that a large proportion of annual returns was earned in the month of January.

Gultekin and Gultekin (1983), in studying international aggregate data using non-parametric methods, conclude the existence of significant turn-of-tax-year effects in most of the major industrialised countries. Indeed, for some countries, these effects were more marked than in the U.S. market. However, they reject the conclusion (in the context of the international evidence) that the phenomenon is a size-related anomaly.

Reinganum (1983) presents strong evidence in support of the tax-loss selling hypothesis, evidenced by the exceptional Returns performance, in the first few days of trading, of small firms whose stock had declined over the preceding six months. However, this represented only a partial explanation, since other small firms outside this category ('prior year 'winners') demonstrated exceptional returns over the month as a whole, and secondly, volume within the category was small. Keim (1983b) pointed out, however, that the tax-loss effect, if true, should have been reconcilable with changing personal income tax rates as these changed over time (the actual changes were, in fact, in the opposite sense).

The main conclusions of Keim (1983b) centre around the fact of the daily abnormal returns distributions having large means relative to other months, and secondly, that the relation between abnormal returns and firm size is not only always negative, but is more pronounced in the month of January than in any other month. He goes on to assert that "*nearly fifty percent of the 'size effect' over the period 1963-1979 is due to January abnormal returns*", and finally, that more than half of the January premium is attributable to large abnormal returns during the first week of trading, this being especially related to the first trading day.

Brown, Keim, Kleidon and Marsh (1983) again examine the 'tax-loss selling' hypothesis proffered to explain the seasonal 'January Effect', concluding that "*U.S. tax laws do not unambiguously predict such an effect*", and that "*the January seasonal may be more correlation than causation*". They also find that evidence from Australia does not support the tax-loss selling hypothesis, since the empirical seasonal effect occurs one month later than that which would be predicted, given the timing of the tax year-end. In regard to the size

[54] The significance of the use of the equally weighted index is that, relative to a market-weighted index, the returns of smaller companies assume a greater contribution.

effect as measured by the premium for small firms, the variation, across months of the year, of the Australian returns delivers a degree of constancy which contrasts with the U.S. picture.

Tinic and West (1984), in common with Rozeff and Kinney (see above), return to the perspective of viewing the phenomenon from the point of view of the risk premium; in so doing, they review the original estimates of Fama and MacBeth (1973) of the two-parameter capital asset pricing model, in the context of the exceptional January premiums. They assert:

> "*January is not simply the month in which overall stock returns have been high relative to the rest of the year, and when small firms' stocks have outperformed the market as a whole; it is the only month when shareholders have consistently been paid for taking on risk!*"

Lakonishok and Smidt (1984), hereafter LS(1984), provide an account of the process by which prices are set in a regulated environment (on the U.S. exchanges); and the resulting mechanism by which equilibrium prices may be lagged as a consequence. The difficulties of inferring equilibrium prices is further exacerbated in cases of 'thin' trading. Because of the combined effect of these processes, chiefly in the case of small firms' stock, LS(1984) focus on the measurement of the volume of trading as an indicator of potential measurement errors in the determination of 'true' (equilibrium) prices, and therefore of Returns. In view of these effects, they are unable to reject Market Efficiency despite the presence of apparent anomalies in respect of size and seasonality.

Kato and Schallheim (1985) examine the Tokyo Stock Exchange (TSE) for size and seasonal anomalies and find that the January effect reveals itself in post-1964 data; this coincided with the time of opening of Japanese stock markets to foreign investors. This finding is supportive of an integrated-market hypothesis, which allows for cross-regional arbitrage opportunities. They find the January effect to be primarily a 'small firms' phenomenon. However, they find no evidence in support of the tax-loss selling hypothesis, in spite of the opportunity provided (by the differing tax regimes) to identify such a characteristic should it exist.

They also look for informational effects whereby different industry groups provide annual information, but at (relatively) different times within the year; some evidence was found to support such an informational hypothesis.

Jaffe and Westerfield (1985) also report a 'turn of the year' effect[55], though the main thrust of the paper relates to 'day of the week' effects.

Ritter (1988) presents the hypothesis that individual investors, who exhibit a preference biased toward small firms, indulge in a practice termed "parking the proceeds" whereby the cash raised from tax-loss selling before the year-end is not returned to the market until the early days of January.

Lamoureux and Sanger (1989) utilise a Generalised Method of Moments (GMM) regression approach to investigate seasonal effects among the (generally smaller) over-the-counter (OTC) stocks traded via the NASDAQ reporting system over the period 1973 - 1985, and find a perfect inverse monotonic relationship between Size and Excess Returns for the month of January, but precisely the opposite for the other months of the year. They find only weak evidence of seasonally-varying transactions costs, which therefore fails to support the hypothesis propounded by Stoll and Whaley (1983) regarding the impact of such costs on Returns behaviour[56]. They summarise by stating:

> "*we find that NASDAQ quoted bid-ask spreads are highly negatively correlated with firm size, are not highly seasonal, and are large enough to preclude trading profits based upon a knowledge of the seasonality of small firms' returns*".

(During the course of establishing intermediate results, they also determine monotonic relationships between firm size and average share price (a positive relationship) and between firm size and relative bid-ask spread[57] (a negative relationship)).

In the introduction to their paper, they highlight the interesting point that small stocks on the NYSE and AMEX exchanges are so by virtue of the fact that, for the most part, they will have suffered recent declines in their fortunes; given that, by and large, firms do not enter the more established exchanges as small companies in the first instance. Clearly, this renders such firms atypical of small firms as a whole, and is a potential source of bias when subjected

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55 This terminology refers to the period including the last day of the calendar year, and the first five days of the new year.

56 As pointed out by Keim (1983b), to explain the observed seasonality of the size effect through transactions costs, the latter must also exhibit seasonal behaviour.

57 Defined as (ask - bid) / [(bid + ask)/2].

to analysis. On a further technical point, they highlight the fact that (non-NMS[58]) OTC stock returns are calculated from successive midpoints of bid and ask prices rather than from closing transaction prices, a fact which permits the elimination of measurement error caused by a shift in order flow from trades at the bid price to trades at the ask price[59].

Bhardwaj and Brooks (1992) conclude the 'January Effect' to be "*primarily a low price effect*", citing high relative transaction costs (associated with such stocks) as precluding the 'trading out' of the phenomenon; however, they caution that the effect is not persistent, since results are dependent on the particular time periods chosen. **Clark, McConnell and Singh (1992)** also examine the bid-ask spread movements at the turn of the year, but fail to report significance in terms of their relation to stock returns.

Clare, Psaradakis and Thomas (1995) also investigate U.K. data (1955 - 1990), taking account of both firm size and of risk. Their findings suggest that seasonal patterns in the UK market are essentially invariant relative to size, and are not due to seasonality in terms of risk. After screening for (and failing to find) the presence of unit roots at seasonal frequencies, but failing to reject the presence of a non-seasonal unit root confirming the trend component, they regress the first difference of the logarithm of the index on a composite term embodying dummy variables for the months of the year. A significant positive return is found for January, together with an abnormally high return for April, indicating that both turn-of-the-year and turn-of-the-tax-year effects are present. Explanatory hypotheses for the UK January effect include the transfer, by international arbitrage, of the US January effect, coupled with a portfolio rebalancing ('window dressing') exercise on the part of fund managers, wishing to have their portfolios viewed by clients in a more favourable light at the time of review.

Arsad and Coutts (1997) utilise daily data from the Financial Times FT30 index over the period 1935 - 1994 to examine both daily and monthly seasonality for the larger firms covered by this index[60]. They find that mean daily Returns are significantly positive (at the 1% level) in the months of January, April and December. Whilst only the month of April features positive mean daily returns for all (5 - year) subsamples, only four of these, all prior

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[58] NMS (National Market System) stocks are typically larger and more actively traded than non-NMS stocks, and, over the period of the study, represented an increasing proportion of the NASDAQ market. Their status automatically qualifies them for margin purchase purposes.

[59] In the case of the (LSPD) data used in this study (see Chapter 3), returns are computed from the last traded price in the month, excepting for certain instances prior to 1978, where prices corresponding to the mid-point of the official quoted range were used in the case of stocks traded on the last day of the month.

[60] However, the data does not incorporate the contributions of dividends to returns.

to the 1965 introduction of Capital Gains Tax, are significant. In contrast, the four subsamples which exhibited significantly positive Returns for January occurred after 1965, lending some support to the tax-loss selling hypothesis.

Draper and Paudyal (1997) widen the scope of the investigation to include, as well as Returns, factors such as bid-ask spread, trading volumes and number of trades (UK data, 1988-94). The seasonal variations of the latter two parameters, together with the derived 'average value of trades', enables them to infer the differential behaviour of the institutional versus the individual investor. However, in common with other contributors (see above), they find that the frictions due to finite transactions cost preclude profitable 'round trip' trading strategies. They do find, however, that increased competition amongst Market Makers limits the latters' ability to modulate, across seasons, the bid-ask spread; this contrasts with the situation in the U.S. market (Clark, McConnell and Singh (1992)).

2.1.6 Price / Earnings Ratio - Value vs. Growth

Basu (1977) examines the influence of Price / Earnings (P/E) ratio on absolute and risk-adjusted stock returns, and finds that, on both of the above bases, low-P/E stocks earned higher returns than high-P/E stocks. In asserting the assumption that the asset-pricing models used in the derivations of Returns have descriptive validity, Basu (1977) is, by implication, challenging the second tenet of the joint hypothesis, i.e. that the price behaviour of the securities investigated is not consistent with the Efficient Market Hypothesis. The logical extension of this is that the "persistent disequilibria" claimed to be present in the security pricing mechanism provide abnormal profit opportunities for traders exploiting a trading rule which recommends investing preferentially in low-P/E stocks.

Basu (1977) concludes by stating: *"Contrary to the growing belief that publicly available information is instantaneously impounded in security prices, there seem to be lags and frictions in the adjustment process. As a result, publicly available P/E ratios seem to possess "information content" and may warrant an investor's attention at the time of portfolio formation or revision".*

Reinganum's (1981) contribution to the Price-Earnings factor debate, since it jointly discussed the P/E effect in conjunction with the 'size effect', and found the latter to dominate, was discussed in section 2.1.4, and is included here for reasons of completeness and sequence. Both it, and Basu (1977), as well as the contradiction between the two papers, are discussed by Cook and Rozeff (1984), below.

Cook and Rozeff (1984) carry out an extensive range of tests in an attempt to resolve the apparent conflict between the results of Basu (1977) and Reinganum (1981). Joint tests of the size and E/P effects are motivated using nine different estimation methods for estimating abnormal returns, involving three different methods of portfolio formation[61] and a variety of statistical tests, and over an independent set of data to that of either Basu (1977) or Reinganum (1981). Notwithstanding the comprehensive nature of the experimental procedures employed, Cook and Rozeff (1984) find, with one exception, their results robust to the methods chosen, and conclude that the main effects are the seasonal (January) effect, the market value effect, and the earnings to price effect. Also present are the interactions: market value to January and E/P to January. No direct interactions between size and P/E are detected. Approximately half of each effect (size and P/E) occurs in the month of January, with the remainder distributed among the other months of the year.

Regarding the contradictory results of the earlier papers, Cook and Rozeff (1984) conclude that Basu's (1977) results are sample-specific, and that those of Reinganum (1981), and in particular his conclusion that the size effect subsumes the P/E effect, are caused by a fortuitous choice of methods. The single exception to the otherwise robust set of results generated by Cook and Rozeff (1984) related to the use of an independent-groups[62] portfolio formation method and market-adjusted returns; this was the method adopted by Reinganum (1981). They state (pp. 460): *"Thus, Reinganum's finding of no E/P effect is not a general one and appears to depend upon the methodology he used".*

Cook and Rozeff's (1984) final paragraph concludes that the evidence points to both effects (size and P/E) being operative, or that they each measure separate aspects of a single, underlying effect. Neither effect is seen, however, to subsume the other.

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[61] The considerations relating to portfolio formation, and elucidated and applied here by Cook and Rozeff (1984), are actively taken account of in the empirical section (Chapter 4).

[62] This is a reference to a portfolio-formation method which stratifies samples on the basis of two (or more) measures (e.g. P/E and size), but carries out each ranking singly and independently. A two (or more) dimensional matrix may then be formed according to the intersections of the two dimensions. This is distinct from the 'within-groups' method which sorts sequentially, e.g. first by size and then (within each size group) by P/E (or vice-versa) to form the matrix of portfolios.

Jaffe, Keim and Westerfield (1989) are broadly supportive of the conclusions of Cook and Rozeff (1984), and criticise the conclusions of Basu (1977) and Reinganum (1981), largely for similar reasons to the former paper. They make use of a longer period of data than the earlier studies, as an aid to separating the size, earnings / price and seasonality effects, taking care to eliminate survival and 'look ahead'[63] biases in their estimation (through judicious choice of admissible data). They utilise the 'within groups' approach (see earlier footnote), using both sequences of portfolio formation. Because of similarity of results, they report only those deriving from the 'E/P followed by market value' sequence.

The Seemingly Unrelated Regression (SUR) approach of **Zellner (1962)** is utilised for the analysis, with its claimed advantages of allowing for the use of the information content in the cross-portfolio correlations between residuals, as well as providing the ability to estimate betas 'in sample', and the associated avoidance of the 'errors in variables' problem.

Both effects (size and E/P) are found to be significant over the full period (1951-86) of the estimation. Analysed from a seasonal perspective, both effects are found to be significant in January, whereas only the E/P effect is significant outside of January. Controlling for price[64] had the effect of attenuating the coefficients associated with both effects, but all remained significant with the exception of the E/P coefficient for January.

2.1.7 Book / Market Ratio Effects

Fama and French (1992), hereafter FF(1992), document the earlier work of **Stattman (1980)** and **Rosenberg, Reid and Lanstein (1985)** in finding a positive relationship between the returns on U.S. stocks and the ratio of the firms' book value of common equity to its market value. The relationship remains significant after controlling for beta and size. **Chan, Hamao and Lakonishok (1991)** find a similar effect for the Japanese stock market.

FF(1992) set out to investigate the joint roles of Market Beta, Size, Earnings / Price ratio, Leverage and Book to Market equity ratios in cross-sectional returns on the three major U.S. stock exchanges (NYSE, AMEX and NASDAQ). In so doing, they acknowledge the common involvement of Price itself in Earnings / Price ratio, Market Equity (size), leverage and book to market equity ratios - all are "*scaled versions of Price*". For this reason, they also

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[63] Such biases might be caused by the researcher making use of information not 'yet' available to investors.

[64] This refinement seeks to identify effects which are a function of, in particular, 'low' stock prices.

postulate that certain of the above characteristic variables may be redundant, in the sense that they potentially carry the same information (regarding possible risk factors) into any model utilising them; in that sense, they may manifest themselves as 'competing' variables.

Their results show that, in multivariate tests, the size and book to market equity ratio relationships are robust to the inclusion of other, competing variables; moreover, they report that "*although the size effect has attracted more attention, book to market equity has a consistently stronger role in average returns*". They go on to state that the above two variables "*seem to absorb the roles of leverage and earnings / price ratio in average stock returns*".

In their concluding section, FF(1992) point out the contribution of Chan, Chen and Hsieh (1985)[65] in possibly relating the size effect to a form of default risk measured by the difference in returns between low- and high-grade bonds; and that of **Chan and Chen (1991)** who relate the book to market equity ratio to a relative distress factor which incorporates the increased sensitivity to adverse economic conditions of firms judged by the market to have poor earnings prospects.

Fama and French (1993) build upon the foundation laid in FF(1992), but express the information content inherent in the size and book to market equity ratio variables differently. They revert from the characteristic-based model[66] of the earlier paper to a mimicking-portfolio approach in which monthly returns on stocks (and also bonds) are regressed on the returns to a market portfolio and also to the mimicking portfolios for Size and for Book to Market equity ratio; as well as to term structure risk factors in bond returns. This is similar in broad principle to the portfolio formation approach of Black and Scholes (1974)[67]. The time series regression slopes are then identical to factor loadings which have an interpretation as risk-factor sensitivities; the treatment of the sensitivities to the supposed risk factors associated with size and with book to market equity ratio becomes analogous to the traditional treatment (in the CAPM) of the sensitivity to the Market. Moreover, the unifying theme carries over to the treatment of bonds, by incorporation of factors relevant to that asset class.

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[65] See summary of this paper in section 2.1.4.

[66] i.e. a model which embodies, directly, the vectors of accounting variables in the 'X' matrix.

[67] See section 2.1.3. for discussion.

Tests of the model are in general convincing as to the additional power (over and above the 'pure' CAPM, as defined in section 2.1.1), but are acknowledged (by the authors) to be weakest when tested against 'extreme' portfolios formed on the basis of characteristics other than those used to form the mimicking portfolios; in this case Earnings to Price (where the 'extreme' portfolio is the negative E/P portfolio), and Dividend Yield (where the 'extreme' portfolio is the Zero-Dividend portfolio).

Fama and French (1996) explore 'three factor models' in general, and seek to provide a unifying theme which encompasses the ICAPM **(Merton (1973)**) and the APT (Ross (1976)) in a discussion centred around the concept of Multifactor Minimum Variance (MMV) optimal portfolios. A number of (successful) tests are similar to those described above (for FF(1993)), using a variety of portfolio formation methods including (as well as the above) portfolios formed on sales growth ranking and past performance (the latter in order to calibrate the model against the contrarian strategy anomalies of **Lakonishok, Schleifer and Vishny (1994)** and **DeBondt and Thaler (1985)**). In a further test (of the 'pure' CAPM), the procedure uses the simpler model to price the other two mimicking portfolios; and finds that it misprices both the high- and low- Book to Market portfolios and the small stock portfolio. Whilst being robust to most of the reported tests, the three-factor model fails, however, to explain the continuation of short-term returns documented by **Jegadeesh and Titman (1993)** and **Asness (1994)**.

Kothari and Shanken (1997) evaluate the ability of an aggregate book to market equity ratio to track time series variation in expected market index returns, and to compare its forecasting ability to that of dividend yield. They find evidence that both book to market and dividend yield track such variation, with the former effect (B/M) being the stronger over the period 1926 - 1991, and dividend yield dominating over the sub-period 1941 - 1991.

Their introductory discussion highlights the competing views of the efficient versus 'inefficient' markets schools of thought; the former (e.g. Fama and French (1988)) holds that a 'discount rate' effect operates whereby changes in risk or liquidity lowers market value, given constant cash flow; this raises both expected returns and financial ratios (e.g. B/M, D/P)[68]. The alternative view holds that the financial ratios reflect the degree to which the market is undervalued (high ratios) or overvalued (low ratios) at a given point in time. They conclude that some evidence of market inefficiency, in that " *the B/M results suggest that expected return variation over the 1926-91 period was not driven entirely by equilibrium* *changes in compensation for risk*". This statement is tempered by the caveats that the effect is mainly driven by the early sub-period 1926-1941, a time of great economic volatility, and a warning in regard to the possibility of 'data mining' effects.

Pontiff and Schall (1998) examine the predictive ability of an aggregate measure of book to market equity ratio, and find that post 1960, that ability is diminished; though it remains in evidence in the S&P index, albeit at a level much weaker than was the case (pre-1960) for the Dow Jones Industrial Average. They state "*The predictive ability of book to market ratios appears to stem from the relation between book value and future earnings*". They extend the work of Kothari and Shanken (1997) by including other variables with potential predictive ability; default spreads, interest rates, term structure slopes and dividend yields. However, they conclude that these variables are weaker predictors than book to market ratio.

Fama and French (1998) focus on the inadequacy of the CAPM to explain the additional premium exhibited by so-called 'value' stocks, defined as having typically high values of the key financial ratios Earnings to Price (E/P), Cash flow to price (C/P), Book to Market (B/M) or Dividend Yield (D/P); and by comparison, the lower expected returns associated with the 'Growth' stocks which are characterised by low values of those same ratios.

The paper discusses the various hypotheses put forward to explain the anomaly, including mispricing (Lakonishok, Schleifer and Vishny (1994), Haugen (1995)); the eventual correction of which produces high realised returns for Value stocks and low returns for Growth stocks; and sample specificity (Black (1993), MacKinlay (1995)); which would imply that the effect may not be persistent over different markets and / or time periods.

FF(1998) seek to explore the extent of the effect in international markets, and confirm this to be the case. In addition, they once again make out the case for a multifactor model of the type described above, capable of reflecting risk factors over and above that of market covariance risk.

Lewellen (1999) studies the time-series relationships among expected return, risk and book to market ratio at the *portfolio* level, finding both statistically and economically significant evidence that B/M does predict time variation in expected stock returns. Drawing the distinction between characteristic-based models and mimicking-portfolio based models, in the context of the risk versus mispricing debate, Lewellen quotes the **Daniel and Titman**

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[68] This assumes that the numerator (B or D) proxies for expected cash flow.

(1997) study which reveals a stronger association between expected returns and B/M than between expected returns and the factor loadings (this is cited as evidence in favour of the mispricing (market inefficiency) argument). In his own study, he sets out to determine whether a portfolio's B/M ratio predicts time variation in its expected return, and tests whether changes in expected return can be explained by changes in risk, and specifically, whether the three-factor model provides a better explanation than a characteristic-based model (which is indifferent as to whether the source of variation is risk or mispricing).

Using the conditional time-series approach of **Shanken (1990)**, Lewellen finds that variation in risk appears to explain the association between B/M and expected returns. Interestingly, the results also show that high values of B/M (indicating possible distress) are associated with relatively lower values of market betas, implying that market risk becomes relatively less important for distressed industries[69].

2.1.8 Non-Synchronous (Infrequent) Trading

Dimson (1979) points out that stocks which are infrequently traded suffer from positive serial correlation due to the averaging effect upon their underlying equilibrium prices, an effect first identified by **Working (1960)**. In consequence, a downward bias is present in the estimates both of their variance and their covariance with the market. The effect of the variance bias among thinly traded stocks is limited, however, in terms of its effect upon the variance of the market as a whole. In consequence, an overall downward bias is effected upon the infrequently traded stock's beta. In contrast, the bias on the beta of frequently traded stocks is an upward one (albeit a weaker effect) due to the reduction in the variance of the market portfolio whilst the covariance term is (in this instance) largely unaffected.

Whilst a number of corrective strategies are available, e.g. **Scholes and Williams (1977)** these do in many instances require knowledge of transaction times and require a frequently updated market index free of non-trading. Dimson's approach is to treat observed prices as having "*an expected value which is a weighted average of a sequence of true prices, where the latter are the transaction prices which would arise if trading were continuous*". The method is termed the "Aggregated Coefficients" method, and realises an unbiased estimator for the beta of stocks by a summation of the slope coefficients in a regression of Returns on lagged, contemporaneous and leading Market Returns. The choice of lagged and leading

[69] Lewellen reports a similar finding by McEnally and Todd (1993).

terms is to some extent arbitrary in practice, but seems (empirically) to require an excess of lagged terms over leading terms for the most infrequently traded stocks.

In a follow-up paper, **Dimson and Marsh (1983)** utilise the trade to trade method of estimating risk, free of infrequent trading bias, and find that the risk measures achieve similar levels of stability to those in the U.S. market (for which thin trading is less of a problem). Further UK evidence is provided by Clare, Morgan and Thomas (forthcoming).

2.1.9 The changing nature of firms' Dividend-Payment characteristics.

Fama and French (2001), henceforth FF(2001), present an important insight into the ways in which, over the last several decades, the nature of the investors' reward process has altered; away from the payment of dividends and toward a process of internal investment aimed at enhancing capital gain. Although the greatest weight of evidence (see section 2.1.3 for references) has weighed against explicit tax-based explanations, FF(2001), in their introduction, refer to the 'enigma' of Dividends, and the presumption that they are 'less valuable than capital gains', putting dividend payers at a competitive disadvantage due to the (assumed) higher cost (to them) of equity. In regard to this matter, in their conclusions they state:

"The evidence that, controlling for characteristics, firms become less likely to pay dividends says that the perceived benefits of dividends decline through time."

The two key parameters encapsulated in the above quotation, namely firm *characteristics* (of Size, Profitability and the opportunities for Investment) on the one hand, versus the *propensity* of firms to pay dividends (even controlling for characteristics) on the other, are the central issues in their paper. They conclude that the characteristics of the universe of quoted stocks on the U.S. markets[70] change over time, largely driven by new listings, whilst also over time, the propensity (to pay) of 'similarly' characterised firms decreases. Largely, the new listings, particularly in the later years of the study (post- 1978), are constituted by small, low profitability firms featuring strong growth and many investment opportunities. For the most part, firms corresponding to this description were classed as Zero-Dividend payers, moreover having 'Never' paid a dividend, as opposed to 'Former' payers for which there was evidence of 'distress' in their financial make-up (low earnings, few investment opportunities).

70 By this is meant the NYSE, AMEX and NASDAQ stock exchanges whose constituent firms' data was used in the study.

The FF(2001) study is also useful in terms of its summary statistics; in relation, particularly, to Zero-Dividend stocks. These are useful in distinguishing, in particular, between the U.S. and U.K. stock markets in this regard. In the last year of the study, some four out of five stocks in the U.S. were Zero-Dividend stocks, having been 2/3 in 1978. Of these, the vast majority (almost 90% of the 'non-payers') were 'Never' payers[71].

The effect of firm size is also important. On average, Dividend-Paying firms are some ten times greater in size than Zero-Dividend firms. Moreover, they account for almost all of the aggregate Market earnings, and some three-quarters of aggregate Book value and of aggregate Market value. Furthermore, the Payout ratio (aggregate dividends to aggregate earnings) of this group effectively defines the Payout ratio of the market as a whole. Thus, despite the numerical superiority of Zero-Dividend firms, their influence is considerably reduced when viewed in value-weighted terms.

2.2 How does the review of the literature guide the direction of the empirical research? - A Summary.

The foregoing review began by highlighting the difficulties of providing a theoretical base for explaining the Equity Premium 'puzzle' of Mehra and Prescott (1985), and the recourse to, and subsequent expansion of, behavioural hypotheses in attempts to resolve it. In another regard, and given the difficulties lying outside of the domain of expectations-forming modelling[72], it would seem that such modelling is the preferred way forward. A variety of approaches have been studied in the earlier discussion, that have largely evolved from the Capital Asset Pricing Model of Sharpe (1964), Lintner (1965) and Mossin (1966), which described the trade-off between portfolio risk and return; that evolution being driven by perceived shortcomings in the predictions of the simple form of the model, and also by the difficulties inherent in testing the CAPM (ref. Roll's (1977) critique). Whilst not all of the attempts to verify the efficacy of the CAPM resulted in its rejection (e.g. Fama and MacBeth (1973)), the proliferation of 'anomalies' literature from the mid-1970's onward suggested that more sophisticated, multivariate models were worthy of investigation.

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[71] It will become clear later (in the empirical sections of this Thesis) that the U.K. situation is very different. Only one in eight U.K. samples over the period 1958-1997 is non-paying; of *these*, only one in five is a 'Never' payer. The basis for comparison is imprecise, since a single 'end of sample' year is being compared to a period average; nevertheless the implication for the contrasting situations in the two markets is clear.

[72] This is a reference to the use of survey techniques as a means of determining expectations (see section 2.0)

In order to provide order and structure to the 'Anomalies' literature, a system of classification was adopted (above) in which firm characteristics (e.g. size), financial ratios (Earnings / Price, Book / Market ratios), firm and government policy variables (Dividend, Taxation) and market characteristics (seasonality effects, frequency of trading) were laid out. Within each of these groups of studies, whilst agreement was not universal, evidence and consensus was broadly in favour of extensions to the basic model being beneficial to the more precise generation of Returns expectation, and that indeed, certain of these characteristics or factors possessed significant explanatory power in the models which employed them.

Following the discussions in Lewellen (1999) regarding the relative merits of characteristic-based and (mimicking portfolio) factor models, the characteristics-based model is arguably more 'neutral' in terms of not *a priori* favouring a risk, as opposed to a mispricing, argument. For this reason, it is the choice made in the empirical work in the remainder of this thesis.

Further considerations relate to the particular scope of the study, in terms of the particular market of interest and the timespan (and constraints) of the data. Also, there exists a multiplicity of techniques and methodologies[73] deriving from the prior literature; a suitable subset of which need to be considered and identified before proceeding with any follow-up study in the area of eventual choice. Finally and most importantly, the ultimate focus depends upon the specifics of the Research Question(s) to be posed; the research needs to be practical, feasible and relevant to the needs of academic and practitioner interest groups, and to be potentially capable of extending the knowledge base into new and original areas.

With these considerations in mind, and guided by all of the above, the following choice was made. Given that the 'local' market is the U.K. Stock Market (for which rich data is available), and the fact that (relative to the more commonly investigated U.S. market) the U.K. market provides a cross-sectionally distinct sample of data that enables some independent confirmation (or rejection) of potentially 'persistent' effects, the chosen dataset is that of the U.K. market.

Given the interest and considerable progress in investigating and documenting the size and seasonality effects for both U.S. and U.K. data, a specific investigation into these effects was rejected[74] in favour of an investigation using Dividend and Earnings data[75]. In particular,

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[73] Newer methodologies are available which become feasible with the advent of increased computing power.

[74] However, where appropriate, these effects will be controlled for.

recent U.S. studies (Christie (1990), Fama and French (2001)), of a particular class of stock (namely Zero-Dividend stocks); coupled with a discernible upward trend in the numbers of this subgroup in recent years in both U.S. and U.K. markets, prompts a focus in this direction, albeit as part of a wider study of Dividend-related effects.

The above discussion leaves only the Research Questions to be settled. Firstly, the nature of the Research Problem is outlined:

To study the particular characteristics of 'Zero Dividend' stocks, which have an important, though incompletely understood role within financial markets.

Ref: "the Zero-Dividend Puzzle"....... Christie (1990).

Following from the above:

1) *How robust is the relationship between Dividend Yield and total stock Returns over the 40-year period for which we have rich data?*

(This is the major topic of investigation in Chapter 4).

2) *What are the special properties of Zero-Dividend stocks, and in what way are these related to the properties of Dividend-Paying stocks?*

(The properties of Zero-Dividend stocks are a continuing topic of investigation in Chapter 4, and the relationships with Dividend-Paying stocks are examined in Chapter 5).

3) *How relevant is the subdivision / distinction of stocks into "Expanding" and "Contracting" categories, as a key to understanding their Returns behaviour?*

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[75] Book to Market ratio data is not easily available for the U.K. Market.

(This feature of Zero-Dividend stock behaviour is examined in terms of its influence on stock migration[76] behaviour in Chapter 5, and in terms of Returns performance in Chapter 6).

> 4) *How does the classification of stocks along the dimension 'Expansion - Contraction' relate to the Fama-French (2001) subdivision into 'Former Payers' and 'Never Paid'.*

(This aspect of Zero-Dividend stock classification is the subject matter of Chapter 6).

The empirical section of this thesis now proceeds, using as a starting point the guidance of **Morgan and Thomas (1998).**

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[76] The definition of this term relates to the movement of stocks between portfolios under re-balancing, and is covered in great detail in Chapter 5.

3.0 Data Organisation

The data source for the investigations is the LBS London Share Price Database (LSPD). Information relating to UK stocks is available dating from the beginning of 1955; the version used in the current research has data up to the end of 1997. A full description is available in the LSPD Reference manual (version 10.0). The following section details the data utilised in the study, and the programs and methods used to manipulate that data.

The LSPD data is provided in the form of ASCII text contained in four large data files as follows:-

1) Source File (76 MB)
2) Returns File (37 MB)
3) Indices File (2 MB)
4) Master Index File (1 MB)

The Source File contains data covering 6,632 companies quoted in London over the period described above, under eight separate headings:

a) General Descriptive Data
b) Prices
c) Share Capital
d) Earnings
e) Capital Changes
f) Par Values
g) Dividends
h) Names & SEDOL Numbers

Items a) and h) embody single records for each firm, b) - d) consist of multiple regularly-spaced (in time) sub-records. The Price Series (b) provides regular (monthly) data for each company; on average, firms over the period have a 'lifetime' of 141 months (11¾ Years). Share Capital and Earnings records feature Annual data. Irregular observations (e) - (g) are arranged in chronologically sequenced lists, and are 'tagged' with date information.

The information is stored in the form of a heterogeneous 'block' of complete data for each company; blocks pertaining to different companies' data are then arranged sequentially.

The Returns File contains data which is derived (calculated) from the data in the Source File, specifically in relation to monthly total returns, but also providing monthly non-trading information, annual Market Capitalisation and General Descriptive data. Data in this file appears in the form of long, single-line records; in the case of Returns and Non-Trading markers (Dates) these each consist of 516 fields corresponding, in sequence, to the individual months of the 43-year span of the data. Non-valid information (e.g. 'Returns') for months prior to the birth, and subsequent to the Death of companies are denoted by a specific code. This code may also appear during the lifetime of a company if, for example, data were not available due to temporary suspension, or for other reasons. Similarly, annual market capitalisation data is stored in records consisting of 43 fields.

The Indices File contains information relating to various of the FTA and other stock indices, together with Exchange Rates, Interest Rates, Economic and Commodity indices. The present study uses only the 3-month Treasury Bill Index for the UK.

Finally, the Master Index File comprises information which facilitates the tracking of individual companies, via cross reference information, through name or Sedol number changes throughout their evolution. This source was used only incidentally during the course of the present study.

3.1 Information Processing

The information in the text files described above required to be manipulated, assembled and subjected to a complex series of calculations before providing the necessary format for a final statistical analysis. The various stages of this process are described below:-

Data Conversion: The heterogeneous format in which the native data is held does not lend itself well to the assembly of the project-specific data required for analysis. A suite of text-processing conversion programs was developed, with source code written in the 'Pascal' language, to read the fixed-length record structure of the native data. Specific types of information were directed to column (tab) separated files, each of which captured one particular aspect of the data (e.g. Monthly Stock Prices). The full set of (initial) tables is listed below (Table 3.1, Primary Database Table):-

Table 3.1 Primary Database Table

	Native File	Converted Table	Table Name	Fields	Records
a)	Source File -	General Descriptive Data	LS97des4	43	6,632
i)		Prices	LS97pri4	11	993,305
j)		Share Capital	LS97shc4	3	84,785
k)		Earnings	LS97eps4	5	84,785
l)		Capital Changes	LS97cap4	15	13,368
m)		Par Values	LS97par4	6	8,423
n)		Dividends	LS97div4	16	128,049
o)		Names & SEDOL Numbers	LS97sed4	12	12,450
p)	Returns File -	Monthly Returns Data	RET97RET	5	978,601*
q)		Monthly Non-Trading Data	RET97DAT	4	3,533,052
r)		Annual Capitalisation Data	RET97CAP	3	294,421
s)		General Descriptive Data	RET97GEN	21	6,847
t)	Indices File -	Indices Data	IND97RET	4	333,852
u)		General Descriptive Data	IND97GEN	10	647
v)	Master Index -	Master Index File	DMI97A	14	15,028

* The conversion program filters out 'missing values', which are not transferred to the table.

The field structure within each of the tables largely follows that set out in the LSPD manual.

In order to obviate the need to have multiple large files open simultaneously during the conversion process, a multiple-pass scheme was adopted whereby each of the above tables was constructed by a dedicated executable program specific to producing that particular table. All characters in the native file were read; only those required by the particular destination table were written out. In the interests of consistency, the sequence of 15 separate passes was executed under the control of a single batch file.

In most instances, indexing data was added to the field structure of the destination tables during the conversion process, in order to facilitate the importation of the complete set of tables into a database structure; for example, each of the sequenced Returns (valid Returns only) is 'tagged' with an index number (RetIndex). In order to facilitate the later 'joining' of tables in the database, a 'key' structure was established which comprised the unique combination of Company Number, Year and Month; where necessary, these data fields were appended to the destination records also.

Importation into the Database Program. Once assembled by the batch routine, the destination files are ready for importation into the chosen Database program. The particular choice in this instance is Microsoft© 'Access', which enables an easy interface with the associated 'Excel' spreadsheet program, later used for preparing the input to the statistical analysis package.

As alluded to above, the chosen key structure within the database depends on there being a unique datum for each measurable quantity in any one month for any one company. Whilst this is for the most part inherent in the structure of monthly data, there are a small number of instances where multiple data items occur. In the case of the present study, for example, there are instances of multiple dividend payments in a given month, and also instances of multiple capital changes and their associated adjustment factors. It is therefore necessary to aggregate 'within month' data in order to provide the single datum required. Rather than access the primary data tables via multiple levels of Query, secondary and tertiary data tables were generated, in order to decrease the time required to access the 'final' subset of data required for the generation of Dividend Yield and market capitalisation values.

In the case of the dividend tables, the progression to the secondary table involved two considerations. Firstly, a filter was applied in order to allow only Interim and Final Dividends to contribute to the eventual calculation of Dividend Yield; Capital, Bonus and Special Distributions, as well as Liquidation Distributions, were disallowed for this purpose. Secondly, a calculated field (Absolute value of Tax Credit) was generated for use in the calculation of the Total Dividend Payment at the next stage. A compromise was required in the application of the filter rule, since a problem arises when two or more dividend types, one allowed, the other disallowed, are paid simultaneously in a single payment. The database records these (relatively infrequent) occurrences with a two- or three- digit code, i.e. combining the single-digit codes for 'simple' transactions; however, it does not distinguish the relative amounts of each dividend payment type within the single payment. The filter rule was applied with the maximum severity, excluding any payment having a disallowed component, at the risk of simultaneously disallowing a valid component.

Given that valid Dividend Types are coded 1,2,3,4,9 (codes from the range 1 to 11), the filter rule applied is as follows:-

"Between 1 And 4 Or 9 Or 12 Or Between 19 And 23 Or 29 Or 34 Or 39 Or 49 Or 91 Or 92 Or 912" (Note: this list covers all of the valid 'type' payments actually present in the Database)

In terms of total dividend payments per share over the entire database, the above scheme allows 94.45% to proceed through the filter; 3.28% is properly rejected; and the 'uncertain' category accounts for 2.27%. The effect of the filter was to reduce the number of dividend records from 128,049 to 125,062, a reduction of 2,987 (2.33%); of which 1,271 were cases in the category of proper rejections, and 1,716 in the 'uncertain' group. The retained records are stored in Table LS97DIV4a.

At the conclusion of the above stage, there remain instances of multiple within-month dividend payments; these are aggregated within their respective Company/Year/Month samples. In addition, the value of 'Total Dividend Payment' (for the month) is derived by summing the 'Net Dividend Payment' and the 'Absolute value of Tax Credit' previously calculated (see above, and also LSPD Reference Manual, section 3.4). The effect of the aggregation is to reduce the number of dividend records from 125,062 to 124,958, a reduction of 104. These records are retained in Table LS97DIV5.

In the case of Capital Changes, a similar 'aggregation' is necessary. However, in this instance, values of the Adjustment Factor (ADJ) require to be *multiplied*, rather than added, in order to arrive at the composite figure. This is straightforwardly implemented within the database package by once again 'Grouping' values within respective Company/Year/Month samples, and, in this case, summing the logarithms of the Adjustment Factor:-

```
Log_Adj: Sum(Log(IIf([ADJ]<>0,[ADJ]/1000,1)))
```

The conditional statement 'traps' values of zero (set in the database to indicate "Adjustment Factor not calculated")[77] before taking the logarithm of the scaled value, substituting instead a default value of unity. Following summation, the antilog is taken, to calculate the single, composite Adjustment Factor for the month:

```
ADJ2: Exp([Log_Adj])
```

There are 240 instances of multiple Adjustment Factors in the database (none higher than 2), resulting in 13,128 records in the modified table LS97CAP5.

Other Derived Tables. Three further derived tables are required within the table set before extraction of the subset of data needed for analysis. These are now described.

The LSPD Returns file reflects declining company fortunes by posting a negative return as share prices decline, according to the relation:

$r_t = Ln((p_t + d_t) / p_{t-1})$ where r_t is the log return in month t.

However, the data posted in the file does not specifically distinguish between the logarithmic return of value '-10.0000' which is (approximately) correct in order to reflect the total loss in value of a failed company, versus the same figure used as a *code* to denote missing returns. In order to obviate 'survival bias' in the later analysis, it is necessary to 'write down' to zero (on a 'once and for all' basis) the value of such firms. At the same time, allowance must be made for firms that cease to exist as independent entities, but whose value is nevertheless (at least in part) preserved; and whose shareholders are therefore compensated by the acquiring company.

Given the ambiguity of the '-10.000' designator (or, at least, that of the single, ending occurrence after the last valid return), and the need, in any case, to distinguish between failed and merged companies, the approach taken is as follows. *All* 'missing value' codes are removed, by the conversion program, as it assembles the table 'RET97RET' (see table 3.1, above). The 'closing returns' are then compiled and appended to 'RET97RET' at a second stage. Since the conversion process adds dates and a sequential index of valid returns as it loads them, it is possible to subsequently identify the 'last' valid return, and add a closing line in the succeeding month. This is done by assembling, in the first instance, a table of such 'closing records'.

Firstly, it is necessary to use the 'Type of Death', 'Date of Last Quotation' and 'Acquiring Company No.' data as criteria in the identification of failed firms. A study of these criteria, in relation to the status of well-known historical cases (see Table 3.2, below), resulted in the following determination, whereby three groups of company were identified under 'Type of Death':

a) TOD = 0 to 5, 11, 12, 13, 15, 17, 18, 19
b) 6, 8, 9, 10, 14
c) 7, 16, 20, 21

Group a) are unconditionally accepted as surviving, value-preserving Companies.

[77] There are only 7 instances of this within the database.

Group b) are considered *failed* companies if their Date of Last Quotation is less than 2000 (the designator for a currently quoted company, as of December 1997) and there is no Acquiring Company (AQCO = 0).

Group c) are unconditionally accepted as failed companies having no residual value.

Table 3.2: Historical examples of Survival / Failure.

Compa	Company Name	Type of	Date Last	Acq. Co.
8615	East Midlands Electricity	5	1165	-1
7574	TSB Group plc	5	2000	3159
4382	ROLLS ROYCE	7	853	0
7371	Aberdeen Steak Houses Gp plc	8	2000	0
6752	Amstrad plc	9	2000	0
9024	Chesterton International plc	10	2000	0
1377	CORAL (J) LD	11	864	0
2003	FORD MOTOR CO.	12	733	0
7591	VIRGIN GROUP PLC	13	1068	0
6569	Shell Trnspt&Trdg'Br'	15	2000	0
6561	Ferranti Intnl plc	16	1129	0
4007	Pentos plc	16	1142	0
1651	DORMAN LONG & CO.	18	809	-1
6574	HAMBROS PLC 'LV'	19	1038	0
6646	EMAP 'A'	19	1047	0
6580	Great Univ Stores 'Anv'	19	1126	2243
4085	Polly Peck Intnl plc	20	1109	0
820	Maxwell Communication Corp	20	1110	0
7827	Resort Hotels plc	21	1132	0
7323	Brent Walker Group plc	21	2000	0

In setting out the above, it is recognised that these survival / failure decisions will not necessarily be wholly accurate for all individual company circumstances; nevertheless, it is considered that the underlying logic makes best use of the generality of available information contained in the database, regarding the question of preservation, or otherwise, of value.

The logic described above is implemented in the form of a 'Make Table' Query, which draws from data in the Descriptor Table (LS97des4), applies the filter logic, and produces a new table entitled 'Failures', which holds 613 company records of those companies deemed to have zero residual value.

Having established the identity of the failed companies, it remains to link these with the corresponding 'Last Valid Records' from the Returns file. Again, in the first instance, a small, dedicated table of these last records is constructed for all companies, prior to joining the tables. Data fields pertaining to Company Number, Year, Month and Returns Index are drawn from the Returns Table (RET97RET). A calculated Month Number (Year*12 + Month) is derived, and the table 'LastRet', with 6563 dated records, is built. This has a smaller number of records than the descriptor table because a small number of companies never generate a single valid return. Finally, the two small tables, 'Failures' and 'LastRet' are joined via their Company Numbers, with the added specification that only records which represent companies featured in both tables proceed to feature in the output. In this way, a set of 606 records representing Closing Returns are generated; these are then appended to the Returns Table. The closing Returns are tagged with a closing log return of '-99', a distinct value (and a slightly closer approximation to a -100% net simple return) which may be used later to aid searches. Additionally, the Year / Month date index is incremented by one month such that the 'Closing Return' follows the 'Last Return' in all cases.

The final table required to hold data for analysis holds the 'Risk Free Rate', and is built from index No. 3 (90 - Day Treasury Bill Rate) lodged in the file 'IND97RET'. The provision of this additional small table considerably speeds up the running of subsequent database queries.

Selecting Out the Data for Analysis. With all necessary tables in place, the process of extracting the precise subset of data required for analysis can begin. This takes the form of a Query which draws data from 7 joined tables, and constructs 17 fields. The ordered fields, and their associated tables, are summarised in Table 3.3:-

Table 3.3 Extended Returns Table

	Field	Mnemonic	Table	Sort Order	Criteria
1.	Company Number	CoNum	RET97RET	Ascending	
2.	Date (Year)	R_Year	RET97RET	Ascending	
3.	Date (Month)	R_Month	RET97RET	Ascending	
4.	Ind. Classification	INDX	LS97des4		<800
5.	Return Index	RetIndex	RET97RET		
6.	Log. Return	ZRET	RET97RET		
7.	Dividend Payment	Month_Total	LS97DIV5		
8.	Ex-Dividend Date	X_Day(Max)	LS97DIV5		
9.	Transaction Price	TP	LS97pri4		
10.	Low Quote / Mid-Sedol	LQ_MS	LS97pri4		
11.	High Quote / Cl. Pr.	HQ_CP	LS97pri4		
12.	Date of last Trade	T_Day	LS97pri4		
13.	Ex-Rights Date	R_Day(Max)	LS97CAP5		
14.	Price Marker	PM	LS97pri4		
15.	Issued Share Cap.	Ish_Cap	LS97shc4		
16.	Adjustment Factor	ADJ2	LS97CAP5		
17.	Market Capitalisation	MCAP	RET97CAP		

The scheme may be viewed as extending the Returns Table by the addition of supplementary fields, since the table joins are structured in such a way as to "Include all records from RET97RET and only those records from [other tables] where the joined fields are equal" (i.e. 'Outer Joins', in database terminology). Once again, the first three fields form the unique key, and are subject to a three- level sort on the basis of those fields. Thus for each company in sequence, date records appear in chronological order. The remaining fields will be briefly outlined at this juncture, and described in more detail as the next stages of data processing are outlined.

The Industrial Classification (INDX) field is included with a criterion of "<800", which filters out Investment Trusts in order to avoid 'double counting' of Returns. The presence of the Return Index (RetIndex) field permits 'qualification' strategies to be implemented at a later stage, once Dividend Yield and (High Resolution) Market Capitalisation have been calculated (see below).

The Log Return (ZRET) is central to the analysis to follow; once portfolio construction has taken place, portfolio returns form the 'dependent variable' in the statistical analysis.

The Dividend Payment stream forms the next field, and will be used to compute a monthly rolling dividend. Three Price Series follow; a selection procedure, dependent upon values in the last field (Price Marker) will, on a record-by-record basis, emulate the algorithm used to determine the effective Prices which are used to calculate the Returns in the Returns File. In this way, a common series of prices will have been used to determine both Dividend Yield and Returns.

Finally, Issued Share Capital and the composite Adjustment Factor will be used to determine a monthly updated measure of Market Capitalisation which will replace the annually updated values that feature in the MCAP field. The reasons for this are outlined in more detail in section 3; the MCAP series will be utilised merely as a means of determining whether data is valid for the particular month of a company's data.

(Note: In the above two cases, Dividend Payment Stream and Adjustment Factor, an additional consideration arises which has to do with the *timing* of these measures in relation to the last trading date (within the month) for the individual stock. In cases of infrequent trading, the 'posted' price of the stock for the particular month may have been determined at an earlier date than the date of a subsequent capital change, or dividend. In such cases, the adjustment factor requires to be applied to the next price datum - which naturally occurs in the following month; similarly, a dividend payment with a later 'ex-' date will influence the following month's price but not that posted for the current month, which has already been determined. In order to facilitate the allocation of these measures to the appropriate period, the 'ex-' (Rights / Scrip and Dividend) dates are extracted from the database for further processing).

Ancillary Calculation augmenting the 17-Field structure. The above-described field structure is augmented by the addition of 15 calculated fields which provide, ultimately, for the calculation of Dividend Yield and Market Capitalisation, and the eventual use of these measures to sort stocks into yield and size portfolios. Owing to the complexity of the necessary calculations, the flexibility of a spreadsheet format was called for; this necessitated the subdivision into blocks of (approximately) 600 companies in order to remain within the 64K record limit of the format. Fourteen such files were created to span all of the stocks. The additional fields are described below:

Composite Price Record 1 (CPR1) (R). This field is computed from the three price series Transaction Price (TP); Low Quote / Mid-Sedol (LQ_MS); and High Quote / Closing Price (HQ_CP) according to the algorithm suggested in section 2.6 of the LSPD Manual for the price basis for the calculation of Returns. The implementation, in terms of cell formula, is as follows:

```
=IF(MID(TEXT(N3,"00000"),3,2)<>"00",I3,IF(L3<>0,I3,IF(B3<78,(J3+K3)/2,K3)))
```

The above formula is that for Line 3, but is copied to all records; Field (N) is the 'Price Marker' code, from which the relevant digits 3 and 4 are extracted and compared to "00", the sub-code indicating that the Closing Price (HQ_CP), Field (K), is that for the last day of the month. If not equal to "00", then Field (I), Transaction Price, is selected. If the code is "00", then the transaction date (Field (L)) is interrogated; code "0" implies that the last trade took place on the last trading day of the month, in which case, Transaction Price is still selected. Otherwise, a choice of Closing Price (K) or, prior to 1978, the average of High (K) and Low (J) quotes is taken as the definitive price. Field (B) is the (2-digit) year code.

<u>Composite Price Record 2 (CPR2) (S).</u> On occasion, the above procedure selected a price value of zero when the selected item (e.g. Transaction Price) was unavailable and consequently set to this (default) value. It later became clear (from examination / comparison of the Returns file data, see below) that the finite price used to determine Returns could best be emulated by choosing, in such cases, the higher of two prices from Fields (I) and (K). The formula (Line 3) is indicated below:

=IF(R3>0,R3,MAX(I3,K3)) { Field 'R' is CPR1}

<u>Composite Price Record 3 (CPR3) (T)</u>. Despite the enhancement to the algorithm represented by the addition of CPR2, there were found to be a small proportion of instances where price series CPR2 did not reconcile with a price series generated by 'Back Calculating' from the Returns values (ZRET); (see below under 'BackCalc' for a full description of the determination of this series). These anomalies were, for the most part, associated with instances of dividend payments or adjustment factors, notwithstanding the corrections applied as described above. By way of example, finite dividend payments were associated with both zero returns and yet unchanging prices. In other instances, price changes following an increase in the Issued Share Capital (and covered by an appropriate adjustment factor) were delayed. Because Market Capitalisation is determined by the product of these two terms, this potentially caused 'phantom' transient increases in the measure of MCAP. This in turn would then have resulted in an inappropriate allocation to size portfolios. CPR3 therefore represents a correction for these effects, and as such, the final determination of a definitive price series used to calculate Dividend Yield, and yet compatible (to the maximum extent possible) with the implied, underlying price series used to generate the Returns series. However, further discussion of the algorithm used to generate CPR3 will be delayed until its input terms ('BackCalc' and 'Threshold') have been fully described, below.

Adjustment Factor (ADJ3) (U). The evaluation of the Capital Change Adjustment Factor is complicated by the need to determine whether it be assigned to the current or to the next month, or merely be set to the default value of unity. The concise statement below implements the necessary outcomes, but the use of the 'multiply' operator renders the logic somewhat obscure. Because of this, a flowchart is also provided, in the interests of a fuller explanation.

=IF(A3<>A2,1, { if adjacent records are not for the same company, insert default}

IF(L2*(M2-L2)>0,IF(P2="",1,P2), { Select default or ADJ2 from previous month only if the *previous* Transaction Date is earlier than the 'Ex-' Date}

IF(L3*(M3-L3)>0,IF(P2="",1,P2), { Select default or ADJ2 from previous month only if the *current* Transaction Date is earlier than the 'Ex-' Date}

IF(P3="",1,P3)))) { If neither of the above Date relationships hold, select default or ADJ2 from the *current* month }

Field (A) is Company Number, (L) is Transaction Date {"0" implies 'end of month'}, (M) is 'Ex-' Date within month, (P) is raw Adjustment Factor (ADJ2) from the database.

The next three fields serve to provide the correction discussed under CPR3, above.

BackCalc (V) implements the reverse algorithm to that used to calculate log-returns in the first instance; being in essence a process of integration, it requires an initial price to be set, from whence it uses Returns data to calculate prices:

=IF(Z3=1,S3,T2*EXP(F3)*U3-AA3*U3/100)

If the record represents the first return for the particular company, or is the first return after a break in the series, (Zn = 1; see derivation of field (Z) below), then the current value from CPR2, Field (S), is input to the cell; this is therefore 'equal' by construction, so that any differences (W) need to be identified in subsequent records. These (records) are loaded with the antilog of ZRET, the logarithmic return (F), factored by the previous value of CPR3, and corrected by subtracting out the effect of any dividend payment; both components of the sum are corrected for adjustment factor (U). (AA) is the corrected (time-shifted-if-necessary) dividend stream.

Diff (W) is given by: =IF(S3=0,0,(S3-V3)/S3); after screening for occasional instances of a zero price for CPR2 (much reduced in frequency compared with CPR1, following the correction which generates CPR2), the normalised difference between the prices (CPR2 vs. BackCalc is returned.

Threshold (X). In order to facilitate selection (of CPR3) between the price series CPR2 and BackCalc, a threshold of difference (Diff(W)) determines the value of Threshold as '0' (Threshold not exceeded) vs. '1' (Threshold exceeded). The threshold is set to correspond to a 10% difference between the two price series; the rationale for this choice of value is that, for a relatively small number of single samples (one month's datum for one company), such a difference in calculating dividend yield will not significantly influence the final regression analysis result, even in the (less likely) event that the choice made between the two alternatives is incorrect. The threshold could, of course be increased or decreased; decreasing the threshold will produce more reversions to the price series based on Returns. There is, however, a rationale for minimising the frequency of reversions, and (relatedly) not prolonging runs of values based on Returns. Firstly, like any integration process, the calculation is subject to drift, being dependent on its predecessor value's accuracy; secondly, there is a tendency for the Returns price series, through its influence in determining CPR3, to 'capture' the price determination process, thereby producing potentially long runs.

Accordingly, two steps are taken to prevent this state of affairs; firstly, the threshold is set so as to deal only with relatively large discrepancies, such as might be caused by a clear anomaly in the series CPR2. Secondly, the length of runs are limited to 2, which is found (empirically) to be sufficient to deal with the issues described above; in particular, that of the problem of the delay in the original price series' responding to share capital changes.

The equation for the threshold is : =IF(ABS(W3)>0.1,1,0);
and that for the selection to CPR3 is (at line 5):

=IF(ROW()<5,S5,IF(Z5<3,S5,IF(X2=1,S5,IF(X5=1,V5,S5)))).

Here, from line 5 onwards, the logic 'looks back' three records prior to the current record; should that particular record have exceeded the threshold (and therefore selected the Returns price series) then an enforced reset to the selection of CPR2 takes place. Otherwise, the selection proceeds to a choice based upon the current threshold. This limits the length of the 'run', as described above. Prior to line 5, the first conditional statement causes the value of CPR2 to be loaded, since the system cannot 'look back' beyond the start of records.

MonthNo (Y) is calculated from the Year/Month date: =B3*12+C3.

RetInd2 (Z) is similar to valid returns index RetInd (E), except that in the event of a break in the continuous returns record, RetInd2 is reset to 1:

=IF(E3=1,1,IF(Y3-Y2=1,Z2+1,1))

MT1 (AA) is the corrected (time-shifted-if-necessary) dividend stream (see above), calculated in a similar fashion to the adjustment factor:

=IF(A3<>A2,G3,IF(L2*(H2-L2)>0,IF(G2="",0,G2),IF(L3*(H3-L3)>0,IF(G2="",0,G2),IF(G3="",0,G3))))

MT2 (AB) represents the Total Dividend paid to all shareholders on each occasion a dividend is paid. It is calculated as:

=AA3*AE3*U3/10000000

i.e. the Dividend per Share (in hundredths of pence), corrected for adjustment factor (U) and multiplied by the number of shares in issue (000's). The scaling factor returns the total dividend in units of £M. This calculation facilitates the determination of a rolling annual total even when a (non-unity) adjustment factor appears within the rolling 12-month period (see below).

Roll_Total (AC) is the rolling average annual total dividend payment for the 12 month period immediately preceding the current month in which it is expressed (Section 3 has more detail on the derivation and underlying rationale for this parameter). It is first calculated in Line 14, with blank cells substituting for values (RetInd2<13) which cannot be calculated. The test involving Company Number (A) ensures that the span of values being summed pertain to the same company, for obvious reasons.

```
=IF(Z14<13,"",IF(A14=A2,SUM(AB2:AB13),""))
```

Div_Yld (AD) is calculable one month later than Roll_Total, with the formula at Line 15 being as follows:

```
=IF(Z15<14,"",IF(T2=0,"",IF(A15=A2,AC15/AF3,"")))
```

Potential 'Divide by zero' errors are trapped by the second conditional statement, though again, their occurrence in the database is rare given the correction which generates CPR2

Corr_ShC (AE) maintains an up to date record of the number of shares currently in issue in any given month for each individual company:

```
=IF(ROW()=2,O3,IF(A3-A2<>0,O3,IF(C3=1,O3,AE2/U3))) {Line 3}
```

For the first (non-header) row in any of the files, the datum is taken from Ish_Cap (O), looking horizontally along the record for the 'current' value. By virtue of the way in which the database tables were joined earlier, each month of a particular calendar year will carry the same (annual) count. The usual test for Company Number follows, again with current data being retrieved in the case of the first record for a new company. As the annual data is refreshed each January, current data is loaded for this month from Field (C). For all other situations, the 'current' count is derived from the previous, being adjusted as necessary by division by ADJ3 (U).

C_MCAP (AF). The final field required is the 'Corrected MCAP', calculated as the product of current share price from CPR3 (T) and Corr_ShC (AE), expressed in £M. This series provides a more dynamic representation of Capitalisation than the annual (beginning of Year) MCAP data provided in the Returns file. It also has the significant advantage of having greater magnitude resolution than the integer (£M) MCAP figures quoted, which greatly facilitate the sorting and separation of smaller companies into portfolios.

```
=IF(ROW()=2,"",IF(A3-A2<>0,"",IF(AE2<0,"",AE2*T2/100000)))
```

The 3rd conditional clause ensures that 'No Information' codes for Share Capital (negative numbers) result in blank cells. In line with convention (e.g. Christie(1990), the Capitalisation for month t is taken as that for the beginning of the month. This is assumed to be identical to that for the end of the previous month, t-1; accordingly, the last available price for t-1 is used, together with month t-1's Share Capital, in the calculation.

3.2 The Secondary Database

On completion, the 14 large spreadsheet files are loaded into a 'Secondary' database having all 32 (17 original plus 15 derived) fields. A final (calculated) field is added, which converts the log. Returns to Net Simple Returns, in order to facilitate the aggregation of stocks within individual portfolios (see following paragraph). From this point, having re-integrated all of the companies whose longitudinal (time series) data has been augmented by the (now 18) calculated fields, the focus of interest will essentially be cross-sectional. For convenience in terms of file number and size, but also to facilitate seasonal investigation, the cross-sectional data will be partitioned on an annual, rather than a monthly basis. Thus the secondary database will be used to load 43 files containing all relevant data for a particular calendar year, each covering all companies which are current in the database over the years 1955 to 1997 (inclusive). Sorting into Yield / Size portfolios will be executed on a month-by-month basis, however. These operations are described in more detail below.

Note on calculation of Returns: The form in which Returns are lodged in the database (logarithm of the gross return, $ZRET = \log_e(1 + R_t)$), is intended to facilitate the calculation of multi-period, compounded returns. Successive values of $(1 + R_t)$ are effectively multiplied (or their logarithms added), in order to generate the equivalent multi-period return. However, when a single-period (e.g. 1 - month) portfolio return is required to be calculated from returns of individual component stocks, this measure is not appropriate, in spite of the fact that it represents an approximation for small values; (in some cases, individual monthly returns may not be considered 'small'). Rather, the portfolio return, R_p is given by the simple average (assuming equal weighting) of its component stocks:

$$R_p = (R_a + R_b + \ldots\ldots\ldots R_n) / n$$

This requires the conversion of the log-of-gross-return form to the net simple return according to the relation: $R_t = \exp(ZRET_t) - 1$.

Table 3.4 (below) shows the complement of the 33 Fields described above, together with the criteria employed. These are now discussed. As indicated above, the 'Year' criterion 'XX' ranges from '55' to '97'. The qualification period for new companies entering the database is such that 24 months of valid Returns data is required prior to permitting a stock to enter a portfolio; this issue is discussed further in Section 3. Additionally, following a break in a returns record sequence, a stock is required to produce 14 continuous months of returns prior to resuming its candidacy for inclusion. This is the minimum time needed to calculate Dividend Yield; however, the criterion is kept to this minimum in order to reduce the probability for stocks to lose all value while 'hiding' behind this 'mask', and thus fail to be recognised as posting a terminal' return of -100% (Net Return). Finally, firms are excluded while they are coded in the database with '-1' or '0' for Share Capital and '-1' for (Annual) Market Capitalisation (i.e. they do not have valid data recorded for these months); and similarly, exclusions are in force for 'Null' values of Dividend Yield and Corrected Market Capitalisation. In most instances, these negative features will appear 'in tandem' in affected records.

Eight of these fields are selected for export to the 'Year' spreadsheet(s) for onward processing; these are marked (*) in Table 3.4.

Table 3.4 The Secondary Database Table

	Field	Mnemonic	Org. Table	Sort Order	Criteria
1.*	Company Number	CoNum	RET97RET	Ascending	
2.*	Date (Year)	R_Year	RET97RET	Ascending	XX
3.*	Date (Month)	R_Month	RET97RET	Ascending	
4.*	Ind. Classification	INDX	LS97des4		
5.*	Return Index	RetIndex	RET97RET		>24
6.	Log. Return	ZRET	RET97RET		
7.	Dividend Payment	Month_Total	LS97DIV5		
8.	Ex-Dividend Date	X_Day(Max)	LS97DIV5		
9.	Transaction Price	TP	LS97pri4		
10.	Low Quote / Mid-Sl	LQ_MS	LS97pri4		
11.	High Quote / Cl. Pr.	HQ_CP	LS97pri4		
12.	Date of last Trade	T_Day	LS97pri4		
13.	Ex-Rights Date	R_Day(Max)	LS97CAP5		
14.	Price Marker	PM	LS97pri4		
15.	Issued Share Cap.	Ish_Cap	LS97shc4		>0
16.	Adjustment Factor	ADJ2	LS97CAP5		
17.	Market Capitalisation	MCAP	RET97CAP		>-1
18.	Composite Price Rec	CPR1			
19.	Composite Price Rec	CPR2			
20.	Composite Price Rec	CPR3			
21.	Adjustment Factor	ADJ3			
22.	Reverse Calculation	BackCalc			
23.	Difference	Diff			
24.	Threshold	Thresh			
25.	Month Number	MonthNo			
26.	Sec. Return Index	RetInd2			>14
27.	Monthly Total (1)	MT1			
28.	Monthly Total (2)	MT2			
29.	Roll Total	Roll_Total			
30.*	Dividend Yield	Div_Yld			Not Is Null
31.	Corrected Sh. Cap	Corr_ShC			
32.*	Corrected MCAP	C_MCAP			Not Is Null
33.*	Net Simple Return	NRET	(Calculated Field)		

3.3 The 'Year' Tables

As outlined above, the fields marked (*) are selected by query (incorporating the necessary selection criteria) into 43 'Year' spreadsheets (1958 - 1997), with the principal aim from this point onward being to rank and sort stocks into portfolios based upon both Dividend Yield and Market Capitalisation. Subsequently, the data is summarised in terms of the performance of the portfolios rather than in terms of individual stocks.

Details of the theoretical issues which underpin this method of approach are deferred to Section 3; at this juncture, the processing necessary to achieve the above aims is outlined.

In an analogous fashion to that described above for the derivation of the secondary database, 6 calculated columns are added to the (9) original fields exported to the spreadsheet. These comprise the following (formulae are shown for record #3):

Table 3.5 (Quintile Assignments)

Field	Mnemonic	Formula
L: Dividend Yield Ranking	%RANK(D)	=PERCENTRANK(Jan,H3)
M: Dividend Yield Quintile	D_Quintile	=IF(L3>0.8,1,IF(L3>0.6,2,IF(L3>0.4,3,IF(L3>0.2,4,5))))
J: Capitalisation Ranking	%RANK(C)	=PERCENTRANK(Jan1,G4)
K: Capitalisation Quintile	C_Quintile	=IF(J3>0.8,1,IF(J3>0.6,2,IF(J3>0.4,3,IF(J3>0.2,4,IF(J3>=0,5,6)))))
N: Row Address	Row_Add	=IF(M3-M4<>0,ROW(),IF(M3-M2<>0,ROW(),""))
O: Log Capitalisation	LOGCAP	=IF(G3>0,LN(G3),0)

The treatment of Dividend Yield Ranking and Capitalisation Ranking is similar, and will be discussed together. The file records are first sorted, primarily by Month, and Secondarily by Dividend Yield. Then, in each case, the value in a single cell (e.g. 'H3', the value of Dividend yield, field 'H', record #3) is compared to all others within a 'Named Range'; in the case of the above example, "Jan". The range "Jan" corresponds to all cells in Dividend Yield Field 'H' which are characterised by their being 1) relevant to the month of January (for the particular year to which the file relates), and 2) have *non-zero* values for Dividend Yield. This relationship is identified by the fact that Month Field (D) values indicate month '1', and Field (H) values are non-zero. Beginning and Ending record numbers for each range are identified by a prior 'scan' which is described in more detail below. Zero-Dividend stocks are covered by a separate range in field 'H', ('Jan0'); this is also identified during the prior scan.

Once the Dividend Yield values are ranked in Field (L), they may then be tagged with Quintile identifiers (in Field (M)) according to whether the 'PercentRank' value places them in the range: 1>x>0.8 (1); 0.8>x>0.6 (2), etc. Quintile (5) embodies values in the range 0.2>x>0, but not including zero values, which are separately identified as Fractile (6).

The effect of the above manipulations is to produce six 'strata', or categories of stocks based upon Dividend Yield. Within each of these categories, a secondary process of breakdown according to Capitalisation takes place. The treatment of Capitalisation ranking follows similar lines; once DY 'Quintile' identifiers 1 - 6 have been assigned, six sub-ranges (e.g. Jan1 - Jan6) may be defined for each DY Quintile's span of records, within all months. These ranges are defined within Field (G), Market Capitalisation. The resulting rankings form Field (J); the corresponding Capitalisation Quintiles are recorded in Field (K), using once again a form of the multiple-branch conditional statement indicated above.

Since the average 'Year' file comprises more than 15,000 records, and each of the 43 'Year' files require to be subdivided into 30 Yield / Size portfolios for each of the 12 months of the year, it became highly desirable to automate the process of defining and calculating the relevant record ranges. The invocation of automation also contributes to the accuracy and consistency of the process, especially in view of the fact that it is inherently repetitive in nature, and moreover, this allows for the additional processing which is required to build complete 'Year' files which form a precursor to the summarising of portfolio data.

The implementation of the above automation is effected through Visual Basic Programming, which serves as an adjunct to the basic Spreadsheet format. Each 'Year' file, created from the database query and loaded with the initial 9 Fields, is also loaded with a generic VB Program. This program is edited to adapt a small number of parameters, and a single table, to suit the individual year (e.g. 1980). The process consists of 2-stages, each of which is called by a calling routine. The full program will be briefly summarised in this section. Stage 1, called by 'InitData', performs the following three routines:

1) <u>FirstSort:</u> performs the sort by Month, Dividend Yield and Market Capitalisation. (See above).

2) <u>Rowfinder:</u> performs the scan, identifying 24 row numbers (2x 12 months) corresponding to the start of ranges, plus the end of the last range.

3) <u>BuildCode</u>: creates a new worksheet ('CodeBld) and copies a template to it, followed by the 25 scanned row values. End-of-range values are calculated, and the numerical information converted to text; thereafter, a process of text concatenation builds appropriate syntax around this information, producing a segment of valid VB code which is then transferred via a Copy / Paste operation as part of the editing process for the 'Year'.

On completion of editing, the remaining processes take place fully automatically as Stage 2. Called by 'Procdata'; the following seven routines contribute to the assembly of a further five worksheets (seven in total) which make up the completed 'Year' file.

4) <u>MonthRange:</u> adds fields %Rank(D) to RowAdd to the original dump from the database (see above), and uses the information in the pasted table to firstly create named ranges (via a further subroutine call), and subsequently to load these ranges with the appropriate formulae, as described in Table 3.5.

5) RowCalc: Following the above operation, 12 'month ranges' have been created each having 5 subdivisions according to Dividend Yield, and a further 12 'month ranges' hold the Zero-Dividend stocks. Each of the 72 ranges is defined by a 'start' and 'end' row number; these values, and their text equivalents, are grouped and stored in a separate worksheet ('RowNum') for use in the next part of the process, the ranking according to market size.

6) QuintileRange: In a similar operation to that of the determination of Dividend Yield quintiles (though without the added complication of determining a separate sixth category as for Zero-Dividend stocks), a second-level set of named ranges is calculated to facilitate the subdivision of each of the above 72 ranges into 5 size-based quintiles. This results in the completion of fields %Rank(C) and C_Quintile (Table 3.5).

7) CalcPivot1: With the completion of the primary data worksheet, data is available for summarising. A pivot table, comprising 12 sets of 6 (DY) x 5 (Cap) Row-column matrices, together with Row, Column and 'Corner' averages, is constructed in a new worksheet 'Averages'. Cells in the body of the matrix contain the effective returns, expressed as simple averages of the (assumed equally weighted) constituent stocks.

8) CalcPivot2: produces an identically formatted pivot table having in its data section the *count* of constituent stocks within each portfolio, together with totals for each subdivision according to category (Dividend Yield or Market Capitalisation) and a 'Grand Total'.

9) Summarise: produces monthly portfolio returns in a similar fashion to CalcPivot1, but in a form more appropriate for submission to the statistical analysis package, whereas Pivot Tables produce a format more easily interpreted on visual inspection. Summarise first adds a column to calculate the Logarithm of Market Capitalisation, and, after calculating the portfolio returns, copies these to a final worksheet entitled 'Summary1'.

10) Dquint: has a dual function. Firstly, it adds columns to the 'Summary1' data which calculate a unique portfolio number (in the range 1 to 30) corresponding to the 6x5 Yield / Size categories; it also adds a unique 'Month Number'

corresponding to the Year / Month values in columns 'B' and 'C'. (Month No. 1 is defined as January, 1900). Secondly, it formats the column widths of the data columns.

3.4 Aggregation of the Summary Data

At this stage, the desired summary information is distributed among the 43 'Year' files, and needs to be brought together prior to the process of aggregating, or 'grouping', individual company data into portfolios which are constructed according to the desired criteria. This process represents the preparation of the files required for statistical analysis.

This information has two components; the monthly data related to the 30 individual portfolios, and the monthly average return over all portfolios. The latter figure is taken to be the performance of the 'Market' for the month concerned. In addition, information related to the Risk Free rate, and available from the Primary database, needs to be included in the data for statistical analysis, in order to express data in 'Excess Returns' form. The approach adopted is as follows.

The individual company data from the 'Year' files, now incorporating the Dividend Yield strata identifiers ('1' corresponding to the highest yield strata, '6' to the Zero-Dividend strata), and the Market Capitalisation quintiles ('1' highest capitalisation, '5' lowest, within each dividend-yield stratum) is collected into a single database file. Use of the 'Group By' aggregation function within the database software enables aggregation of the individual firm data within each month into 30 Yield / Size portfolios. Coupled with the fact that there are 480 months within the 40-year period of interest (1958-1997), this results in an aggregation file holding 14,400 records.

A similar grouping procedure, this time over all firms in a given month, delivers the 'Market' performance for each month in the form of 480 records.

The above data components, in the form of database tables, are merged in a Tertiary database, to which is straightforwardly copied the 'RiskFree' table from the Primary database (see above). The three tables are joined by their 'MonthNo' fields, and effectively provide 'Market' and 'RiskFree' field extensions to the 14,400 'Portfolio.Month' sample records. These records now require only to be augmented by a number of calculated fields prior to being submitted for statistical analysis. The following table (Table 3.6) details the field structure of the final table, with the additional (calculated) fields being listed with their formulae.

Table 3.6. Tertiary Database Table

Field	Field Name	Description	Source / Formula
A	R_Year	Year of Data	Summary
B	R_Month	Month of Data	Summary
C	MonthNo	Calculated Month Number	Summary
D	D_Quintile	Dividend Quintile	Summary
E	C_Quintile	Capitalisation Quintile	Summary
F	PortfolioNo	Portfolio Number (1 - 30)	Summary
G	NRET	Portfolio Net Return	Summary
H	RF_Return	Risk Free Rate (T/Bill)	RiskFree
I	Market	'Market' Net Return	Market
J	Div_Yld	Dividend Yield	Summary
K	C_MCAP	Market Capitalisation	Summary
L	LOGCAP	Mean of Logs of Ind. Stock Size	Summary
M	LMCAP	Log of Mean C_MCAP	=IF(K2>0,LN(K2),0)
N	XSRET	Excess Return on Portfolio	=G2-H2
O	MKTXS	Excess Return on Market	=I2-H2
P	DJAN	Dummy Variable for January	=IF($B2=1,1,0)
Q	DAPR	Dummy Variable for April	=IF($B2=4,1,0)
R	DSEP	Dummy Variable for September	=IF($B2=9,1,0)
S	DZERO	Dummy Variable for ZD Stock	=IF(D2=6,1,0)
T	DJ_MKT	Interaction Variable (Jan - Mkt)	=P2*$O2
U	DA_MKT	Interaction Variable (Apr - Mkt)	=Q2*$O2
V	DS_MKT	Interaction Variable (Sep - Mkt)	=R2*$O2
W	DJ_ZERO	Interaction Variable (Jan - Zero)	=P2*$S2
X	DA_ZERO	Interaction Variable (Apr - Zero)	=Q2*$S2
Y	DS_ZERO	Interaction Variable (Sep - Zero)	=R2*$S2
Z	DJ_DIV	Interaction Variable (Jan - Div)	=P2*$J2
AA	DA_DIV	Interaction Variable (Apr - Div)	=Q2*$J2
AB	DS_DIV	Interaction Variable (Sep - Div)	=R2*$J2
AC	DJ_CAP	Interaction Variable (Jan - Cap)	=P2*$L2
AD	DA_CAP	Interaction Variable (Apr - Cap)	=Q2*$L2
AE	DS_CAP	Interaction Variable (Sep - Cap)	=R2*$L2

With the final data table in place, analysis may proceed. Several different forms of analysis are undertaken, these falling broadly into the following categories:

1) Non-risk adjusted tabulation of Returns (and Standard Deviation of Returns) vs. Dividend Yield and Market Size for individual portfolios, and (similarly) for Returns vs. Dividend Yield for Dividend Yield categories (strata). This analysis is then extended by opening a 'Seasonality' dimension.

2) Risk-adjusted tabulation, based upon a simple CAPM model, for the above.

3) A comprehensive Risk-Adjusted analysis covering all portfolios over the following periods:

a) The full (40-year) period 1958 - 1997 (inclusive)

b) 2x 20-year 'half' periods 1958 - 77, 1978 - 97.

c) 31x rolling 10 - year periods commencing with 1958 - 1967 (rolled annually)

d) The period February 1975 - December 1993 (in order to facilitate comparison with an earlier paper using the LSPD data, Morgan and Thomas (1998).

4) Additionally, a number of Tables and Figures displaying contextual data:

a) Two-way classification of numbers of stocks in Dividend Yield and Size portfolios

b) Two-way classification of stock capitalisation

c) Table showing total numbers of stocks in the sample over time

d) Figure showing numbers of stocks in High Dividend and Zero Dividend categories over time.

With the data suitably organised, the empirical work proceeds.

4.0 The Determinants of U.K. Stock Returns

4.1 Introduction

This chapter represents the first of three sections which are devoted to empirical analyses of diverse but related aspects of Stock Returns performance. The present chapter aims to examine the adequacy of the 'pure' form of the Capital Asset Pricing Model (CAPM) first discussed in Chapter 2, in the sense in which (excess) returns may be adequately 'explained' by reference purely to a single parameter, that associated with the return on the Market portfolio. The approach in general is to propose additional explanatory variables, with the null hypothesis that these additional variables have no significant role to play in a mathematical model which purports to explain returns behaviour, against an alternative which holds that one or more of the coefficients associated with new explanators is/are of significance.

The question then reverts to which particular additional variables should be brought into consideration in order to fulfil this role. Guidance is provided by prior literature (Chapter 2), subject to the inevitable constraint as to data availability, albeit from a source of UK Stock Market data recognised as being most comprehensive (Chapter 3). In essence, the current chapter builds primarily upon the methodology of Morgan and Thomas (1998), (hereafter MT(1998)), and its associated antecedent literature; most notably Banz (1981), Christie (1990), **Clare, Smith and Thomas (1997)** and **Keim (1985)**.

The particular contribution of this chapter is to extend the above-referenced work in a number of important ways. Given the implied emphasis on smaller firms[78], an improved measure of firm size is generated from the available data (see following section). Secondly, an additional explanator (Payout Ratio) is brought into play, largely based upon the perceived need to improve the model by incorporating earnings information (after the three-factor model of Fama and French (1992)[79]), but in a way designed to avoid potential collinearity effects in relation to the Dividend Yield regressor. Thirdly, the methodology is extended to

[78] Zero-Dividend companies, by and large, tend to be smaller companies.

[79] After initial consideration as a factor, the use of Earnings to Price ratio was ultimately substituted by a Book to Market Value in FF(1992), whilst recognising that the two are close proxies for measuring 'Relative Distress'. Data availability constraints here preclude the use of B/M; Earnings data is, however, available and is used here.

include a more robust estimation method, that of Generalised Method of Moments (GMM)[80]. Fourthly, a drive is instigated toward a more parsimonious model, in the spirit of **Hendry (1995)**, which in turn assists the process of (fifthly) incorporating joint estimation techniques, thereby allowing the judicious imposition of targeted restrictions, enabling greater insights into the special nature of specific portfolios than is afforded by the (inevitable) 'common value' restriction inherent in the coefficient of (e.g. Beta) in the earlier regressions.

4.2 Data and Methodology

The empirical analysis begins with an examination of stock returns over the period of January 1958 to December 1997, and in particular with the relationship of monthly total Returns to Dividend Yield, Market Capitalisation and Seasonality. This (40-year) span of complete calendar years not only makes virtually full use of the available relevant data in the London Share Price Database (LSPD), but lends itself well to the analysis of sub-periods; both 'half' and 'quarter' period studies are easily incorporated. Moreover, the first 10-year quarter-period includes an initial 8½ years prior to the incorporation of capital gains tax in the UK in 1965.

Initially in this chapter, the methodology of MT(1998) is closely followed, albeit in the context of the period of interest extending their 1975-93 time frame with both earlier and later data (see above). In addition, in order not to exclude a disproportionate number of small capitalisation and Zero-Dividend stocks (see, in addition, Christie (1990)), the pre-qualification period is reduced from the 60 continuous months of Keim (1985) to 24 months[81]. Additional tests in MT(1998) showed this reduction to be methodologically acceptable. In view of the importance attached in this paper to Zero-Dividend stocks, however, the incorporation of Market Capitalisation information differs from that of earlier papers. The method of sorting used by Keim (1985) avoids the imposition of a 'hierarchy of sorts' as between Dividend Yield and Market Capitalisation. Rather, two separate sorts were carried out, enabling individual stocks to be 'tagged' with their quintile identifiers; the two 'tags' then functioning as co-ordinates in assigning stocks to their appropriate portfolios within a 2-dimensional dividend yield / market capitalisation matrix. The 'even-handed' approach avoids *a priori* 'favouring' of either factor, but suffers from the problem of

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[80] The rationale for this addition is more fully covered in following sections.

[81] It is the case that each additional 12 months of pre-qualification, up to 5 years, reduces the number of companies featuring in the data set by over 8%. This figure, compounded, would result in over one third of UK returns records being excluded from consideration by the 60-month rule; at 24 months, the reduction is less than one sixth.

engendering a highly asymmetric assignment to certain portfolios; thus in MT(1998, Table 3) 60.9% of all Zero-Dividend stocks were assigned to the smallest capitalisation / Zero-Dividend portfolio, and only 3.3% of Zero-Dividend stocks were assigned to the largest capitalisation / Zero-Dividend portfolio. Quite simply, the majority of Zero-Dividend firms are small; and, amongst small firms (those in the lowest size quintile), Zero-Dividend firms are the largest grouping, standing at almost one-third of the total, twice the number of the next nearest dividend yield group. This co- incidence of measures results in the asymmetry described. (In contrast, Table 4.1 below shows the numbers of samples assigned to each portfolio by the method of formation described in the following paragraphs. Apart from the unavoidable numerical imbalance between Zero-Dividend stocks and individual quintiles of dividend-paying stocks[82] due to the differing selection criterion, the portfolios within the matrix are closely similar in size).

Given that an implied 'hierarchy of sorts' derives from the above discussion, the question now posed is as to which, of dividend yield or market capitalisation, should form the basis of the primary sort, and which the secondary. Three reasons are given for the choice of dividend yield as the primary sort candidate. Firstly, the hypothesis that dividend yield is the more dominant effect is plausible, and supported by some evidence (Keim (1985)); secondly, dividend yield is (at least in part) a policy parameter under the control of firms, in a way in which size clearly is not. Thirdly, methodological compatibility with the literature quoted earlier facilitates comparison of results, at least up to the point of divergence of method.

Thus portfolio formation by (initially) Dividend Yield closely follows Keim (1985), Christie (1990) and MT (1998), except that the 'Dividend Announcement' criterion favoured by Christie (1990) is rejected as impractical in the UK context, due to lack of data; (only 55% of company data incorporates the information necessary to implement this scheme). Rather, the 'usual' computation[83], based upon the sum of dividends DIV_T, paid in the months t_{-12} to t_{-1}, divided by the price of the stock at time t_{-13}, (P_{t-13}) :

$$DY_t = 1/\,P_{t-13} * \Sigma_{t-13}\, DIV_T \;\;\ldots\ldots(1)$$

[82] Only chance would engender perfect balance here, but the relaxation of the qualification period to 24 months does serve to admit a proportionately larger complement of Zero-Dividend stocks, thus militating toward parity.

[83] It has been argued by some that a 'fresher' measure of Dividend Yield is afforded by division by P_{t-1} rather than P_{t-13}; however, Keim(1985) claims to have used both measures with little quantitative or qualitative difference in result.

Using this measure, the population of firms is ranked each month, and subdivided into six groups; non-Zero-Dividend firms being formed into quintiles, with Zero-Dividend firms remaining as a distinct group. Certain preliminary analysis was carried out using the six equally-weighted portfolios deriving from the above scheme; however, for much of the remaining work, the additional, separate subdivision based on Market Capitalisation was necessary. Thus, each of the six Dividend Yield groups was further subdivided, being ranked, internally, according to size; 30 portfolios, summarised in Table 4.1 (below, and referred to above), were formed.

Table 4.1

Two-way classification of stocks by 1) Dividend Yield Group and 2) Market Capitalisation Quintile (Jan 1958 - Dec 1997)

	Large	2	3	4	Small	Totals	%
High Divd.	23441	23324	23342	23334	23723	117164	17.499
2	23579	23459	23475	23461	23849	117823	17.597
3	23572	23462	23452	23450	23849	117785	17.592
4	23575	23441	23456	23475	23829	117776	17.590
Low Divd.	23753	23631	23646	23647	24014	118691	17.727
Zero Divd.	16123	15959	15964	15965	16297	80308	11.994
Totals	134043	133276	133335	133332	135561	669547	100
%	20.020	19.905	19.914	19.914	20.247	100	

The units above are 'Company x Month' sample records falling into particular portfolios across the entire (480 month) period.

In order to develop a responsive, dynamic measure of market capitalisation of the sort recommended by Christie (1990), (see below), the market capitalisation data presented in the Returns file of the LSPD was rejected in favour of an alternative measure. The (Returns File) market capitalisation data suffers from poor resolution, both in terms of magnitude and of time; amounts are given to the nearest integer £1M, too crude a measure to rank smaller firms in a fashion smooth enough to result in balanced quintiles; and the data is annual, which precludes the rapid re-classification required in order to take account, in particular, of firms announcing dividend cuts and suffering rapid changes in share price as a result.

The measure of market capitalisation used here is based upon the product of share price (at the end of the preceding month) and the number of shares outstanding. The latter figure is given each year in explicit form for the beginning of January; this information is factored (if necessary) through the year, using the 'Adjustment Factor' which is provided to take account of capital changes (e.g. Scrip, Rights issues, etc.). Thus in the months February - December, the number of shares outstanding is taken as being unchanged from the previous month, unless an Adjustment Factor is quoted; however, each January, the 'annually updated' figure is taken as definitive[84].

The result of these manipulations is the system of 30 (6x5) portfolios, ranked primarily by Dividend Yield and secondarily (i.e. within dividend category) by Market Capitalisation, as indicated in Table 4.1. Portfolios are dynamically re-balanced on a month-by-month basis on both criteria. This ensures that each portfolio remains populated by 'like' firms through time. For each portfolio, there exists a time series of 480 monthly observations. Figure 4.1 shows the variation, with time, of the number of samples in the Zero-Dividend category (across all firm sizes), and, arbitrarily chosen as typical, the corresponding number of firms in the highest yield category. (Numbers in the other dividend-paying yield categories are closely similar, differing only because the system of ranking leaves occasional 'N^{th} = ' samples grouped together). Thus numbers of firms in the Zero-Dividend category approximate to 100 in the first half sub-period, fluctuating and rising to 250 by the end of the second sub-period. Numbers in the dividend paying quintiles both begin and end at 250, but with declining trends punctuated by two 'step' increases between February and March 1973 and between January and February 1977, due to significant new admission changes to the LSPD Database which had occurred two years previously to these dates, and which (firms) had now emerged from the 24- month qualification period[85]. Only the latter of these step increases, however, significantly affects the Zero-Dividend stock numbers. The subdivision of these stocks by Capitalisation is substantially equal; thus, at the end of the period, the number of firms in each of the 30 portfolios approximates to 50.

Table 4.2 shows a summary of the number of firms in the total sample during each month throughout the period. It shows that the minimum number of firms in any one monthly sample was 877, (January 1973) shortly before the 'step' increase of that year from 880 to1246 (Feb/Mar). The maximum, 2022, occurred in February 1977 following the step increase (of qualified firms) for *that* year, having stood at 1224 during the previous month.

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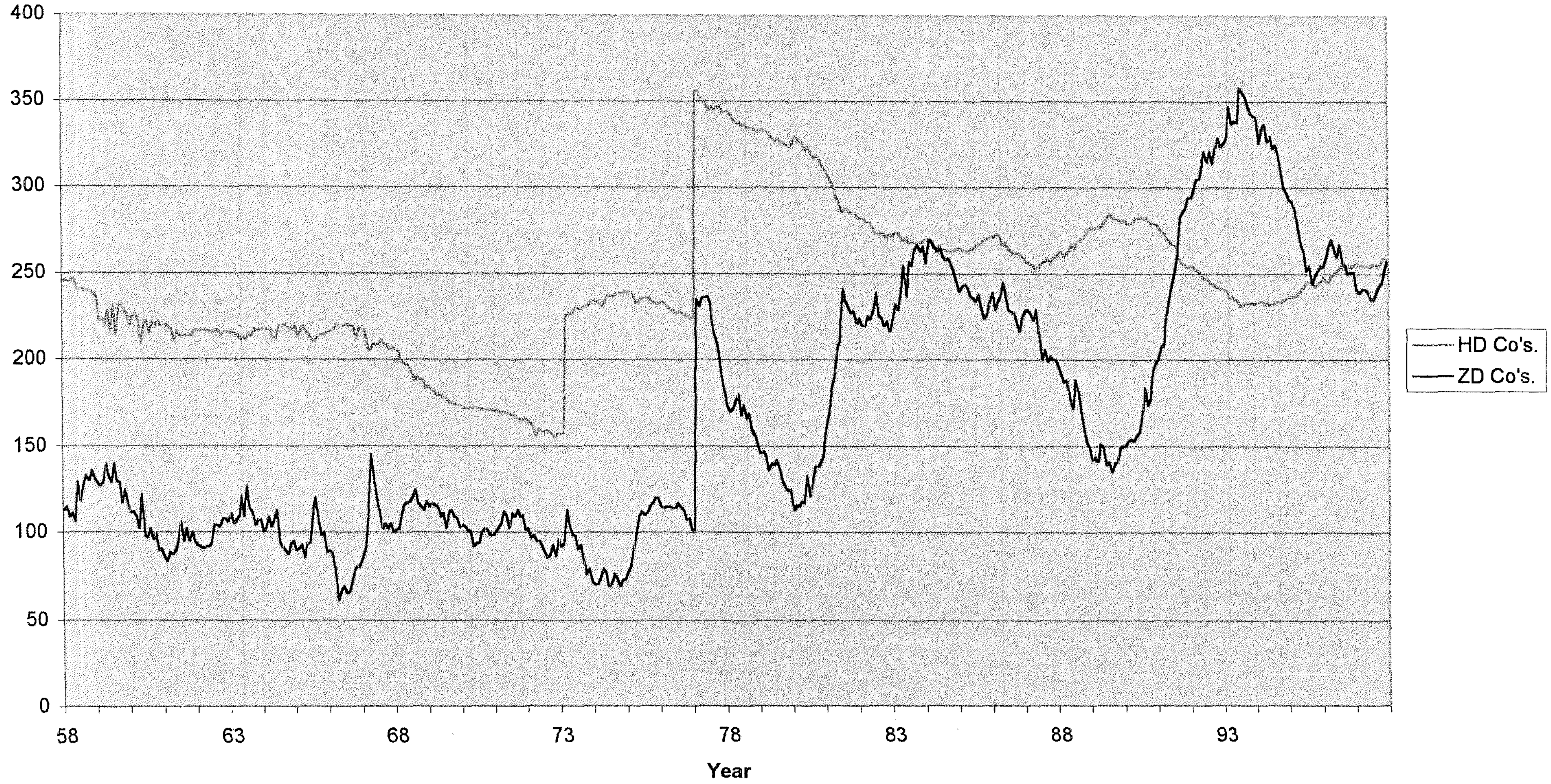
[84] Discrepancies are in any case small, and are ascribed to the timing of the measurements; however, using the above scheme, potential errors are not allowed to cumulate beyond 11 months.

[85] In 1971, the largest companies (by market value in 1976) and "Times top 1000" 1976 (quoted companies only) were added to the LSPD database, and in 1975, "All British quoted companies" were included. Other, smaller samples were added at various other times, but these two tranches represented the major additions.

Figure 4.1 - Numbers of High Dividend and Zero Dividend Companies.



Sum of Count	Month												
Year	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
58	1353	1351	1348	1346	1345	1344	1342	1339	1336	1334	1333	1325	16096
59	1319	1314	1311	1304	1306	1301	1299	1292	1286	1281	1275	1267	15555
60	1257	1252	1241	1231	1229	1220	1214	1213	1211	1207	1202	1199	14676
61	1193	1187	1182	1181	1178	1177	1175	1174	1173	1179	1181	1179	14159
62	1180	1178	1176	1179	1180	1181	1183	1191	1187	1189	1190	1190	14204
63	1189	1187	1188	1183	1178	1179	1186	1193	1194	1192	1193	1195	14257
64	1191	1195	1196	1195	1196	1193	1194	1193	1192	1190	1189	1190	14314
65	1192	1186	1183	1185	1179	1170	1170	1175	1174	1176	1174	1169	14133
66	1176	1174	1174	1167	1164	1167	1168	1173	1176	1179	1179	1178	14075
67	1177	1179	1181	1182	1183	1172	1163	1159	1155	1147	1146	1140	13984
68	1134	1134	1127	1111	1103	1103	1089	1081	1075	1067	1060	1050	13134
69	1044	1034	1033	1022	1015	1004	997	995	990	987	983	983	12087
70	974	966	964	962	954	956	957	961	958	957	958	957	11524
71	961	960	955	964	960	957	960	957	946	943	936	932	11431
72	928	917	909	900	895	887	882	883	882	881	878	881	10723
73	877	880	1246	1244	1242	1245	1244	1243	1241	1238	1241	1247	14188
74	1246	1244	1242	1245	1250	1257	1263	1267	1270	1266	1275	1280	15105
75	1281	1288	1288	1286	1287	1289	1292	1296	1298	1291	1289	1286	15471
76	1284	1281	1277	1267	1261	1260	1256	1257	1251	1239	1235	1226	15094
77	1224	2022	2016	2005	1996	1985	1972	1962	1944	1941	1935	1913	22915
78	1902	1899	1890	1881	1873	1866	1862	1860	1850	1840	1833	1825	22381
79	1819	1822	1816	1806	1801	1793	1793	1788	1770	1770	1758	1753	21489
80	1747	1772	1765	1763	1753	1750	1747	1742	1732	1733	1732	1721	20957
81	1718	1712	1707	1700	1690	1682	1675	1673	1674	1666	1657	1650	20204
82	1644	1637	1635	1631	1628	1618	1613	1601	1597	1591	1584	1588	19367
83	1586	1609	1606	1605	1604	1598	1603	1607	1610	1610	1610	1614	19262
84	1609	1618	1615	1595	1594	1599	1586	1581	1580	1577	1573	1571	19098
85	1571	1568	1566	1560	1563	1564	1575	1581	1579	1578	1583	1592	18880
86	1600	1596	1604	1600	1587	1580	1560	1550	1544	1537	1529	1533	18820
87	1526	1519	1514	1504	1500	1490	1487	1495	1500	1494	1499	1506	18034
88	1511	1511	1502	1504	1503	1510	1518	1533	1525	1521	1529	1532	18199
89	1534	1528	1529	1540	1545	1557	1564	1567	1560	1555	1558	1557	18594
90	1562	1555	1556	1564	1573	1572	1589	1599	1596	1589	1594	1596	18945
91	1594	1589	1586	1592	1593	1586	1590	1593	1578	1577	1568	1570	19016
92	1574	1573	1572	1570	1561	1559	1556	1546	1541	1537	1538	1533	18660
93	1536	1533	1529	1524	1518	1513	1515	1520	1521	1512	1512	1508	18241
94	1509	1500	1507	1500	1494	1495	1488	1499	1492	1478	1481	1483	17926
95	1483	1481	1474	1475	1476	1478	1485	1486	1479	1471	1475	1492	17755
96	1498	1493	1501	1520	1526	1525	1538	1542	1536	1529	1528	1533	18269
97	1528	1521	1520	1523	1520	1512	1522	1523	1517	1535	1550	1554	18325
Grand Total	55231	55965	56231	56116	56003	55894	55872	55890	55720	55584	55543	55498	669547

Table 4.2 Number of firms in sample (by Year / Month)

The opening figure (Jan 1958) was 1353, the closing (Dec 1997) 1554. The whole-period average was 1395.

Table 4.3 indicates the 'typical' capitalisation spread within portfolios by showing the transition thresholds of capitalisation (for each Dividend Yield category) between adjacent market capitalisation portfolios, for the end of the period (December 1997). These are considered to be more insightful than nominal values averaged over a period during which inflation averaged some 6½ %.

Table 4.3
Maximum capitalisation (£M) of companies in each of 30 portfolios (December 1997).

	Large	2	3	4	Small
High Divd.	29088.2	203.6	46.4	22.9	9.4
2	25838.8	532.5	106.1	40.4	16.8
3	48743.0	475.8	130.6	46.6	22.2
4	17952.7	460.6	163.5	66.6	21.5
Low Divd.	32271.8	535.7	150.9	53.2	21.0
Zero Divd.	2999.4	55.3	12.4	6.2	2.8

4.3 Initial results for raw returns

Following MT(1998), average returns and dividend yields are tabulated for each of the 6 dividend yield portfolios; in this case, with the benefit of the greater number of samples in the extended full period, it becomes feasible in addition to do likewise for the 30 dividend yield / market capitalisation portfolios. These results are firstly presented (Table 4.4) in the form of (averaged) net simple returns, appropriate for the aggregation, cross-sectionally, of individual stocks within portfolios (each month). In addition, (Table 4.5) they are also shown as equivalent monthly compounded portfolio returns, in order to reflect the performance of each of the portfolios longitudinally over the full time period. In each case, the rightmost column shows the results for the 6 Dividend Yield portfolios.

		C_Quintile					
D_Quintile	Data	1	2	3	4	5	Grand Total
1	Average of NRET	0.0210	0.0202	0.0205	0.0234	0.0298	0.0230
	StdDevp of NRET	0.0571	0.0551	0.0516	0.0489	0.0448	0.0518
	Average of Div_Yld	0.1099	0.1127	0.1136	0.1201	0.1382	0.1189
2	Average of NRET	0.0177	0.0167	0.0187	0.0196	0.0236	0.0192
	StdDevp of NRET	0.0596	0.0565	0.0550	0.0509	0.0470	0.0540
	Average of Div_Yld	0.0720	0.0727	0.0729	0.0733	0.0735	0.0729
3	Average of NRET	0.0143	0.0159	0.0149	0.0158	0.0221	0.0166
	StdDevp of NRET	0.0595	0.0553	0.0536	0.0489	0.0481	0.0533
	Average of Div_Yld	0.0564	0.0565	0.0567	0.0568	0.0570	0.0567
4	Average of NRET	0.0132	0.0135	0.0133	0.0148	0.0195	0.0149
	StdDevp of NRET	0.0604	0.0591	0.0545	0.0529	0.0494	0.0555
	Average of Div_Yld	0.0427	0.0427	0.0429	0.0429	0.0428	0.0428
5	Average of NRET	0.0121	0.0121	0.0112	0.0116	0.0212	0.0136
	StdDevp of NRET	0.0635	0.0612	0.0592	0.0537	0.0532	0.0584
	Average of Div_Yld	0.0254	0.0250	0.0246	0.0240	0.0236	0.0245
6	Average of NRET	0.0131	0.0127	0.0190	0.0259	0.0580	0.0257
	StdDevp of NRET	0.0667	0.0663	0.0673	0.0756	0.0861	0.0747
	Average of Div_Yld	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total Average of NRET		0.0152	0.0152	0.0163	0.0185	0.0290	0.0188
Total StdDevp of NRET		0.0613	0.0591	0.0572	0.0562	0.0582	0.0586
Total Average of Div_Yld		0.0511	0.0516	0.0518	0.0529	0.0558	0.0526

Table 4.4 Mean and Standard Deviation of Net Simple Returns

(Including mean of Dividend Yield) - by Dividend Strata and Capitalisation Quintile.

Table 4.4.1

Net Simple Returns

(by month, and by Size Quintile)

		Month												
D_Quintile	Data	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
1	Average of NRET(1)	0.0542	0.0294	0.0174	0.0408	0.0054	0.0018	0.0177	0.0195	0.0105	0.0161	0.0118	0.0269	0.0210
	Average of NRET(2)	0.0530	0.0310	0.0262	0.0438	0.0181	-0.0006	0.0091	0.0143	0.0112	0.0115	0.0046	0.0199	0.0202
	Average of NRET(3)	0.0508	0.0304	0.0246	0.0382	0.0192	0.0033	0.0136	0.0174	0.0056	0.0161	0.0075	0.0196	0.0205
	Average of NRET(4)	0.0578	0.0313	0.0269	0.0402	0.0246	0.0117	0.0130	0.0172	0.0157	0.0112	0.0121	0.0196	0.0234
	Average of NRET(5)	0.0517	0.0389	0.0353	0.0492	0.0327	0.0154	0.0283	0.0149	0.0223	0.0239	0.0232	0.0219	0.0298
	Average of NRET(T)	0.0535	0.0322	0.0261	0.0425	0.0200	0.0064	0.0164	0.0167	0.0131	0.0158	0.0119	0.0216	0.0230
2	Average of NRET(1)	0.0496	0.0198	0.0170	0.0396	0.0004	-0.0015	0.0084	0.0228	0.0071	0.0140	0.0060	0.0294	0.0177
	Average of NRET(2)	0.0492	0.0254	0.0195	0.0401	0.0058	-0.0045	0.0050	0.0200	0.0062	0.0129	0.0020	0.0185	0.0167
	Average of NRET(3)	0.0513	0.0285	0.0245	0.0413	0.0118	-0.0019	0.0061	0.0193	0.0106	0.0089	0.0046	0.0191	0.0187
	Average of NRET(4)	0.0540	0.0310	0.0179	0.0360	0.0181	0.0037	0.0087	0.0154	0.0103	0.0086	0.0102	0.0207	0.0196
	Average of NRET(5)	0.0503	0.0388	0.0268	0.0418	0.0194	0.0080	0.0189	0.0183	0.0128	0.0162	0.0163	0.0156	0.0236
	Average of NRET(T)	0.0509	0.0287	0.0211	0.0398	0.0111	0.0008	0.0095	0.0192	0.0094	0.0121	0.0079	0.0206	0.0193
3	Average of NRET(1)	0.0427	0.0182	0.0154	0.0377	-0.0008	-0.0022	0.0048	0.0213	0.0006	0.0035	0.0033	0.0274	0.0143
	Average of NRET(2)	0.0480	0.0251	0.0216	0.0367	0.0029	-0.0054	0.0061	0.0177	0.0067	0.0101	0.0007	0.0209	0.0159
	Average of NRET(3)	0.0449	0.0230	0.0196	0.0360	0.0069	-0.0014	0.0041	0.0154	0.0102	0.0044	-0.0003	0.0156	0.0149
	Average of NRET(4)	0.0477	0.0247	0.0196	0.0337	0.0125	0.0017	0.0026	0.0167	0.0083	0.0061	0.0008	0.0153	0.0158
	Average of NRET(5)	0.0525	0.0388	0.0185	0.0402	0.0221	0.0087	0.0144	0.0172	0.0119	0.0120	0.0119	0.0171	0.0221
	Average of NRET(T)	0.0472	0.0260	0.0189	0.0369	0.0088	0.0003	0.0064	0.0177	0.0076	0.0072	0.0033	0.0193	0.0166
4	Average of NRET(1)	0.0351	0.0169	0.0163	0.0354	-0.0055	-0.0040	0.0022	0.0198	0.0019	0.0054	0.0079	0.0266	0.0132
	Average of NRET(2)	0.0443	0.0185	0.0189	0.0329	0.0000	-0.0047	0.0009	0.0219	0.0060	0.0025	-0.0014	0.0224	0.0135
	Average of NRET(3)	0.0447	0.0214	0.0209	0.0320	0.0056	-0.0070	0.0002	0.0133	0.0071	0.0055	-0.0022	0.0183	0.0133
	Average of NRET(4)	0.0460	0.0204	0.0198	0.0317	0.0122	-0.0022	0.0004	0.0091	0.0104	0.0048	0.0063	0.0184	0.0148
	Average of NRET(5)	0.0501	0.0255	0.0236	0.0344	0.0197	0.0024	0.0120	0.0154	0.0125	0.0113	0.0087	0.0184	0.0195
	Average of NRET(T)	0.0441	0.0206	0.0199	0.0333	0.0064	-0.0031	0.0032	0.0159	0.0076	0.0059	0.0039	0.0208	0.0149
5	Average of NRET(1)	0.0349	0.0197	0.0145	0.0296	-0.0041	-0.0067	0.0017	0.0233	-0.0017	0.0038	0.0040	0.0263	0.0121
	Average of NRET(2)	0.0419	0.0201	0.0183	0.0331	-0.0020	-0.0070	0.0008	0.0183	-0.0003	0.0018	-0.0045	0.0245	0.0121
	Average of NRET(3)	0.0446	0.0193	0.0088	0.0313	0.0050	-0.0090	0.0004	0.0144	0.0041	0.0003	-0.0003	0.0154	0.0112
	Average of NRET(4)	0.0456	0.0135	0.0150	0.0297	0.0086	-0.0019	0.0007	0.0081	0.0011	0.0047	0.0023	0.0113	0.0116
	Average of NRET(5)	0.0437	0.0275	0.0153	0.0473	0.0179	0.0150	0.0100	0.0208	0.0117	0.0153	0.0070	0.0229	0.0212
	Average of NRET(T)	0.0421	0.0200	0.0144	0.0342	0.0051	-0.0019	0.0027	0.0170	0.0030	0.0052	0.0017	0.0201	0.0137
6	Average of NRET(1)	0.0640	0.0155	0.0033	0.0424	-0.0029	-0.0056	0.0085	0.0107	-0.0061	0.0033	-0.0009	0.0244	0.0131
	Average of NRET(2)	0.0517	0.0243	0.0003	0.0425	0.0102	-0.0057	0.0010	0.0127	0.0046	-0.0005	-0.0091	0.0205	0.0127
	Average of NRET(3)	0.0528	0.0370	0.0066	0.0414	0.0124	0.0019	0.0164	0.0119	0.0030	0.0085	0.0094	0.0265	0.0190
	Average of NRET(4)	0.0622	0.0465	0.0199	0.0474	0.0288	0.0083	0.0094	0.0154	0.0134	0.0218	0.0150	0.0222	0.0259
	Average of NRET(5)	0.0932	0.0943	0.0538	0.0743	0.0551	0.0429	0.0610	0.0365	0.0441	0.0325	0.0515	0.0570	0.0580
	Average of NRET(T)	0.0648	0.0437	0.0169	0.0496	0.0209	0.0084	0.0194	0.0175	0.0118	0.0132	0.0132	0.0302	0.0258
Total Average of NRET(1)		0.0467	0.0199	0.0140	0.0376	-0.0012	-0.0030	0.0072	0.0196	0.0021	0.0077	0.0054	0.0269	0.0152
Total Average of NRET(2)		0.0480	0.0241	0.0175	0.0382	0.0058	-0.0047	0.0038	0.0175	0.0057	0.0064	-0.0012	0.0211	0.0152
Total Average of NRET(3)		0.0482	0.0266	0.0175	0.0367	0.0102	-0.0023	0.0068	0.0153	0.0068	0.0073	0.0031	0.0191	0.0163
Total Average of NRET(4)		0.0522	0.0279	0.0199	0.0364	0.0175	0.0036	0.0058	0.0136	0.0099	0.0095	0.0078	0.0179	0.0185
Total Average of NRET(5)		0.0569	0.0440	0.0289	0.0479	0.0278	0.0154	0.0241	0.0205	0.0192	0.0185	0.0198	0.0255	0.0290
Total Average of NRET(T)		0.0504	0.0285	0.0196	0.0394	0.0121	0.0018	0.0096	0.0173	0.0087	0.0099	0.0070	0.0221	0.0189

Table 4.4.2

Number of Company*Month Samples corresponding to Cells in Table 4.4.1

		Month												
D_Quintile	Data	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
1	Sum of Count(1)	1940	1964	1971	1960	1957	1953	1952	1951	1953	1948	1945	1947	23441
	Sum of Count(2)	1934	1953	1961	1958	1942	1948	1946	1942	1938	1937	1934	1931	23324
	Sum of Count(3)	1933	1958	1958	1954	1946	1944	1943	1944	1944	1941	1939	1938	23342
	Sum of Count(4)	1932	1950	1964	1950	1945	1946	1943	1940	1944	1942	1939	1939	23334
	Sum of Count(5)	1965	1990	1993	1986	1982	1977	1978	1974	1973	1971	1965	1969	23723
	Sum of Count(T)	9704	9815	9847	9808	9772	9768	9762	9751	9752	9739	9722	9724	117164
2	Sum of Count(1)	1947	1975	1982	1981	1974	1973	1963	1963	1958	1957	1955	1951	23579
	Sum of Count(2)	1941	1970	1966	1965	1962	1959	1955	1960	1944	1946	1948	1943	23459
	Sum of Count(3)	1938	1964	1973	1968	1965	1963	1950	1956	1953	1949	1950	1946	23475
	Sum of Count(4)	1940	1967	1976	1973	1965	1959	1956	1952	1950	1945	1938	1940	23461
	Sum of Count(5)	1969	2000	2000	1997	1994	1994	1986	1992	1977	1977	1984	1979	23849
	Sum of Count(T)	9735	9876	9897	9884	9860	9848	9810	9823	9782	9774	9775	9759	117823
3	Sum of Count(1)	1957	1976	1984	1974	1970	1967	1961	1964	1958	1958	1948	1955	23572
	Sum of Count(2)	1948	1970	1978	1966	1962	1949	1950	1957	1945	1946	1944	1947	23462
	Sum of Count(3)	1946	1966	1976	1965	1960	1953	1950	1954	1950	1940	1944	1948	23452
	Sum of Count(4)	1947	1968	1974	1968	1960	1959	1949	1951	1949	1950	1934	1941	23450
	Sum of Count(5)	1981	2000	2009	1995	1991	1982	1984	1989	1981	1978	1975	1984	23849
	Sum of Count(T)	9779	9880	9921	9868	9843	9810	9794	9815	9783	9772	9745	9775	117785
4	Sum of Count(1)	1953	1974	1985	1975	1965	1971	1963	1965	1957	1960	1956	1951	23575
	Sum of Count(2)	1940	1964	1965	1962	1957	1955	1954	1950	1949	1949	1945	1951	23441
	Sum of Count(3)	1940	1964	1972	1958	1957	1960	1954	1954	1950	1950	1951	1946	23456
	Sum of Count(4)	1943	1963	1978	1969	1956	1963	1954	1958	1952	1955	1945	1939	23475
	Sum of Count(5)	1975	1998	2001	1993	1987	1988	1984	1985	1981	1979	1979	1979	23829
	Sum of Count(T)	9751	9863	9901	9857	9822	9837	9809	9812	9789	9793	9776	9766	117776
5	Sum of Count(1)	1968	1991	1995	1992	1984	1979	1978	1979	1973	1972	1969	1973	23753
	Sum of Count(2)	1958	1978	1986	1976	1972	1974	1969	1969	1968	1963	1961	1957	23631
	Sum of Count(3)	1959	1980	1988	1986	1973	1974	1968	1971	1964	1962	1962	1959	23646
	Sum of Count(4)	1955	1980	1987	1983	1979	1967	1972	1974	1962	1959	1965	1964	23647
	Sum of Count(5)	1990	2009	2018	2011	2005	2004	1998	2000	1998	1996	1992	1993	24014
	Sum of Count(T)	9830	9938	9974	9948	9913	9898	9885	9893	9865	9852	9849	9846	118691
6	Sum of Count(1)	1290	1328	1342	1352	1365	1352	1368	1366	1356	1336	1340	1328	16123
	Sum of Count(2)	1275	1308	1330	1345	1349	1341	1355	1351	1339	1321	1329	1316	15959
	Sum of Count(3)	1279	1309	1330	1343	1352	1337	1347	1349	1344	1326	1327	1321	15964
	Sum of Count(4)	1283	1310	1334	1339	1350	1334	1359	1353	1339	1319	1327	1318	15965
	Sum of Count(5)	1305	1338	1355	1372	1377	1369	1383	1377	1371	1352	1353	1345	16297
	Sum of Count(T)	6432	6593	6691	6751	6793	6733	6812	6796	6749	6654	6676	6628	80308
Total Sum of Count(1)		11055	11208	11259	11234	11215	11195	11185	11188	11155	11131	11113	11105	134043
Total Sum of Count(2)		10996	11143	11186	11172	11144	11126	11129	11129	11083	11062	11061	11045	133276
Total Sum of Count(3)		10995	11141	11197	11174	11153	11131	11112	11128	11105	11068	11073	11058	133335
Total Sum of Count(4)		11000	11138	11213	11182	11155	11128	11133	11128	11096	11070	11048	11041	133332
Total Sum of Count(5)		11185	11335	11376	11354	11336	11314	11313	11317	11281	11253	11248	11249	135561
Total Sum of Count(T)		55231	55965	56231	56116	56003	55894	55872	55890	55720	55584	55543	55498	669547

		C_Quintile						
D_Quintile	Data	1	2	3	4	5	Grand Total	MT(1998)
1	Average of NRET	0.0227	0.0228	0.0245	0.0251	0.0325	0.0255	0.0262
	StdDevp of NRET	0.0631	0.0595	0.0570	0.0546	0.0485	0.0569	
	Average of Div_Yld	0.1239	0.1415	0.1217	0.1256	0.1226	0.1271	
2	Average of NRET	0.0215	0.0211	0.0234	0.0214	0.0285	0.0232	0.0229
	StdDevp of NRET	0.0618	0.0589	0.0580	0.0537	0.0531	0.0573	
	Average of Div_Yld	0.0798	0.0801	0.0804	0.0804	0.0806	0.0803	
3	Average of NRET	0.0195	0.0199	0.0191	0.0194	0.0262	0.0208	0.0199
	StdDevp of NRET	0.0599	0.0572	0.0555	0.0517	0.0532	0.0556	
	Average of Div_Yld	0.0618	0.0618	0.0619	0.0620	0.0619	0.0619	
4	Average of NRET	0.0157	0.0180	0.0168	0.0189	0.0240	0.0187	0.0177
	StdDevp of NRET	0.0607	0.0566	0.0538	0.0526	0.0510	0.0551	
	Average of Div_Yld	0.0451	0.0449	0.0450	0.0450	0.0447	0.0449	
5	Average of NRET	0.0151	0.0149	0.0131	0.0149	0.0258	0.0168	0.0150
	StdDevp of NRET	0.0615	0.0598	0.0572	0.0535	0.0540	0.0575	
	Average of Div_Yld	0.0247	0.0245	0.0237	0.0227	0.0227	0.0236	
6	Average of NRET	0.0159	0.0087	0.0166	0.0190	0.0557	0.0232	0.0178
	StdDevp of NRET	0.0710	0.0715	0.0748	0.0783	0.0867	0.0785	
	Average of Div_Yld	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Total Average of NRET		0.0184	0.0176	0.0189	0.0198	0.0321	0.0214	
Total StdDevp of NRET		0.0632	0.0610	0.0599	0.0582	0.0602	0.0608	
Total Average of Div_Yld		0.0559	0.0588	0.0554	0.0560	0.0554	0.0563	

Table 4.4.3 Net Simple Returns over period of Morgan and Thomas (1998) study (February 1975 - December 1993).

		R_Month												
D_Quintile	Data	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
1	Average of NRET	0.0608	0.0463	0.0421	0.0419	0.0237	0.0112	0.0132	0.0175	0.0133	-0.0001	0.0118	0.0265	0.0255
	StdDevp of NRET	0.0529	0.0561	0.0504	0.0488	0.0467	0.0502	0.0496	0.0539	0.0592	0.0721	0.0618	0.0423	0.0569
2	Average of NRET	0.0605	0.0451	0.0327	0.0407	0.0181	0.0071	0.0091	0.0176	0.0086	0.0016	0.0113	0.0276	0.0232
	StdDevp of NRET	0.0513	0.0596	0.0453	0.0485	0.0458	0.0478	0.0510	0.0548	0.0615	0.0761	0.0621	0.0424	0.0573
3	Average of NRET	0.0536	0.0409	0.0351	0.0363	0.0152	0.0070	0.0088	0.0153	0.0101	-0.0059	0.0080	0.0274	0.0208
	StdDevp of NRET	0.0488	0.0554	0.0455	0.0424	0.0465	0.0502	0.0499	0.0548	0.0608	0.0745	0.0565	0.0430	0.0556
4	Average of NRET	0.0522	0.0358	0.0310	0.0323	0.0155	0.0045	0.0029	0.0146	0.0088	-0.0062	0.0069	0.0280	0.0187
	StdDevp of NRET	0.0503	0.0606	0.0501	0.0419	0.0444	0.0483	0.0473	0.0561	0.0594	0.0691	0.0545	0.0434	0.0551
5	Average of NRET	0.0480	0.0400	0.0278	0.0323	0.0120	0.0005	0.0025	0.0150	0.0021	-0.0091	0.0071	0.0248	0.0168
	StdDevp of NRET	0.0522	0.0653	0.0514	0.0474	0.0467	0.0520	0.0516	0.0558	0.0586	0.0691	0.0596	0.0439	0.0575
6	Average of NRET	0.0720	0.0437	0.0188	0.0505	0.0191	0.0088	0.0157	0.0135	0.0029	-0.0030	0.0101	0.0287	0.0232
	StdDevp of NRET	0.0808	0.0697	0.0719	0.0722	0.0612	0.0858	0.0952	0.0671	0.0647	0.0915	0.0834	0.0533	0.0785
Total Average of NRET		0.0579	0.0420	0.0312	0.0390	0.0173	0.0065	0.0087	0.0156	0.0076	-0.0038	0.0092	0.0272	0.0214
Total StdDevp of NRET		0.0577	0.0614	0.0537	0.0516	0.0490	0.0574	0.0601	0.0573	0.0609	0.0759	0.0637	0.0449	0.0608

Table 4.4.4 Net Simple Returns over period of Morgan and Thomas (1998) study (February 1975 - December 1993).

(Expansion by month replaces expansion by Capitalisation quintile, relative to Table 4.4.3)

Table 4.5 Average Monthly (%) Compound Returns (Jan. 1958 - Dec. 1997)

	Large	2	3	4	Small	(All Caps)
High Divd.	1.94	1.87	1.92	2.23	2.88	2.19
2	1.60	1.51	1.72	1.83	2.25	1.80
3	1.26	1.44	1.34	1.46	2.10	1.54
4	1.14	1.18	1.19	1.34	1.83	1.36
Low Divd.	1.02	1.02	0.95	1.01	1.98	1.22
Zero Divd.	1.09	1.05	1.67	2.31	5.47	2.41

Referring to Table 4.4, viewing horizontally (with 'constant' dividend yield), the characteristic is one of 'flat' returns performance among the larger companies (overall 1.52% per month), followed by a rising trend as company size decreases, particularly within capitalisation quintile groups 4 and 5, up to an overall 2.9% per month among dividend-paying stocks. Vertically, the 'U' shaped curve identified by other researchers (Keim (1985); Christie (1990)) is apparent, with Returns generally declining with decreasing dividend yield from quintile 1 to 5, followed by an upturn into the Zero-Dividend category. An exception to this 'rule' is the case of the smallest capitalisation quintile, where the upturn commences in the low dividend-paying quintile. Returns for the Zero-Dividend / smallest capitalisation portfolio (portfolio 30) are over twice that of any other, excepting the high dividend / smallest capitalisation portfolio, where the ratio is just under 2. However, this high return may be largely due to the compensation required by investors to invest in illiquid, thinly-traded sub - £3M (1997 values) stocks, with larger bid-ask spreads relative to (generally) low price levels per share, many of them 'penny' stocks.

Table 4.4.1 shows, in its rightmost column, the same net simple returns information presented in the body of Table 4.4; it also opens up a 'seasonality' dimension in the main body of the table, showing the breakdown of Returns by Month for the 30 portfolios. Corresponding cells of Table 4.4.2 show the number of (company*month) samples contributing to the averages shown in Table 4.4.1. Again, this indicates exceptional January returns performance, with returns for dividend-paying quintiles 1 and 2 exceeding 5.0%, and the Zero-Dividend group approaching 6.5%. Unsurprisingly, portfolio 30 returns 9.32% in January; interestingly, this is maintained (at 9.43%) into February. Despite these values, exceptional returns in the UK appear to be not simply confined to small companies in January as is suggested for the US market (Keim (1985), Haugen and Lakonishok (1988)).

April returns represent the second highest seasonal returns group, averaging almost 4.0%, and with a commensurately-scaled variation characteristic across portfolios as that for January. Thus the Zero-Dividend group returns 5.0% (approx.) compared to the 6.5% January figure. At the other extreme, June shows an overall return of just 0.18%; many subgroup returns are negative. September (overall 0.87%) is the second-lowest returning month. These results are in line with the findings of Clare, Psaradakis and Thomas (1995).

Before proceeding to adjust the 'raw' results for risk, it is instructive to effect a comparison with MT(1998); this serves to 'calibrate' the findings thus far. Table 4.4.3 shows, in its rightmost column, the earlier results, which bear a direct comparison with the (new) Net Returns figures to their immediate left. The period is adjusted to be identical (1975/2 - 1993/12); the differences between the two columns reflecting (i) the effect of the more precise 'survival' criteria used in the present study[86], and (ii) the effect of the reduced 'qualification period of 24 months. Results are closely comparable, excepting the cases of the lowest- and the Zero-Dividend stocks, which are more sensitive both to survival and qualification criteria, as indeed would be expected. Table 4.4.3 also expands the Capitalisation dimension, Table 4.4.4 that of Seasonality, for the period concerned.

4.4 Adjustment for Risk

Following established practice (e.g. MT(1998)), the one-period Sharpe-Lintner CAPM is used to generate abnormal returns, by estimating the relation:

$$R_{pt} - R_{ft} = \alpha_p + \beta_p(R_{mt} - R_{ft}) + u_{pt} \quad ....(2)$$

Where p = 1,2,...,6 (for dividend yield categories); p = 1,2,...,30 (for dividend yield / market capitalisation portfolios); t = 1 - 480.

R_{pt} is the rate of return for portfolio p in month t, R_{mt} is the market return for month t, an equally-weighted average of all stocks in the sample, R_{ft} is the monthly risk-free rate for month t, based on the 3-month Treasury Bill Rate, and u_{pt} is the vector of residuals.

86 The simpler criteria used in MT(1998) allowed only 'Type of Death' (TOD) <= 5 to be classed as 'surviving' stocks; all others as failures - see section 3.1, above.

According to the CAPM, abnormal returns are identified by statistically significant, non-zero values of α_p [87]. Table 4.6 (rightmost column for dividend yield categories) shows that high abnormal returns are associated with high dividend yields. Returns decline monotonically with decreasing dividend yield through to the lowest, non Zero-Dividend paying category, though not including Zero-Dividend stocks; here, positive abnormal returns are once again in evidence. Negative abnormal returns are associated with the three lowest yield categories, with the value for category 5 being -0.54%, in contrast with category 1, at 0.55%. The corresponding figure for the Zero-Dividend category is 0.69%.

Observation of the within-category subdivisions (by market capitalisation) reveals the profound influence of the smaller stocks on the above figures; this is particularly the case for the extreme categories (highest and zero) of dividend yield. Thus the abnormal return of portfolio 30 is 4.19%, that of portfolio 5 (the highest yield / smallest capitalisation portfolio) is 1.52%. Examination, as before, of the 'horizontal' (within dividend category) characteristic reveals a similar pattern; largely constant abnormal returns across the 3 largest size quintiles (2 largest in the case of the Zero-Dividend category), but with rapidly increasing abnormal returns with decreasing size thereafter. Vertically, the 'U' shaped characteristic is in evidence across all size quintiles, but becomes greatly pronounced as size decreases.

Examination of the beta (covariance risk factor) characteristic is revealing, particularly with decreasing size. Looking first at the largest size quintile, beta increases, as might be expected, as dividend yield drops into the 'low' and 'zero' categories. However, from a peak of 1.15 (portfolio 26, the large capitalisation, Zero-Dividend portfolio), beta drops sharply to a value of 0.8 in the case of portfolio 30. What appears to be a paradox here (low beta in spite of the high 'own variance' of portfolio 30) is resolved by observing the low value of R^2 (0.22); in fact, the variance of the returns of this portfolio is apparently somewhat 'de-coupled' from market variance[88]. An isolated, but 'telling' example of this fact is given by the response of portfolio 30 to the 37.2% (equally-weighted) market increase which took place in a single month in January 1975; the small-cap Zero-Dividend portfolio responded by only 4.4%. Clearly, this 'extreme' portfolio, carrying relatively little market weight, is frequently ignored by a large part of the market as a whole. However, a caveat is in order here - these early,

[87] This parameter is commonly referred to as 'Jensen's Alpha', after Jensen (1968).

[88] MT(1998) p.9 footnote 9 note that i) "beta estimates ...do not rise as dividend yields fall", and ii) "the beta for the Zero-Dividend portfolio is by far the highest". The effects described (above) may have been masked in the earlier study by virtue of the asymmetric 'crowding' of zero beta stocks largely into a single yield / size portfolio. As is shown here, with a sufficiently populated 'portfolio 26', the rising beta in the 'large-cap' / Zero-Dividend portfolio does in fact emerge, as does that of the 'large-cap' / *low* dividend portfolio (and also the distinction between these and the lower beta in portfolio 30).

		C_Quintile			Small Co's.		
D_Quintile	Data	1	2	3	4	5	Overall (by Div)
1	ALPHA Coefficient	0.0019	0.0013	0.0026	0.0065	0.0152	0.0055
	t-value (Alpha)	1.76	1.39	2.76	6.11	10.84	9.80
High Divd.	BETA Coefficient	1.04	1.03	0.95	0.87	0.67	0.91
	R Squared	0.84	0.88	0.85	0.79	0.56	0.94
2	ALPHA Coefficient	-0.0016	-0.0026	-0.0005	0.0016	0.0074	0.0009
	t-value (Alpha)	-1.29	-3.02	-0.65	1.86	6.40	2.18
	BETA Coefficient	1.07	1.06	1.05	0.95	0.80	0.99
	R Squared	0.81	0.89	0.92	0.88	0.73	0.97
3	ALPHA Coefficient	-0.0047	-0.0032	-0.0040	-0.0017	0.0054	-0.0016
	t-value (Alpha)	-3.53	-3.93	-5.39	-2.06	4.97	-4.12
	BETA Coefficient	1.04	1.05	1.02	0.91	0.84	0.97
	R Squared	0.78	0.90	0.92	0.87	0.77	0.97
4	ALPHA Coefficient	-0.0059	-0.0064	-0.0056	-0.0037	0.0026	-0.0038
	t-value (Alpha)	-4.19	-7.12	-7.05	-4.50	2.28	-7.40
	BETA Coefficient	1.04	1.12	1.03	1.00	0.86	1.01
	R Squared	0.76	0.90	0.90	0.89	0.76	0.96
5	ALPHA Coefficient	-0.0078	-0.0081	-0.0087	-0.0069	0.0044	-0.0054
	t-value (Alpha)	-5.49	-7.78	-9.38	-6.95	2.94	-9.61
Low Divd.	BETA Coefficient	1.11	1.14	1.11	0.99	0.85	1.04
	R Squared	0.78	0.87	0.89	0.85	0.65	0.95
6	ALPHA Coefficient	-0.0073	-0.0073	0.0004	0.0070	0.0419	0.0069
	t-value (Alpha)	-4.66	-4.39	0.20	2.66	11.64	5.03
Zero Divd.	BETA Coefficient	1.15	1.12	1.00	1.03	0.80	1.02
	R Squared	0.75	0.72	0.56	0.47	0.22	0.75
Overall ALPHA Coeff. (by Cap)		-0.0042	-0.0044	-0.0026	0.0005	0.0128	0.0004
Overall BETA Coeff. (by Cap)		1.08	1.09	1.03	0.96	0.81	0.99

Table 4.6 'Market' model: $R_{pt} - R_{ft} = \alpha_p + \beta_p (R_{mt} - R_{ft}) + \varepsilon$ (for 30 portfolios, summarising DY & CAP subtotals)

exploratory observations are based upon a simple, non-robust estimation technique (OLS); later, this will be extended using estimators robust to heteroscedasticity and autocorrelation, such as that induced by infrequent (thin) trading.

The portfolio 30 beta, however, is not the lowest. Portfolio 5 (High dividend / Small Cap) is only 0.67; here, the value of R^2 is higher, at 0.56. This apparent further anomaly is resolved, at least in part, by observing that the standard deviation of portfolio 5 returns is the *lowest* of all portfolios, at 4.48% (see Table 4.4). In contrast, that of portfolio 30 is the *highest*, at 8.61%.

4.5 Examination of a more complete model specification

In order to further illuminate the complex relationship between Returns and Dividend Yield, Firm size and Seasonality (in the light of the above), the model suggested by MT(1998) was constructed and run with the summarised data from the 30 portfolios.
Their general model was an extension of equation (2) above to include seasonal intercept dummy variables for the months of January, April and September (based upon the findings of **Clare, Psaradakis and Thomas (1995)**, who determined these specific months' coefficients as being significant), a dummy variable to cover Zero-Dividend stocks, and seasonal interaction dummies to capture slope influences on market risk[89], the Zero-Dividend dummy, dividend yield and (log) size.

Defining δ_n as: $\{ \beta_n + \beta_{nJ}.DJ_t + \beta_{nA}.DA_t + \beta_{nS}.DS_t \}$ .... $n = 0,1,2,3,4$[90]

The model is concisely recorded as:

$$R_{pt} - R_{ft} = \delta_0 + \delta_1 . (R_{mt} - R_{ft}) + \delta_2 . D_{0p} + \delta_3 . DY_{pt} + \delta_4 . LSIZE_{pt} + u_{pt} \quad ....(3)$$

where p = 1 to 30, t = 1 to 480; DJ_t , DA_t and DS_t are the three seasonal effect zero-one dummies for January, April and September respectively. D_{0p} is a dummy variable taking the value 1 if DY_{pt} , the dividend yield = 0 and takes the value 0 otherwise; and $LSIZE_{pt}$ is the arithmetic average of the natural logarithms of the Market Capitalisations (£M) of the firms comprising a given portfolio in a given month. (This is equivalent to assigning [to LSIZE] the

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89 This follows the suggestion by Brown, et al (1983) of the possibility of seasonally varying covariance risk.

90 In the above notation, β_0 is equivalent to α in equation (2)

natural logarithm of the *geometric* average of the capitalisation of constituent firms in the portfolio).

The above model is designed to capture not only the effect of seasonality on abnormal returns (i.e. intercept terms) *after* correcting for the influence of risk, dividend yield, size and the fact (or otherwise) of Zero-Dividend status; but also the possible influences of seasonality upon the coefficients of, or sensitivity to, those factors. Whilst it is non-linear in the variables, it remains linear in the parameters.

Table 4.7 presents the OLS estimation results. Results for the full 40 - year period (January 1958 to December 1997) indicate a favourable value of zero for the constant term, indicating the likelihood that a subset of the hypothesised factors in the model do in fact largely capture the variations in the data. Among the seasonal dummies, only the dummy variable for April is significant at 5%, though the abnormal April return value is in fact *negative*, at -0.55%, after controlling for the other factors. Little evidence is seen of seasonally varying beta, though the value for January is significant at 10%; its negative sign (-0.027) indicating a reduction in covariance risk during that month.

The coefficient of the Zero-Dividend dummy variable (0.67%), is both positive and highly significant (at the 1% level); moreover, the significant positive interaction variables for January and April (also significant at 1%) indicate a reinforcement of the Returns effect for Zero-Dividend stocks during these months.

The relationship between Returns and dividend yields is essentially non-seasonal, but strongly positive and highly significant. The magnitude of the coefficient (0.044) is such that on average, and *ceteris paribus*, firms in the highest dividend yield category, with average yields approaching 12% per annum, will return in excess of 0.4% per month more than firms in the low (non-zero) dividend category yielding 2.5% per annum (on average). The effect is significant at 1%.

The relationship between Returns and (the logarithm of) firm size is such that, on average, a factor 10 increase in size generates, *ceteris paribus*, a 0.37% *decrease* in monthly returns; however, during April, this tendency reverses. In this case, larger firms earn, on average, 0.23% *higher* monthly returns per factor 10 increase in size. The first of these effects is significant at the 1% level, the second at 5%.

Period JAN 1958 - DEC 1997 (Full Period)						
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	0.0000	0.00081	0.00	0.9969	0.00077	0.0000
DJAN	-0.0027	0.00252	-1.06	0.2910	0.00262	0.0001
DAPR	-0.0055	0.00266	-2.06	0.0397	0.00246	0.0003
DSEP	0.0021	0.00259	0.80	0.4222	0.00228	0.0000
MKTXS	0.9887	0.00635	155.58	0.0000	0.00894	0.6273
DJ_MKT	-0.0270	0.01410	-1.92	0.0551	0.04354	0.0003
DA_MKT	0.0147	0.02299	0.64	0.5231	0.03250	0.0000
DS_MKT	-0.0011	0.01924	-0.06	0.9534	0.02054	0.0000
DZERO	0.0067	0.00108	6.20	0.0000	0.00128	0.0027
DJ_ZERO	0.0123	0.00339	3.64	0.0003	0.00498	0.0009
DA_ZERO	0.0093	0.00340	2.75	0.0061	0.00411	0.0005
DS_ZERO	-0.0052	0.00344	-1.51	0.1312	0.00339	0.0002
Div_Yld	0.0440	0.00885	4.97	0.0000	0.00783	0.0017
DJ_DIV	0.0296	0.02617	1.13	0.2574	0.02759	0.0001
DA_DIV	0.0356	0.02799	1.27	0.2028	0.02581	0.0001
DS_DIV	-0.0092	0.02839	-0.32	0.7466	0.02236	0.0000
LOGCAP	-0.0016	0.00015	-10.85	0.0000	0.00017	0.0081
DJ_CAP	0.0002	0.00047	0.47	0.6363	0.00067	0.0000
DA_CAP	0.0010	0.00047	2.18	0.0295	0.00052	0.0003
DS_CAP	-0.0004	0.00047	-0.90	0.3660	0.00053	0.0001
R^2 =	F(19,14380)			\sigma	0.0308	DW =
0.727	2020.5	[0.0000]				1.78

Table 4.7 Extended Model Results (Full Period)

* Significance (at the 5% level) indicated by shading.

4.5.1 Information in the sub-period analyses

Examination of the sub-period regressions (tabulated in Tables 4.7.1 - 4.7.6), and summarised in Table 4.8) confirms that the constant term is effectively absent, as is any role for seasonal variation in covariance risk, or seasonal influence on the Dividend Yield coefficient. The April dummy variable mentioned above is significant only over the full period; its coefficient actually changes sign in the last quarter period. The non-seasonal Zero-Dividend dummy variable coefficient is significant in all of the full, first and second *half* periods, but features significantly only in the first and third *quarter* periods. Its value is always positive, but declines into insignificance in the last quarter period; evidence from the seasonal interaction coefficients would indicate, however, that Zero-Dividend abnormal returns in the second half-period 'crowd' into the peak months of January and April.

The coefficient of non-seasonal dividend yield displays a persistently increasing trend over the course of the four 'quarter' periods. Whilst it just fails to be significant at 5% in the second quarter period (t-value = 1.88, t-prob = 6.09%), it is significant at 1% over the full- and two half periods, and similarly also over the latter two quarter periods. It reaches a value of 0.0819 in the fourth quarter period, which is close to double its value over the full period (see above). This may, however, be a function of depressed stock prices during the years of severe recession in the early 1990's, and this aspect warrants further investigation in future research.

In contrast, the non-seasonal size effect, after reaching a peak in the third quarter period, declines into insignificance in the fourth quarter period. Nevertheless, it is significant (and consistently negative) in six of the seven periods studied. The *seasonal* size effect is frequently significant, but is characterised by fluctuating values and signs.

4.6 The Role of Payout Ratio as an explanator

The role of earnings, usually impounded in the form of Price / Earnings Ratio (P/E) or its inverse, (E/P), has featured frequently in the literature (see Section 2.1.6). Thus, Basu, (1977,**1983**) concludes that E/P contributes to explaining the cross-section of average returns, even when controlling for size and beta. Ball (1978) suggests E/P as a proxy for unspecified factors in expected returns. Fama and French (1992) acknowledge a strong relationship between average stock returns and E/P, although they go on to state that "*the combination of*

Period JAN 1958 - DEC 1977 (Ist half sub-period)						
EQ(1) Modelling	XSRET by	OLS (using	Statin2a	.xls)		
The present	sample is:	1 to 7200				
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	0.0005	0.00117	0.46	0.6487	0.00098	0.0000
DJAN	-0.0039	0.00357	-1.10	0.2737	0.00376	0.0002
DAPR	-0.0074	0.00388	-1.91	0.0557	0.00358	0.0005
DSEP	-0.0010	0.00377	-0.26	0.7973	0.00287	0.0000
MKTXS	0.9787	0.00975	100.35	0.0000	0.01223	0.5838
DJ_MKT	-0.0206	0.01796	-1.15	0.2519	0.05252	0.0002
DA_MKT	0.0366	0.03246	1.13	0.2599	0.04889	0.0002
DS_MKT	0.0022	0.02850	0.08	0.9385	0.02888	0.0000
DZERO	0.0052	0.00177	2.95	0.0032	0.00190	0.0012
DJ_ZERO	0.0074	0.00551	1.34	0.1813	0.00870	0.0002
DA_ZERO	0.0083	0.00560	1.49	0.1360	0.00744	0.0003
DS_ZERO	-0.0022	0.00566	-0.39	0.6954	0.00537	0.0000
Div_Yld	0.0323	0.01251	2.58	0.0099	0.01031	0.0009
DJ_DIV	0.0407	0.03677	1.11	0.2689	0.03946	0.0002
DA_DIV	0.0423	0.03945	1.07	0.2841	0.03674	0.0002
DS_DIV	0.0124	0.04016	0.31	0.7570	0.02884	0.0000
LOGCAP	-0.0029	0.00027	-10.54	0.0000	0.00029	0.0152
DJ_CAP	0.0019	0.00085	2.20	0.0282	0.00127	0.0007
DA_CAP	0.0030	0.00087	3.45	0.0006	0.00099	0.0017
DS_CAP	0.0004	0.00086	0.49	0.6274	0.00092	0.0000
R^2 =	F(19,7180)			\sigma	0.0334	DW =
0.717	959.7	[0.0000]				1.92

<u>**Table 4.7.1 Extended Model Results (1st half Period)**</u>

* Significance (at the 5% level) indicated by shading.

Period JAN 1978 - DEC 1997 (2nd half sub-period)						
EQ(1) Modelling	XSRET by	OLS (using	Statin2b	.xls)		
The present	sample is:	1 to 7200				
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	0.0003	0.00115	0.26	0.7957	0.00116	0.0000
DJAN	0.0012	0.00374	0.33	0.7389	0.00381	0.0000
DAPR	-0.0020	0.00370	-0.54	0.5865	0.00333	0.0000
DSEP	0.0067	0.00365	1.84	0.0662	0.00343	0.0005
MKTXS	0.9994	0.00810	123.33	0.0000	0.01309	0.6793
DJ_MKT	-0.0170	0.02802	-0.61	0.5447	0.03522	0.0001
DA_MKT	-0.0104	0.03338	-0.31	0.7558	0.03379	0.0000
DS_MKT	0.0099	0.02600	0.38	0.7022	0.02911	0.0000
DZERO	0.0056	0.00134	4.16	0.0000	0.00173	0.0024
DJ_ZERO	0.0178	0.00426	4.18	0.0000	0.00570	0.0024
DA_ZERO	0.0131	0.00424	3.08	0.0021	0.00463	0.0013
DS_ZERO	-0.0073	0.00426	-1.71	0.0870	0.00444	0.0004
Div_Yld	0.0589	0.01299	4.54	0.0000	0.01183	0.0029
DJ_DIV	0.0107	0.03815	0.28	0.7794	0.03739	0.0000
DA_DIV	0.0417	0.04127	1.01	0.3118	0.03410	0.0001
DS_DIV	-0.0233	0.04176	-0.56	0.5767	0.03554	0.0000
LOGCAP	-0.0014	0.00020	-6.77	0.0000	0.00022	0.0063
DJ_CAP	-0.0014	0.00064	-2.22	0.0264	0.00079	0.0007
DA_CAP	-0.0005	0.00063	-0.76	0.4494	0.00056	0.0001
DS_CAP	-0.0014	0.00063	-2.22	0.0263	0.00068	0.0007
R^2 =	F(19,7180)			sigma	0.0278	DW =
0.74424	1099.6	[0.0000]				1.59

Table 4.7.2 Extended Model Results (2nd half Period)

* Significance (at the 5% level) indicated by shading.

Period JAN 1958 - DEC 1967 (!st Quarter Period)						
EQ(2) Modelling	XSRET by	OLS (using	Statin2c	.xls)		
The present	sample is:	1 to 3600				
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	-0.0012	0.00138	-0.90	0.3692	0.00120	0.0002
DJAN	0.0010	0.00469	0.22	0.8285	0.00530	0.0000
DAPR	-0.0048	0.00466	-1.04	0.3010	0.00395	0.0003
DSEP	0.0049	0.00463	1.05	0.2939	0.00447	0.0003
MKTXS	0.9687	0.01565	61.89	0.0000	0.02022	0.5169
DJ_MKT	-0.0137	0.08702	-0.16	0.8751	0.12909	0.0000
DA_MKT	0.0608	0.05816	1.05	0.2958	0.05957	0.0003
DS_MKT	-0.0047	0.08201	-0.06	0.9541	0.07627	0.0000
DZERO	0.0063	0.00217	2.89	0.0039	0.00216	0.0023
DJ_ZERO	0.0013	0.00691	0.19	0.8489	0.00734	0.0000
DA_ZERO	0.0026	0.00677	0.39	0.6986	0.00725	0.0000
DS_ZERO	-0.0028	0.00692	-0.41	0.6855	0.00718	0.0000
Div_Yld	0.0338	0.01492	2.27	0.0235	0.01339	0.0014
DJ_DIV	0.0116	0.04617	0.25	0.8019	0.04370	0.0000
DA_DIV	0.0127	0.04622	0.27	0.7841	0.04109	0.0000
DS_DIV	-0.0609	0.04786	-1.27	0.2030	0.04306	0.0005
LOGCAP	-0.0018	0.00033	-5.43	0.0000	0.00037	0.0082
DJ_CAP	-0.0029	0.00105	-2.71	0.0068	0.00147	0.0020
DA_CAP	0.0035	0.00104	3.38	0.0007	0.00109	0.0032
DS_CAP	-0.0005	0.00105	-0.46	0.6443	0.00143	0.0001
R^2 =	F(19,3580)			\sigma =	0.0271	DW =
0.572224	252.05	[0.0000]				2.03

<u>Table 4.7.3 Extended Model Results (1st Quarter Period)</u>

* Significance (at the 5% level) indicated by shading.

Period JAN 1968 - DEC 1977 (2nd Quarter Period)						
EQ(3) Modelling	XSRET by	OLS (using	Statin2d	.xls)		
The present	sample is:	1 to 3600				
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	0.0033	0.00190	1.75	0.0799	0.00160	0.0009
DJAN	-0.0097	0.00567	-1.71	0.0871	0.00613	0.0008
DAPR	-0.0096	0.00635	-1.51	0.1303	0.00599	0.0006
DSEP	-0.0066	0.00614	-1.08	0.2792	0.00385	0.0003
MKTXS	0.9840	0.01308	75.25	0.0000	0.01503	0.6126
DJ_MKT	-0.0236	0.02276	-1.04	0.3005	0.05441	0.0003
DA_MKT	0.0229	0.04371	0.52	0.6002	0.05822	0.0001
DS_MKT	-0.0109	0.03516	-0.31	0.7563	0.03171	0.0000
DZERO	0.0041	0.00276	1.50	0.1336	0.00294	0.0006
DJ_ZERO	0.0092	0.00846	1.09	0.2752	0.01469	0.0003
DA_ZERO	0.0141	0.00878	1.61	0.1084	0.01222	0.0007
DS_ZERO	-0.0025	0.00884	-0.29	0.7743	0.00790	0.0000
Div_Yld	0.0372	0.01984	1.88	0.0609	0.01524	0.0010
DJ_DIV	0.0293	0.05636	0.52	0.6034	0.06162	0.0001
DA_DIV	0.0742	0.06371	1.16	0.2444	0.05693	0.0004
DS_DIV	0.0821	0.06421	1.28	0.2008	0.03970	0.0005
LOGCAP	-0.0043	0.00045	-9.60	0.0000	0.00048	0.0251
DJ_CAP	0.0065	0.00138	4.72	0.0000	0.00211	0.0062
DA_CAP	0.0025	0.00142	1.74	0.0819	0.00183	0.0008
DS_CAP	0.0013	0.00142	0.90	0.3694	0.00113	0.0002
R^2 =	F(19,3580)			\sigma =	0.0385	DW =
0.761	601.29	[0.0000]				1.88

Table 4.7.4 Extended Model Results (2nd Quarter Period)

* Significance (at the 5% level) indicated by shading.

Period JAN 1978 - DEC 1987 (3rd Quarter Period)						
EQ(4) Modelling	XSRET	by OLS (using	Statin2e	.xls)		
The present	sample is:	1 to 3600				
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	0.0013	0.00165	0.80	0.4242	0.00171	0.0002
DJAN	-0.0059	0.00602	-0.98	0.3294	0.00503	0.0003
DAPR	-0.0097	0.00550	-1.76	0.0790	0.00461	0.0009
DSEP	0.0138	0.00528	2.62	0.0089	0.00460	0.0019
MKTXS	1.0094	0.01086	92.91	0.0000	0.01949	0.7069
DJ_MKT	0.0208	0.07049	0.30	0.7682	0.05898	0.0000
DA_MKT	-0.0094	0.06311	-0.15	0.8818	0.05847	0.0000
DS_MKT	0.0142	0.03602	0.39	0.6943	0.04098	0.0000
DZERO	0.0088	0.00204	4.32	0.0000	0.00275	0.0052
DJ_ZERO	0.0249	0.00644	3.87	0.0001	0.00778	0.0042
DA_ZERO	0.0165	0.00646	2.55	0.0107	0.00705	0.0018
DS_ZERO	-0.0160	0.00649	-2.46	0.0140	0.00712	0.0017
Div_Yld	0.0636	0.01742	3.65	0.0003	0.01670	0.0037
DJ_DIV	0.0316	0.04995	0.63	0.5277	0.04590	0.0001
DA_DIV	0.0826	0.05514	1.50	0.1344	0.04258	0.0006
DS_DIV	-0.0636	0.05688	-1.12	0.2635	0.04645	0.0003
LOGCAP	-0.0028	0.00032	-8.58	0.0000	0.00036	0.0201
DJ_CAP	-0.0004	0.00104	-0.39	0.6982	0.00117	0.0000
DA_CAP	0.0014	0.00102	1.37	0.1700	0.00086	0.0005
DS_CAP	-0.0031	0.00102	-3.09	0.0020	0.00091	0.0027
R^2 =	F(19,3580)			\sigma =	0.028969	DW =
0.751485	569.77	[0.0000]				1.59

Table 4.7.5 Extended Model Results (3rd Quarter Period)

* Significance (at the 5% level) indicated by shading.

Period JAN 1988 - DEC1997 (4th Quarter Period)						
EQ(5) Modelling	XSRET	by OLS (using	Statin2f	.xls)		
The present	sample is:	1 to 3600				
Variable	Coefficient	Std.Error	t-value	t-prob	JHCSE	PartR^2
Constant	-0.0020	0.00160	-1.24	0.2164	0.00157	0.0004
DJAN	0.0058	0.00514	1.14	0.2557	0.00602	0.0004
DAPR	0.0073	0.00508	1.44	0.1495	0.00529	0.0006
DSEP	-0.0002	0.00504	-0.05	0.9644	0.00508	0.0000
MKTXS	0.9951	0.01251	79.52	0.0000	0.01330	0.6385
DJ_MKT	-0.0162	0.03055	-0.53	0.5950	0.04175	0.0001
DA_MKT	-0.0025	0.03874	-0.06	0.9486	0.04133	0.0000
DS_MKT	-0.0004	0.03770	-0.01	0.9913	0.03576	0.0000
DZERO	0.0027	0.00176	1.55	0.1205	0.00219	0.0007
DJ_ZERO	0.0128	0.00566	2.27	0.0234	0.00834	0.0014
DA_ZERO	0.0104	0.00555	1.87	0.0615	0.00628	0.0010
DS_ZERO	0.0001	0.00555	0.03	0.9803	0.00559	0.0000
Div_Yld	0.0819	0.02155	3.80	0.0001	0.01795	0.0040
DJ_DIV	0.0302	0.06859	0.44	0.6595	0.06450	0.0001
DA_DIV	0.0028	0.06884	0.04	0.9681	0.05637	0.0000
DS_DIV	0.0218	0.06838	0.32	0.7493	0.06389	0.0000
LOGCAP	-0.0005	0.00028	-1.92	0.0553	0.00030	0.0010
DJ_CAP	-0.0025	0.00088	-2.88	0.0040	0.00121	0.0023
DA_CAP	-0.0024	0.00088	-2.68	0.0074	0.00087	0.0020
DS_CAP	-0.0002	0.00088	-0.18	0.8606	0.00103	0.0000
R^2 =	F(19,3580)			\sigma =	0.0261647	DW =
0.734845	522.19	[0.0000]				1.64

Table 4.7.6 Extended Model Results (4th Quarter Period)

* Significance (at the 5% level) indicated by shading.

Variable	FULL Period	1st Half Per.	2nd Half Per.	1st Qtr. Per.	2nd Qtr. Per.	3rd Qtr. Per.	4th Qtr. Per.
Constant	0.0000	0.0005	0.0003	-0.0012	0.0033	0.0013	-0.0020
DJAN	-0.0027	-0.0039	0.0012	0.0010	-0.0097	-0.0059	0.0058
DAPR	-0.0055	-0.0074	-0.0020	-0.0048	-0.0096	-0.0097	0.0073
DSEP	0.0021	-0.0010	0.0067	0.0049	-0.0066	0.0138	-0.0002
MKTXS	0.9887	0.9787	0.9994	0.9687	0.9840	1.0094	0.9951
DJ_MKT	-0.0270	-0.0206	-0.0170	-0.0137	-0.0236	0.0208	-0.0162
DA_MKT	0.0147	0.0366	-0.0104	0.0608	0.0229	-0.0094	-0.0025
DS_MKT	-0.0011	0.0022	0.0099	-0.0047	-0.0109	0.0142	-0.0004
DZERO	0.0067	0.0052	0.0056	0.0063	0.0041	0.0088	0.0027
DJ_ZERO	0.0123	0.0074	0.0178	0.0013	0.0092	0.0249	0.0128
DA_ZERO	0.0093	0.0083	0.0131	0.0026	0.0141	0.0165	0.0104
DS_ZERO	-0.0052	-0.0022	-0.0073	-0.0028	-0.0025	-0.0160	0.0001
Div_Yld	0.0440	0.0323	0.0589	0.0338	0.0372	0.0636	0.0819
DJ_DIV	0.0296	0.0407	0.0107	0.0116	0.0293	0.0316	0.0302
DA_DIV	0.0356	0.0423	0.0417	0.0127	0.0742	0.0826	0.0028
DS_DIV	-0.0092	0.0124	-0.0233	-0.0609	0.0821	-0.0636	0.0218
LOGCAP	-0.0016	-0.0029	-0.0014	-0.0018	-0.0043	-0.0028	-0.0005
DJ_CAP	0.0002	0.0019	-0.0014	-0.0029	0.0065	-0.0004	-0.0025
DA_CAP	0.0010	0.0030	-0.0005	0.0035	0.0025	0.0014	-0.0024
DS_CAP	-0.0004	0.0004	-0.0014	-0.0005	0.0013	-0.0031	-0.0002
R^2 =	0.7275	0.7175	0.7442	0.5722	0.7614	0.7515	0.7348

Table 4.8 Summary of Extended Model Results (Full and all sub- periods)

size and Book / Market Equity [BE/ME] seems to absorb the roles of leverage and E/P, at least during our 1963 - 1990 sample period". The lack of Book / Market Equity data in the LSPD precludes following their lead in this regard, but a strong case for the inclusion of earnings ratio information in our model seems to have been made. As Fama and French (1992) point out, some redundancy within a set of variables, each of which is scaled by price, is inevitable. The list includes E/P, ME, leverage and BE/ME; logically, it also includes Dividend Yield (D/P).

This is indeed borne out in our data sample. Earnings yield and dividend yield are highly correlated variables ($\rho = 0.96$). Thus, in order to introduce earnings as an explanator, whilst circumventing the problems associated with collinearity, the additional information is (here) expressed in terms of a further commonly used metric, that of 'Payout Ratio', in general the proportion of firm's earnings paid to shareholders in the form of dividends.

Thought of in terms of the logarithms of the variables, the vector of Payout Ratio is effectively the difference between the (near) collinear constituent variables; as such, it is likely to relate to the latter in an (approximately) orthogonal fashion, having an attendant low correlation with them.

4.6.1 Data Processing

In the LSPD, earnings data is presented annually, together with the fiscal year to which the data relates. However, although a column of 'Earnings publication dates' is provided, this is, to all intents and purposes, empty[91]. The assumption is therefore made that the quoted earnings relate to the calendar year denoted by the value in the 'fiscal year' column, and further, that this value becomes known in the January of the following calendar year. Since the Issued Share Capital value is also defined each January, the total earnings of the firm are taken to be the product of the above two quantities, i.e. Earnings per Share multiplied by Issued Share Capital.

From this point, the calculation of Earnings Yield is identical to that of Dividend Yield (see section 4.2, above). Payout Ratio is calculated for each (DY/MC) portfolio for each month as the ratio of the rolling total of dividends paid over the course of the 12 months *preceding* the current month, divided by the equivalently calculated rolling total of earnings.

[91] Only two cells (out of 655,770) contain data.

The 'normal' range of values for Payout Ratio might be taken to be 0<PR<1, with Zero-Dividend firms being at the lower end of this range, and firms without investment capital needs (by assumption) being at the upper end of this 'normal' range. In practice, such instances represent only some two-thirds of cases (66%). The exceptions are, of course, overall loss-making portfolios which continue to pay dividends (negative Payout Ratios) at 0.6%; and portfolios which continue to pay levels of dividend not covered by earnings (PR>1) at 33.4%. Allied to the above, a computational problem arises by virtue of the value of the denominator when earnings / losses are close to zero. In this case, the value of Payout Ratio is modulated over large ranges by small and insignificant changes in earnings, virtually irrespective of dividends (in the numerator), as the quantity follows a predominantly reciprocal law in this range.

In order to address this problem, the technique of 'Windsorisation' is employed in order to obviate the creation of 'outliers' in the subsequent regression analysis. Limiting values for PR are chosen, guided by the correlation coefficient (over the whole sample of 14400 portfolio.months) between the 'dependent' variable NRET (net monthly returns) and the candidate explanatory variable 'Payout Ratio'. In the absence of truncation, the effect of the outliers is to suppress the value of the above correlation coefficient (ρ= -0.0060); at the opposite extreme, truncation to the boundaries of the 'normal' range (as defined above) results in a value ρ= -0.0234. A set of limits, such that the range -5<PR<+5 holds, results in ρ= -0.0237, little changed from the previous value. In terms of the numbers of samples requiring truncation, these are comfortably low, at 16 (negative values) and 52 (positive values), relative to the 14400 total sample number. Thus although the choice of limits is partially arbitrary, these values allow most of the samples lying outside the 'normal' range to express their information content, whilst disallowing the small number of extreme values from distorting the picture. Rather, the implied distortion of the earnings figures required to produce the limiting values in the 16/52 cases is acceptably small, based on the arguments presented above.

The distribution of non-'normal' Payout Ratios is extremely skewed with time. Of the one-third of portfolio samples which exhibit high ratios, almost nine tenths of these occur within the first half of the sample (1958 - 77). Large, high dividend yield companies are the most likely to present high ratios (>1), the frequency decreasing both with yield and with size. The distribution of low ratios (<0) is oppositely skewed toward the small, low-yielding companies. Low ratios (for portfolios) do not occur until 1992, however. Over the period

1978 - 87 (the third decade of the overall sample period), there were only ten non-normal (high ratio) samples from a subtotal of 3600. The overall Payout Ratio for the full sample period, expressed as the ratio of all dividends paid to all earnings, is 0.70; however, the ratio is high (>1) for the first half (1958 - 77) of the period, which would seem to indicate a general propensity for firms to raise capital, simply in order to distribute dividends![92]

This high degree of asymmetry appears to manifest itself in the relationship between Returns and Payout Ratio. As is to be expected from the negative correlation coefficient noted earlier (for the whole sample period), the regression coefficient for the full period is negative (and significant at the 2% level). However, as the rolling ten-year regression results show, (see Tables 4.9.1 and 4.9.2) all significant (at 5%) coefficients are positive. Only five of the 31 rolling periods exhibit a negative coefficient. Both half-periods (1958 - 77, 1978-97), present positive coefficients; only the former is significant (at 1%). What is interesting, however, is the extent to which the role of Dividend Yield, as an important explanator of Returns performance, is diminished once payout ratio is allowed to enter the equation and to demonstrate its influence.

4.6.2 The use of Rolling Regressions

In the preceding section, the use of rolling regressions was alluded to. This form of summarising / presenting results is perhaps worthy of some comment, as it is also used in later sections. An important consideration in any regression analysis is the stability (with time) of the resultant coefficients. Were we to have a correctly specified model, or (equivalently) perfect knowledge of the underlying Data Generation Process (Hendry (1995)), then we would have a situation where data related to all necessary column vectors comprising the **X** matrix were present, together with a vector $\boldsymbol{\beta}$ of the constant parameters[93] of the 'perfect' model. The product $\mathbf{y} = \mathbf{X}\boldsymbol{\beta}$ would establish the fundamental relationship between **y** and **X**, irrespective of time (or sample)[94]. Short of this ideal, any $\boldsymbol{\beta}$ vector determined by an estimator *not* provided with such perfect knowledge of the full **X** matrix

[92] A cautionary caveat here would appear to be the statement in the LSPD manual : "Note: this data [earnings] has not been verified". This author's conjecture is that the earlier data (in particular) may be less reliable than the later.

[93] By definition, a parameter does not alter across realisations of a stochastic process. This is usually extended to imply that such different realisations also pertain to observations of the process across different time periods.

[94] In this (idealised) example, even 'structural' changes would be identified by data within the **X** matrix.

Start Year	End Year	Constant	DJAN	DAPR	DSEP	MKTXS	DJ_MKT	DA_MKT	DS_MKT	DZERO	DJ_ZERO	DA_ZERO	DS_ZERO	Div_Yld	DJ_DIV	DA_DIV	DS_DIV	LOGCAP	DJ_CAP	DA_CAP	DS_CAP
58	67	-0.0003	0.0007	-0.0064	0.0032	0.9788	0.0182	0.0386	0.0027	0.0016	0.0014	0.0068	-0.0045	0.0240	0.0089	0.0349	-0.0419	-0.0017	-0.0030	0.0038	0.0001
59	68	0.0001	-0.0012	-0.0067	0.0045	0.9817	0.0014	0.0281	0.0230	0.0021	0.0024	0.0080	-0.0073	0.0274	0.0190	0.0336	-0.0528	-0.0021	-0.0007	0.0039	-0.0008
60	69	0.0006	-0.0022	-0.0060	0.0031	0.9869	0.0347	0.0170	0.0076	0.0029	0.0052	0.0057	-0.0023	0.0194	0.0144	0.0343	-0.0571	-0.0022	0.0000	0.0034	0.0007
61	70	0.0004	-0.0038	-0.0033	0.0012	0.9845	0.0327	0.0166	0.0178	0.0044	0.0030	-0.0015	-0.0012	0.0281	0.0223	0.0109	-0.0597	-0.0026	0.0017	0.0028	0.0025
62	71	-0.0006	-0.0014	-0.0027	0.0000	0.9970	0.0289	0.0008	0.0264	0.0085	0.0000	-0.0074	-0.0045	0.0405	-0.0009	0.0014	-0.0416	-0.0026	0.0005	0.0033	0.0023
63	72	0.0001	-0.0066	-0.0045	0.0004	1.0056	0.0649	0.0141	-0.0057	0.0090	0.0127	0.0015	-0.0054	0.0387	0.0392	0.0448	-0.0393	-0.0028	0.0002	0.0009	0.0022
64	73	0.0018	-0.0052	-0.0044	-0.0029	0.9981	0.0214	0.0216	0.0056	0.0058	0.0139	0.0012	-0.0002	0.0260	0.0481	0.0382	-0.0193	-0.0031	0.0001	0.0011	0.0032
65	74	0.0012	-0.0026	-0.0046	-0.0004	0.9908	0.0167	0.0318	0.0062	0.0063	0.0128	0.0050	-0.0011	0.0419	-0.0013	0.0294	-0.0406	-0.0032	0.0009	0.0013	0.0022
66	75	0.0007	-0.0035	-0.0069	-0.0020	0.9815	-0.0275	0.0271	0.0019	0.0049	0.0022	0.0084	0.0000	0.0541	-0.0024	0.0591	-0.0004	-0.0033	0.0040	0.0019	0.0015
67	76	0.0016	-0.0071	-0.0047	-0.0005	0.9816	-0.0266	0.0218	0.0010	0.0025	0.0050	0.0087	-0.0006	0.0472	0.0238	0.0307	0.0140	-0.0034	0.0050	0.0015	-0.0003
68	77	0.0044	-0.0102	-0.0072	-0.0064	0.9819	-0.0228	0.0233	-0.0093	-0.0001	0.0093	0.0114	0.0013	0.0268	0.0337	0.0498	0.0747	-0.0043	0.0065	0.0020	0.0010
69	78	0.0047	-0.0018	-0.0069	-0.0067	0.9815	-0.0301	0.0280	-0.0070	-0.0012	0.0069	0.0125	0.0057	0.0293	0.0021	0.0541	0.0630	-0.0044	0.0025	0.0014	0.0013
70	79	0.0055	-0.0032	-0.0076	-0.0048	0.9823	-0.0309	0.0284	-0.0080	-0.0023	0.0054	0.0138	0.0023	0.0226	0.0169	0.0352	0.0595	-0.0044	0.0026	0.0024	0.0004
71	80	0.0052	-0.0057	-0.0132	-0.0028	0.9846	-0.0301	0.0327	-0.0109	-0.0021	0.0093	0.0214	0.0032	0.0170	0.0195	0.0374	0.0655	-0.0039	0.0036	0.0050	-0.0012
72	81	0.0045	-0.0051	-0.0141	0.0016	0.9809	-0.0250	0.0384	-0.0052	-0.0046	0.0102	0.0267	-0.0004	0.0207	0.0134	0.0908	0.0418	-0.0033	0.0032	0.0028	-0.0029
73	82	0.0032	-0.0070	-0.0135	0.0004	0.9772	-0.0191	0.0274	0.0038	-0.0049	0.0012	0.0181	-0.0004	0.0269	0.0106	0.0658	0.0336	-0.0028	0.0048	0.0045	-0.0017
74	83	0.0018	-0.0047	-0.0148	0.0048	0.9783	-0.0262	0.0279	0.0028	-0.0018	0.0077	0.0237	-0.0057	0.0359	-0.0211	0.0757	0.0158	-0.0025	0.0049	0.0042	-0.0032
75	84	0.0022	-0.0041	-0.0131	0.0046	0.9811	-0.0361	0.0165	-0.0044	-0.0031	0.0108	0.0193	-0.0073	0.0282	-0.0146	0.0684	0.0091	-0.0021	0.0044	0.0035	-0.0024
76	85	0.0025	-0.0020	-0.0077	0.0067	0.9933	-0.0088	0.0067	-0.0043	-0.0014	0.0201	0.0152	-0.0080	0.0216	0.0212	0.0439	0.0001	-0.0019	-0.0009	0.0016	-0.0028
77	86	0.0027	0.0010	-0.0081	0.0073	0.9943	-0.0065	0.0005	-0.0160	0.0004	0.0160	0.0198	-0.0093	0.0257	-0.0003	0.0709	0.0001	-0.0021	-0.0014	0.0008	-0.0028
78	87	0.0037	-0.0025	-0.0093	0.0106	1.0144	0.0224	-0.0148	0.0053	0.0026	0.0158	0.0213	-0.0126	0.0218	0.0118	0.0831	-0.0187	-0.0024	-0.0011	0.0010	-0.0030
79	88	0.0046	-0.0050	-0.0102	0.0066	1.0147	0.0083	-0.0110	0.0040	0.0003	0.0167	0.0256	-0.0118	0.0175	-0.0108	0.0883	-0.0098	-0.0024	0.0009	0.0011	-0.0015
80	89	0.0035	-0.0070	-0.0106	0.0072	1.0144	-0.0021	-0.0275	0.0044	0.0008	0.0176	0.0278	-0.0133	0.0228	-0.0152	0.1207	0.0046	-0.0019	0.0018	0.0008	-0.0018
81	90	0.0026	-0.0005	-0.0063	0.0066	1.0104	-0.0006	-0.0256	-0.0015	-0.0007	0.0167	0.0238	-0.0143	0.0280	-0.0202	0.1280	0.0295	-0.0015	-0.0005	-0.0007	-0.0020
82	91	0.0038	-0.0035	-0.0054	0.0042	1.0117	0.0009	0.0030	-0.0182	-0.0021	0.0150	0.0204	-0.0091	0.0261	-0.0188	0.0802	0.0523	-0.0016	0.0006	-0.0002	-0.0018
83	92	0.0040	-0.0066	-0.0075	-0.0007	1.0087	0.0077	-0.0106	-0.0106	-0.0007	0.0163	0.0231	-0.0073	0.0241	-0.0210	0.1149	0.0657	-0.0017	0.0016	0.0000	-0.0004
84	93	0.0044	-0.0041	-0.0039	-0.0028	1.0091	-0.0044	-0.0086	-0.0116	-0.0011	0.0127	0.0206	-0.0053	0.0249	-0.0171	0.0966	0.0897	-0.0018	0.0008	-0.0009	0.0001
85	94	0.0051	-0.0013	-0.0023	0.0005	1.0088	-0.0096	-0.0117	-0.0124	-0.0010	0.0153	0.0215	-0.0025	0.0221	-0.0105	0.1059	0.1102	-0.0018	-0.0004	-0.0014	-0.0014
86	95	0.0042	0.0012	-0.0024	-0.0007	1.0094	-0.0156	-0.0142	-0.0097	-0.0014	0.0156	0.0184	0.0006	0.0170	-0.0089	0.1130	0.0864	-0.0014	-0.0011	-0.0012	-0.0008
87	96	0.0030	0.0005	-0.0011	-0.0012	1.0102	-0.0180	-0.0069	-0.0099	-0.0011	0.0111	0.0156	-0.0007	0.0144	-0.0085	0.0643	0.0738	-0.0010	-0.0006	-0.0010	-0.0005
88	97	-0.0020	0.0083	0.0041	0.0004	0.9987	-0.0060	0.0006	0.0036	-0.0016	0.0096	0.0150	0.0007	0.0621	-0.0582	0.0542	0.0225	-0.0002	-0.0021	-0.0022	-0.0004
89	FULL	0.0015	0.0001	-0.0060	0.0007	0.9921	-0.0271	0.0101	-0.0042	0.0015	0.0080	0.0123	-0.0035	0.0235	-0.0027	0.0433	0.0082	-0.0015	0.0000	0.0010	-0.0003
90	1st Half	0.0016	-0.0039	-0.0067	-0.0020	0.9798	-0.0219	0.0304	0.0007	0.0008	0.0067	0.0086	-0.0009	0.0222	0.0390	0.0366	0.0224	-0.0028	0.0018	0.0028	0.0007
91	2nd Half	0.0020	0.0030	-0.0035	0.0052	1.0051	-0.0101	-0.0096	0.0046	-0.0002	0.0130	0.0179	-0.0052	0.0222	-0.0141	0.0603	0.0044	-0.0011	-0.0015	-0.0005	-0.0014
92	MT(1998)	0.0029	-0.0018	-0.0098	0.0020	0.9971	-0.0022	-0.0064	-0.0117	-0.0015	0.0166	0.0207	-0.0060	0.0196	-0.0054	0.0776	0.0245	-0.0016	0.0000	0.0013	-0.0009
Original	MT(1998)	0.0002	-0.0097	-0.0133	0.0061	1.0000	-0.0001	0.0000	0.0000	-0.0003	0.0240	0.0249	-0.0136	0.0600	0.0600	0.0800	-0.0005	-0.0012	0.0012	0.0020	-0.0015
(60 vs. 24 Months, Different survival criteria, Simpler dividend criteria.																					

Table 4.9.1 Summary of Extended Model Results (Rolling 10-year periods)

(Estimation using OLS; Payout Ratio variable omitted)

Start Year	End Year	Constant	DJAN	DAPR	DSEP	MKTXS	DJ_MKT	DA_MKT	DS_MKT	DZERO	DJ_ZERO	DA_ZERC	DS_ZERC	Div_Yld	DJ_DIV	DA_DIV	DS_DIV	LOGCAP	DJ_CAP	DA_CAP	DS_CAP	Pay_Ratio
58	67	-0.0021	0.0005	-0.0061	0.0033	0.9834	0.0008	0.0370	-0.0065	0.0018	0.0019	0.0065	-0.0045	-0.0033	0.0163	0.0311	-0.0408	-0.0027	-0.0030	0.0037	0.0001	0.0027
59	68	-0.0018	-0.0013	-0.0064	0.0045	0.9863	-0.0163	0.0244	0.0119	0.0024	0.0027	0.0076	-0.0071	-0.0035	0.0249	0.0294	-0.0502	-0.0032	-0.0006	0.0039	-0.0008	0.0029
60	69	-0.0011	-0.0025	-0.0056	0.0030	0.9884	0.0271	0.0119	0.0029	0.0030	0.0056	0.0053	-0.0021	-0.0207	0.0230	0.0301	-0.0548	-0.0035	0.0000	0.0034	0.0007	0.0033
61	70	-0.0016	-0.0041	-0.0027	0.0009	0.9859	0.0249	0.0155	0.0204	0.0047	0.0033	-0.0021	-0.0009	-0.0194	0.0296	0.0027	-0.0551	-0.0040	0.0017	0.0027	0.0025	0.0037
62	71	-0.0025	-0.0019	-0.0024	-0.0006	1.0031	0.0173	-0.0013	0.0369	0.0088	0.0006	-0.0078	-0.0042	-0.0061	0.0099	-0.0045	-0.0358	-0.0039	0.0006	0.0033	0.0023	0.0037
63	72	-0.0021	-0.0074	-0.0044	0.0002	1.0142	0.0630	0.0156	-0.0267	0.0097	0.0132	0.0011	-0.0050	-0.0071	0.0477	0.0396	-0.0325	-0.0040	0.0002	0.0009	0.0022	0.0038
64	73	0.0002	-0.0054	-0.0044	-0.0031	1.0012	0.0104	0.0272	-0.0082	0.0364	0.0143	0.0009	0.0002	-0.0152	0.0569	0.0336	-0.0127	-0.0041	0.0002	0.0010	0.0032	0.0033
65	74	-0.0004	-0.0028	-0.0046	-0.0009	0.9816	0.0083	0.0400	-0.0012	0.0070	0.0132	0.0047	-0.0006	0.0021	0.0073	0.0239	-0.0328	-0.0041	0.0009	0.0012	0.0022	0.0032
66	75	-0.0006	-0.0033	-0.0068	-0.0021	0.9826	-0.0288	0.0326	0.0002	0.0059	0.0019	0.0079	0.0002	0.0393	-0.0056	0.0509	0.0027	-0.0037	0.0039	0.0018	0.0015	0.0018
67	76	0.0004	-0.0073	-0.0046	-0.0006	0.9815	-0.0267	0.0240	-0.0009	0.0036	0.0052	0.0085	-0.0005	0.0397	0.0270	0.0276	0.0161	-0.0037	0.0050	0.0015	-0.0003	0.0014
68	77	0.0027	-0.0103	-0.0069	-0.0065	0.9830	-0.0239	0.0241	-0.0097	0.0013	0.0093	0.0110	0.0014	0.0227	0.0335	0.0442	0.0762	-0.0046	0.0065	0.0020	0.0010	0.0017
69	78	0.0031	-0.0020	-0.0069	-0.0067	0.9837	-0.0329	0.0282	-0.0078	0.0002	0.0072	0.0123	0.0057	0.0264	0.0045	0.0509	0.0637	-0.0047	0.0025	0.0014	0.0013	0.0017
70	79	0.0047	-0.0033	-0.0075	-0.0047	0.9831	-0.0324	0.0275	-0.0075	-0.0015	0.0056	0.0138	0.0022	0.0206	0.0185	0.0341	0.0590	-0.0046	0.0026	0.0023	0.0004	0.0011
71	80	0.0052	-0.0057	-0.0132	-0.0028	0.9846	-0.0300	0.0330	-0.0110	-0.0022	0.0093	0.0214	0.0032	0.0171	0.0194	0.0375	0.0656	-0.0039	0.0036	0.0050	-0.0012	0.0001
72	81	0.0048	-0.0051	-0.0142	0.0015	0.9803	-0.0239	0.0407	-0.0052	-0.0049	0.0102	0.0268	-0.0004	0.0218	0.0129	0.0914	0.0421	-0.0033	0.0032	0.0028	-0.0029	-0.0005
73	82	0.0035	-0.0070	-0.0136	0.0004	0.9764	-0.0178	0.0298	0.0042	-0.0052	0.0012	0.0182	-0.0004	0.0282	0.0100	0.0661	0.0338	-0.0027	0.0048	0.0045	-0.0017	-0.0005
74	83	0.0018	-0.0047	-0.0148	0.0048	0.9784	-0.0263	0.0277	0.0028	-0.0018	0.0077	0.0237	-0.0057	0.0358	-0.0210	0.0757	0.0158	-0.0025	0.0049	0.0042	-0.0032	0.0000
75	84	0.0019	-0.0040	-0.0129	0.0047	0.9807	-0.0384	0.0140	-0.0041	-0.0027	0.0109	0.0192	-0.0074	0.0241	-0.0134	0.0670	0.0085	-0.0021	0.0043	0.0035	-0.0024	0.0011
76	85	0.0034	-0.0024	-0.0080	0.0066	0.9926	0.0023	0.0044	-0.0061	-0.0024	0.0200	0.0155	-0.0080	0.0312	0.0184	0.0479	0.0003	-0.0019	-0.0008	0.0016	-0.0028	-0.0028
77	86	0.0031	0.0009	-0.0082	0.0073	0.9948	-0.0035	0.0000	-0.0167	0.0000	0.0159	0.0199	-0.0092	0.0286	-0.0013	0.0723	0.0002	-0.0021	-0.0014	0.0008	-0.0028	-0.0011
78	87	0.0003	-0.0020	-0.0082	0.0115	1.0133	0.0169	-0.0129	0.0073	0.0059	0.0155	0.0203	-0.0135	0.0127	0.0097	0.0684	-0.0318	-0.0024	-0.0011	0.0009	-0.0030	0.0070
79	88	0.0007	-0.0052	-0.0089	0.0077	1.0132	0.0037	-0.0089	0.0052	0.0042	0.0172	0.0243	-0.0128	0.0071	-0.0040	0.0686	-0.0257	-0.0023	0.0009	0.0010	-0.0016	0.0080
80	89	-0.0021	-0.0076	-0.0087	0.0087	1.0128	-0.0008	-0.0254	0.0046	0.0063	0.0182	0.0259	-0.0147	0.0087	-0.0058	0.0910	-0.0175	-0.0018	0.0019	0.0007	-0.0019	0.0109
81	90	-0.0037	-0.0010	-0.0044	0.0082	1.0102	-0.0017	-0.0178	0.0002	0.0055	0.0173	0.0216	-0.0157	0.0126	-0.0098	0.0930	0.0050	-0.0014	-0.0004	-0.0008	-0.0021	0.0118
82	91	-0.0033	-0.0044	-0.0031	0.0060	1.0117	0.0062	0.0094	-0.0160	0.0047	0.0157	0.0180	-0.0109	0.0088	-0.0070	0.0362	0.0216	-0.0015	0.0007	-0.0002	-0.0018	0.0128
83	92	0.0025	-0.0069	-0.0072	0.0000	1.0085	0.0100	-0.0146	-0.0103	0.0008	0.0164	0.0228	-0.0079	0.0201	-0.0182	0.1060	0.0567	-0.0017	0.0016	0.0000	-0.0004	0.0028
84	93	0.0038	-0.0041	-0.0037	-0.0026	1.0087	-0.0043	-0.0105	-0.0111	-0.0005	0.0128	0.0204	-0.0055	0.0230	-0.0157	0.0917	0.0856	-0.0018	0.0008	-0.0009	-0.0001	0.0011
85	94	0.0046	-0.0014	-0.0021	0.0007	1.0083	-0.0096	-0.0131	-0.0120	-0.0005	0.0153	0.0213	-0.0028	0.0205	-0.0093	0.1001	0.1054	-0.0018	-0.0004	-0.0014	-0.0014	0.0009
86	95	0.0041	0.0012	-0.0024	-0.0006	1.0093	-0.0156	-0.0145	-0.0096	-0.0013	0.0156	0.0183	0.0005	0.0165	-0.0086	0.1110	0.0847	-0.0014	-0.0011	-0.0012	-0.0008	0.0003
87	96	0.0031	0.0005	-0.0011	-0.0012	1.0102	-0.0180	-0.0067	-0.0100	-0.0011	0.0111	0.0156	-0.0007	0.0145	-0.0086	0.0650	0.0744	-0.0010	-0.0006	-0.0010	-0.0005	0.0001
88	97	-0.0018	0.0085	0.0041	0.0003	0.9993	-0.0062	0.0010	0.0030	-0.0018	0.0093	0.0150	0.0008	0.0683	-0.0640	0.0555	0.0229	-0.0002	-0.0021	-0.0022	-0.0003	-0.0006
89	FULL	0.0022	0.0000	-0.0062	0.0006	0.9920	-0.0269	0.0108	-0.0034	0.0009	0.0079	0.0124	-0.0034	0.0261	-0.0044	0.0455	0.0091	-0.0015	0.0000	0.0010	-0.0003	-0.0008
90	1st Half	0.0000	-0.0041	-0.0064	-0.0021	0.9812	-0.0225	0.0332	-0.0003	0.0020	0.0067	0.0081	-0.0007	0.0128	0.0407	0.0311	0.0241	-0.0033	0.0018	0.0027	0.0007	0.0018
91	2nd Half	0.0017	0.0030	-0.0034	0.0053	1.0050	-0.0103	-0.0103	0.0047	0.0002	0.0130	0.0178	-0.0054	0.0207	-0.0130	0.0586	0.0026	-0.0011	-0.0015	-0.0005	-0.0014	0.0007
92	MT(1998)	0.0026	-0.0018	-0.0096	0.0021	0.9969	-0.0031	-0.0074	-0.0115	-0.0012	0.0166	0.0206	-0.0061	0.0180	-0.0043	0.0761	0.0233	-0.0016	0.0000	0.0012	-0.0009	0.0006
Original	MT(1998)	0.0002	-0.0097	-0.0133	0.0061	1.0000	-0.0001	0.0000	0.0000	-0.0003	0.0240	0.0249	-0.0136	0.0600	0.0600	0.0800	-0.0005	-0.0012	0.0012	0.0020	-0.0015	
(60 vs. 24 Months, Different survival criteria, Simpler dividend criteria.																						

Table 4.9.2 Summary of Extended Model Results (Rolling 10-year periods)

(Estimation using OLS; Payout Ratio variable included)

* Shading indicates significance at the 5% level.

(e.g. with omitted but necessary regressors), then in the general case, the β vector will estimate differently with different samples (e.g. across time).

There exist tests for correct specification, which effectively test the restriction $\beta_1 = \beta_2$, (where the index relates to the sample), e.g. the Chow test (Chow (1960)), CUSUM or $CUSUM^2$ tests. The former, in its simplest form, requires knowledge of the time at which the possible structural change took place; in all cases, the correct overall critical value of the test sequence is both difficult to calculate and likely to induce low power (Hendry (1995), pp. 85).

The use of rolling regressions provides a means for subjective assessment of the time trace of parameter change, as opposed to the use of simple tests with relatively uninformative binary outcomes related to some critical value. In an ideal world, given unlimited data availability (potentially allowing the formation of the 'correct' **X** matrix), then the time trace of the parameter change is potentially informative as to what additional data may be required to improve the modelling of the process.

The emergence of Payout Ratio as a significant explanator over a number of different periods is also interesting given that, unlike the case of the Dividend Yield and Market Capitalisation variables, which were utilised (in the methodology) as portfolio determinants in order to ensure a spread of values, no such consideration was employed in the case of Payout Ratio[95]. Nevertheless, the anomaly whereby the sign of the coefficient is difficult to reconcile, coupled with the general instability of the parameter, makes interpretation of the contribution of Payout Ratio difficult at this stage. Conclusions regarding this issue are thus deferred pending further investigation.

4.7 Estimation using Generalised Method of Moments (GMM)

Up to this point, the use of the Ordinary Least Squares (OLS) estimator, and the results generated from its use, has informed the direction and progress of the investigation up to the stage reached in section 4.6 above. However, the technique of OLS relies upon a set of strong assumptions in order to qualify as the best (i.e. minimum variance) linear unbiased estimator. These, collectively known as the Gauss-Markov assumptions, may be listed as follows:

[95] This point is examined further in section 4.7.

1) $E\{\varepsilon_i\} = 0$, i = 1,....N.

2) $\{\varepsilon_1, \ldots \varepsilon_N\}$ and $\{x_1, \ldots x_N\}$ are independent

3) $V\{\varepsilon_i\} = \sigma^2$, i = 1,....N.

4) $Cov\{\varepsilon_i, \varepsilon_j\} = 0$, i,j = 1,....N, I<>j.

In addition, for the purposes of exact statistical inference, the distribution of the error terms $\{\varepsilon_i\}$ requires to be known. This is in many instances mitigated, however, in the case of large samples, where invocation of the Central Limit Theorem (CLT) may permit the assumption of normality to suffice asymptotically for inferential purposes.

Assumption (1) above is normally satisfied when the set of regressors includes a constant term, and is not, therefore, a cause for concern. Assumption (2) is usually expressed in terms of the *correlation* between error terms and regressors (a weaker assumption than independence); the distinction is also here drawn between *contemporaneous* correlation and correlation between regressors and *past* values of the error terms. In the latter case, parameter estimates are subject to bias, but remain consistent for large samples; in the former (contemporaneous correlation) case, estimates are both biased and inconsistent.

Assumption (3) relates to the question of non-constant variance, or heteroscedasticity; Assumption (4) addresses the issue of serial correlation. Whilst the OLS estimator remains unbiased and consistent in the presence of both heteroscedasticity and autocorrelation, the assumption of a diagonal covariance matrix with individual elements equal (to σ^2) is most likely to give rise to erroneous inferences. In addition, the OLS estimator ceases to be the most efficient (minimum variance) unbiased estimator under these conditions.

Whilst a range of tests is available to isolate the effects of individual departures, within the data, from the 'classical' assumptions (e.g. Goldfeld-Quandt or Breusch-Pagan tests for heteroscedasticity, Durbin-Watson test for autocorrelation), the approach adopted here is to utilise a robust estimator which allows for each and for all of the departures highlighted above. The Generalised Method of Moments (GMM) estimator (**Hansen (1982)**) is such an estimator, when augmented by the techniques of **White (1980)** and **Newey and West (1987)**, in respect of heteroscedasticity and autocorrelation, respectively. It may therefore be described as a heteroscedasticity and autocorrelation consistent (HAC) estimator. Following Lamoureux and Sanger (1989), the possibility of up to 12th order autocorrelation is allowed for.

4.7.1 Applying the more robust estimator (Stage 1)

The adjustment to the shortcomings of the OLS estimation, by way of relaxing the strong assumptions alluded to above, will be made here in two stages, in order to separately address the contribution of each step. Firstly, the choice of instrumental variables necessary for the GMM Estimation will consist merely of the full set of regressors themselves. This is equivalent to specifying the instrument matrix **Z** to be equal to the regressor matrix **X**. In and of itself, this renders the estimator to be none other than OLS. However, this particular estimation will be carried out in such a way as to invoke the HAC capability of the GMM estimator.

The results of the estimation may be most easily viewed by effecting a comparison with the earlier OLS results described above. As would be suggested by econometric theory, the coefficients are estimated identically to the earlier case, since in the presence of heteroscedasticity and autocorrelation, OLS remains unbiased and consistent; though in the presence of these influences, becomes inefficient, and is unreliable from the standpoint of inference. These latter considerations stem from the use, in the OLS estimation, of an inappropriate error covariance matrix, namely $\sigma^2\mathbf{I}$, which assumes away any heteroscedasticity and autocorrelation which may be present. The effect, therefore, on the results as presented manifest themselves in terms of the changes in the complement of coefficients which are significant (here, at 5%, as indicated by the shaded entries in Table 4.9.3).

The HAC estimator in this case is seen to be more demanding[96] in terms of its acceptance of significance, with fewer estimates qualifying in this regard. However, the broad conclusions which emerged from the OLS estimation, in regard to the role played by the various regressors, and their associated parameters, remain substantially unchanged.

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[96] This statement refers to the particular data sample under discussion. In the general case, dependent upon the nature of the true error covariance matrix (W) and regressor matrix (X), confidence intervals may be too wide or too narrow, and a correct null hypothesis rejected less often or more often than is suggested by a test which assumes that cov(e) = $\sigma^2\mathbf{I}$. (See Griffiths, Carter Hill, Judge (1993), pp. 482).

Start Year	End Year	Constant	DJAN	DAPR	DSEP	MKTXS	DJ_MKT	DA_MKT	DS_MKT	DZERO	DJ_ZERO	DA_ZERO	DS_ZERO	Div_Yld	DJ_DIV	DA_DIV	DS_DIV	LOGCAP	DJ_CAP	DA_CAP	DS_CAP
58	67	-0.0003	0.0007	-0.0064	0.0032	0.9788	0.0182	0.0386	0.0027	0.0016	0.0014	0.0068	-0.0045	0.0240	0.0089	0.0349	-0.0419	-0.0017	-0.0030	0.0038	0.0001
59	68	-0.0001	-0.0012	-0.0067	0.0045	0.9817	0.0014	0.0281	0.0230	0.0021	0.0024	0.0080	-0.0073	0.0274	0.0190	0.0336	-0.0528	-0.0021	-0.0007	0.0039	-0.0008
60	69	0.0006	-0.0022	-0.0060	0.0031	0.9869	0.0347	0.0170	0.0076	0.0029	0.0052	0.0057	-0.0023	0.0194	0.0144	0.0343	-0.0571	-0.0022	0.0000	0.0034	0.0007
61	70	0.0004	-0.0038	-0.0033	0.0012	0.9845	0.0327	0.0166	0.0178	0.0044	0.0030	-0.0015	-0.0012	0.0281	0.0223	0.0109	-0.0597	-0.0026	0.0017	0.0028	0.0025
62	71	-0.0006	-0.0014	-0.0027	0.0000	0.9970	0.0289	0.0008	0.0264	0.0085	0.0000	-0.0074	-0.0045	0.0405	-0.0009	0.0014	-0.0416	-0.0026	0.0005	0.0033	0.0023
63	72	-0.0001	-0.0066	-0.0045	0.0004	1.0056	0.0649	0.0141	-0.0057	0.0090	0.0127	0.0015	-0.0054	0.0387	0.0392	0.0448	-0.0393	-0.0028	0.0002	0.0009	0.0022
64	73	0.0018	-0.0052	-0.0044	-0.0029	0.9981	0.0214	0.0216	0.0056	0.0058	0.0139	0.0012	-0.0002	0.0260	0.0481	0.0382	-0.0193	-0.0031	0.0001	0.0011	0.0032
65	74	0.0012	-0.0026	-0.0046	-0.0004	0.9908	0.0167	0.0318	0.0062	0.0063	0.0128	0.0050	-0.0011	0.0419	-0.0013	0.0294	-0.0406	-0.0032	0.0009	0.0013	0.0022
66	75	0.0007	-0.0035	-0.0069	-0.0020	0.9816	-0.0275	0.0271	0.0019	0.0049	0.0022	0.0084	0.0000	0.0541	-0.0024	0.0591	-0.0004	-0.0033	0.0040	0.0019	0.0015
67	76	0.0016	-0.0071	-0.0047	-0.0005	0.9816	-0.0266	0.0218	0.0010	0.0025	0.0050	0.0087	-0.0006	0.0472	0.0238	0.0307	0.0140	-0.0034	0.0050	0.0015	-0.0003
68	77	0.0044	-0.0102	-0.0072	-0.0064	0.9819	-0.0228	0.0233	-0.0093	-0.0001	0.0093	0.0114	0.0013	0.0268	0.0337	0.0498	0.0747	-0.0043	0.0065	0.0020	0.0010
69	78	0.0047	-0.0018	-0.0069	-0.0067	0.9815	-0.0301	0.0280	-0.0070	-0.0012	0.0069	0.0125	0.0057	0.0293	0.0021	0.0541	0.0630	-0.0044	0.0025	0.0014	0.0013
70	79	0.0055	-0.0032	-0.0076	-0.0048	0.9823	-0.0309	0.0284	-0.0080	-0.0023	0.0054	0.0138	0.0023	0.0226	0.0169	0.0352	0.0595	-0.0044	0.0026	0.0024	0.0004
71	80	0.0052	-0.0057	-0.0132	-0.0028	0.9846	-0.0301	0.0327	-0.0109	-0.0021	0.0093	0.0214	0.0032	0.0170	0.0195	0.0374	0.0655	-0.0039	0.0036	0.0050	-0.0012
72	81	0.0045	-0.0051	-0.0141	0.0016	0.9809	-0.0250	0.0384	-0.0052	-0.0046	0.0102	0.0267	-0.0004	0.0207	0.0134	0.0908	0.0418	-0.0033	0.0032	0.0028	-0.0029
73	82	0.0032	-0.0070	-0.0135	0.0004	0.9772	-0.0191	0.0274	0.0038	-0.0049	0.0012	0.0181	-0.0004	0.0269	0.0106	0.0658	0.0336	-0.0028	0.0048	0.0045	-0.0017
74	83	0.0018	-0.0047	-0.0148	0.0048	0.9783	-0.0262	0.0279	0.0028	-0.0018	0.0077	0.0237	-0.0057	0.0359	-0.0211	0.0757	0.0158	-0.0025	0.0049	0.0042	-0.0032
75	84	0.0022	-0.0041	-0.0131	0.0046	0.9811	-0.0361	0.0165	-0.0044	-0.0031	0.0108	0.0193	-0.0073	0.0282	-0.0146	0.0684	0.0091	-0.0021	0.0044	0.0036	-0.0024
76	85	0.0025	-0.0020	-0.0077	0.0067	0.9933	-0.0088	0.0067	-0.0043	-0.0014	0.0201	0.0152	-0.0080	0.0216	0.0212	0.0439	0.0001	-0.0019	-0.0009	0.0016	-0.0028
77	86	0.0027	0.0010	-0.0081	0.0073	0.9943	-0.0065	0.0005	-0.0160	0.0004	0.0160	0.0198	-0.0093	0.0257	-0.0003	0.0709	0.0001	-0.0021	-0.0014	0.0008	-0.0028
78	87	0.0037	-0.0025	-0.0093	0.0106	1.0144	0.0224	-0.0148	0.0053	0.0026	0.0158	0.0213	-0.0125	0.0218	0.0118	0.0831	-0.0187	-0.0024	-0.0011	0.0010	-0.0030
79	88	0.0046	-0.0050	-0.0102	0.0066	1.0148	0.0083	-0.0110	0.0040	0.0003	0.0167	0.0256	-0.0118	0.0175	-0.0108	0.0883	-0.0098	-0.0024	0.0009	0.0011	-0.0015
80	89	0.0035	-0.0070	-0.0106	0.0072	1.0144	-0.0021	-0.0275	0.0044	0.0008	0.0176	0.0278	-0.0133	0.0228	-0.0152	0.1207	0.0046	-0.0019	0.0018	0.0008	-0.0018
81	90	0.0026	-0.0005	-0.0063	0.0066	1.0104	-0.0006	-0.0256	-0.0015	-0.0007	0.0167	0.0236	-0.0143	0.0280	-0.0202	0.1280	0.0295	-0.0015	-0.0005	-0.0007	-0.0020
82	91	0.0036	-0.0035	-0.0054	0.0042	1.0117	0.0009	0.0030	-0.0182	-0.0021	0.0150	0.0204	-0.0091	0.0261	-0.0188	0.0802	0.0523	-0.0016	0.0006	-0.0002	-0.0018
83	92	0.0040	-0.0066	-0.0075	-0.0007	1.0087	0.0077	-0.0106	-0.0106	-0.0007	0.0163	0.0231	-0.0073	0.0241	-0.0210	0.1149	0.0657	-0.0017	0.0016	0.0000	-0.0004
84	93	0.0044	-0.0041	-0.0039	-0.0028	1.0091	-0.0044	-0.0086	-0.0116	-0.0011	0.0127	0.0206	-0.0053	0.0249	-0.0171	0.0966	0.0897	-0.0018	0.0008	-0.0009	-0.0001
85	94	0.0051	-0.0013	-0.0023	0.0005	1.0086	-0.0096	-0.0117	-0.0124	-0.0010	0.0153	0.0215	-0.0025	0.0221	-0.0105	0.1059	0.1102	-0.0018	-0.0004	-0.0014	-0.0014
86	95	0.0042	0.0012	-0.0024	-0.0007	1.0094	-0.0156	-0.0142	-0.0097	-0.0014	0.0156	0.0184	0.0006	0.0170	-0.0089	0.1130	0.0864	-0.0014	-0.0011	-0.0012	-0.0008
87	96	0.0030	0.0005	-0.0011	-0.0012	1.0102	-0.0180	-0.0069	-0.0099	-0.0011	0.0111	0.0156	-0.0007	0.0144	-0.0085	0.0643	0.0738	-0.0010	-0.0006	-0.0010	-0.0005
88	97	-0.0020	0.0083	0.0041	0.0004	0.9987	-0.0060	0.0006	0.0036	-0.0016	0.0096	0.0150	0.0007	0.0621	-0.0582	0.0542	0.0225	-0.0002	-0.0021	-0.0022	-0.0004
89	FULL	0.0015	-0.0001	-0.0060	0.0007	0.9921	-0.0271	0.0101	-0.0042	0.0015	0.0080	0.0123	-0.0035	0.0235	-0.0027	0.0433	0.0082	-0.0015	0.0000	0.0010	-0.0003
90	1st Half	0.0016	-0.0039	-0.0067	-0.0020	0.9798	-0.0219	0.0304	0.0007	0.0008	0.0067	0.0086	-0.0009	0.0222	0.0390	0.0366	0.0224	-0.0028	0.0018	0.0028	0.0007
91	2nd Half	0.0020	0.0030	-0.0035	0.0052	1.0051	-0.0101	-0.0096	0.0046	-0.0002	0.0130	0.0179	-0.0052	0.0222	-0.0141	0.0603	0.0044	-0.0011	-0.0015	-0.0005	-0.0014

Table 4.9.3 Summary of Extended Model Results (Rolling 10-year periods)

(Estimation using GMM; Payout Ratio variable omitted)

* Shading indicates significance at the 5% level.

Start Year	End Year	Constant	DJAN	DAPR	DSEP	MKTXS	DJ_MKT	DA_MKT	DS_MKT	DZERO	DJ_ZERO	DA_ZERC	DS_ZERC	Div_Yld	DJ_DIV	DA_DIV	DS_DIV	LOGCAP	DJ_CAP	DA_CAP	DS_CAP	Pay_Rat
58	67	-0.0021	0.0005	-0.0061	0.0033	0.9834	0.0008	0.0370	-0.0065	0.0018	0.0019	0.0065	-0.0045	-0.0033	0.0163	0.0311	-0.0408	-0.0027	-0.0030	0.0037	0.0001	0.0027
59	68	-0.0018	-0.0013	-0.0064	0.0045	0.9863	-0.0163	0.0244	0.0119	0.0024	0.0027	0.0076	-0.0071	-0.0035	0.0249	0.0294	-0.0502	-0.0032	-0.0006	0.0039	-0.0008	0.0029
60	69	-0.0011	-0.0025	-0.0056	0.0030	0.9884	0.0271	0.0119	0.0029	0.0030	0.0056	0.0053	-0.0021	-0.0207	0.0230	0.0301	-0.0548	-0.0035	0.0000	0.0034	0.0007	0.0033
61	70	-0.0016	-0.0041	-0.0027	0.0009	0.9858	0.0249	0.0155	0.0204	0.0047	0.0033	-0.0021	-0.0009	-0.0194	0.0296	0.0027	-0.0551	-0.0040	0.0017	0.0027	0.0025	0.0037
62	71	-0.0025	-0.0019	-0.0024	-0.0006	1.0031	0.0173	-0.0013	0.0369	0.0088	0.0006	-0.0078	-0.0042	-0.0061	0.0099	-0.0045	-0.0358	-0.0039	0.0006	0.0033	0.0023	0.0037
63	72	-0.0021	-0.0074	-0.0044	0.0002	1.0142	0.0630	0.0156	-0.0267	0.0097	0.0132	0.0011	-0.0050	-0.0071	0.0477	0.0396	-0.0325	-0.0040	0.0002	0.0009	0.0022	0.0038
64	73	0.0002	-0.0054	-0.0044	-0.0031	1.0012	0.0104	0.0272	-0.0082	0.0064	0.0143	0.0009	0.0002	-0.0152	0.0569	0.0336	-0.0127	-0.0041	0.0002	0.0010	0.0032	0.0033
65	74	-0.0004	-0.0028	-0.0046	-0.0009	0.9916	0.0083	0.0400	-0.0012	0.0070	0.0132	0.0047	-0.0006	0.0021	0.0073	0.0239	-0.0328	-0.0041	0.0009	0.0012	0.0022	0.0032
66	75	-0.0006	-0.0033	-0.0068	-0.0021	0.9826	-0.0288	0.0326	0.0002	0.0059	0.0019	0.0079	0.0002	0.0393	-0.0056	0.0509	0.0027	-0.0037	0.0039	0.0018	0.0015	0.0018
67	76	0.0004	-0.0073	-0.0046	-0.0006	0.9815	-0.0267	0.0240	-0.0009	0.0036	0.0052	0.0085	-0.0005	0.0397	0.0270	0.0276	0.0161	-0.0037	0.0050	0.0015	-0.0003	0.0014
68	77	0.0027	-0.0103	-0.0069	-0.0065	0.9830	-0.0239	0.0241	-0.0097	0.0013	0.0093	0.0110	0.0014	0.0227	0.0335	0.0442	0.0762	-0.0046	0.0065	0.0020	0.0010	0.0017
69	78	0.0031	-0.0020	-0.0069	-0.0067	0.9837	-0.0329	0.0282	-0.0078	0.0002	0.0072	0.0123	0.0057	0.0264	0.0045	0.0509	0.0637	-0.0047	0.0025	0.0014	0.0013	0.0017
70	79	0.0047	-0.0033	-0.0075	-0.0047	0.9831	-0.0324	0.0275	-0.0075	-0.0015	0.0056	0.0138	0.0022	0.0206	0.0185	0.0341	0.0590	-0.0046	0.0026	0.0023	0.0004	0.0011
71	80	0.0052	-0.0057	-0.0132	-0.0028	0.9846	-0.0300	0.0330	-0.0110	-0.0022	0.0093	0.0214	0.0032	0.0171	0.0194	0.0375	0.0656	-0.0039	0.0036	0.0050	-0.0012	-0.0001
72	81	0.0048	-0.0051	-0.0142	0.0015	0.9803	-0.0239	0.0407	-0.0052	-0.0049	0.0102	0.0268	-0.0004	0.0218	0.0129	0.0914	0.0421	-0.0033	0.0032	0.0028	-0.0029	-0.0005
73	82	0.0035	-0.0070	-0.0136	0.0004	0.9764	-0.0178	0.0298	0.0042	-0.0052	0.0012	0.0182	-0.0004	0.0282	0.0100	0.0661	0.0338	-0.0027	0.0048	0.0045	-0.0017	-0.0005
74	83	0.0018	-0.0047	-0.0148	0.0048	0.9784	-0.0263	0.0277	0.0028	-0.0018	0.0077	0.0237	-0.0057	0.0358	-0.0210	0.0757	0.0158	-0.0025	0.0048	0.0042	-0.0032	0.0000
75	84	0.0019	-0.0040	-0.0129	0.0047	0.9807	-0.0384	0.0140	-0.0041	-0.0027	0.0109	0.0192	-0.0074	0.0241	-0.0134	0.0670	0.0085	-0.0021	0.0043	0.0035	-0.0024	0.0011
76	85	0.0034	-0.0024	-0.0080	0.0066	0.9926	0.0023	0.0044	-0.0061	-0.0024	0.0200	0.0155	-0.0080	0.0312	0.0184	0.0479	0.0003	-0.0019	-0.0008	0.0016	-0.0028	-0.0028
77	86	0.0031	0.0009	-0.0082	0.0073	0.9948	-0.0035	0.0000	-0.0167	0.0000	0.0159	0.0199	-0.0092	0.0286	-0.0013	0.0723	0.0002	-0.0021	-0.0014	0.0008	-0.0028	-0.0011
78	87	0.0003	-0.0020	-0.0082	0.0115	1.0133	0.0169	-0.0129	0.0073	0.0059	0.0155	0.0203	-0.0135	0.0127	0.0097	0.0684	-0.0318	-0.0024	-0.0011	0.0009	-0.0030	0.0070
79	88	0.0007	-0.0052	-0.0089	0.0077	1.0132	0.0037	-0.0089	0.0052	0.0042	0.0172	0.0243	-0.0128	0.0071	-0.0040	0.0686	-0.0257	-0.0023	0.0009	0.0010	-0.0016	0.0080
80	89	-0.0021	-0.0076	-0.0087	0.0087	1.0128	-0.0008	-0.0254	0.0046	0.0063	0.0182	0.0259	-0.0147	0.0087	-0.0058	0.0910	-0.0175	-0.0018	0.0019	0.0007	-0.0019	0.0109
81	90	-0.0037	-0.0010	-0.0044	0.0082	1.0102	-0.0017	-0.0178	0.0002	0.0055	0.0173	0.0216	-0.0157	0.0126	-0.0098	0.0930	0.0050	-0.0014	-0.0004	-0.0008	-0.0021	0.0118
82	91	-0.0033	-0.0044	-0.0031	0.0060	1.0117	0.0062	0.0094	-0.0160	0.0047	0.0157	0.0180	-0.0109	0.0088	-0.0070	0.0362	0.0216	-0.0015	0.0007	-0.0002	-0.0018	0.0128
83	92	0.0025	-0.0069	-0.0072	0.0000	1.0085	0.0100	-0.0146	-0.0103	0.0008	0.0164	0.0228	-0.0079	0.0201	-0.0182	0.1060	0.0567	-0.0017	0.0016	0.0000	-0.0004	0.0028
84	93	0.0038	-0.0041	-0.0037	-0.0026	1.0088	-0.0043	-0.0105	-0.0111	-0.0005	0.0128	0.0204	-0.0055	0.0230	-0.0157	0.0917	0.0856	-0.0018	0.0008	-0.0009	-0.0001	0.0011
85	94	0.0046	-0.0014	-0.0021	0.0007	1.0083	-0.0096	-0.0131	-0.0120	-0.0005	0.0153	0.0213	-0.0028	0.0205	-0.0093	0.1001	0.1054	-0.0018	-0.0004	-0.0014	-0.0014	0.0009
86	95	0.0041	0.0012	-0.0024	-0.0006	1.0093	-0.0156	-0.0145	-0.0096	-0.0013	0.0166	0.0183	0.0005	0.0165	-0.0086	0.1110	0.0847	-0.0014	-0.0011	-0.0012	-0.0008	0.0003
87	96	0.0031	0.0005	-0.0011	-0.0012	1.0102	-0.0180	-0.0067	-0.0100	-0.0011	0.0111	0.0156	-0.0007	0.0145	-0.0086	0.0650	0.0744	-0.0010	-0.0006	-0.0010	-0.0005	-0.0001
88	97	-0.0018	0.0085	0.0041	0.0003	0.9993	-0.0062	0.0010	0.0030	-0.0018	0.0093	0.0150	0.0008	0.0683	-0.0640	0.0555	0.0229	-0.0002	-0.0021	-0.0022	-0.0003	-0.0006
89	FULL	0.0022	0.0000	-0.0062	0.0006	0.9920	-0.0269	0.0108	-0.0034	0.0009	0.0079	0.0124	-0.0034	0.0261	-0.0044	0.0455	0.0091	-0.0015	0.0000	0.0010	-0.0003	-0.0008
90	1st Half	0.0000	-0.0041	-0.0064	-0.0021	0.9811	-0.0225	0.0332	-0.0003	0.0020	0.0067	0.0081	-0.0007	0.0128	0.0407	0.0311	0.0241	-0.0033	0.0018	0.0027	0.0007	0.0018
91	2nd Half	0.0017	0.0030	-0.0034	0.0053	1.0050	-0.0103	-0.0103	0.0047	0.0002	0.0130	0.0178	-0.0054	0.0207	-0.0130	0.0586	0.0026	-0.0011	-0.0015	-0.0005	-0.0014	0.0007

Table 4.9.4 Summary of Extended Model Results (Rolling 10-year periods)

(Estimation using GMM; Payout Ratio variable included)

* Shading indicates significance at the 5% level.

4.7.2 Choice of alternative Instrumental Variables for the GMM Estimation (Stage 2)

The OLS estimator functions by establishing an objective function which enforces a state of orthogonality between the matrix of regressors and the vector of errors; adjusting the value of the parameter vector in order to satisfy this objective. Expressed algebraically, the (moment) condition is:

$$\mathbf{X}\varepsilon = 0$$

The *imposition* of this state of orthogonality is valid in the absence of correlation between regressors and error terms (see assumption (2) above). Where such correlation does in fact exist, however, the enforcement, numerically, of the (now invalid) moment condition causes the resultant parameter vector (β) to be biased and inconsistent. There exist three commonly referenced instances where the assumption is not justified, two of which potentially may apply in the case of our current data set.

The first instance is that which features dynamic models of the kind which incorporate lagged dependent variables within the regressor matrix, when autocorrelation of the error terms is also present. The autocorrelation typically implies dependence between successive error terms ε_t and ε_{t-1}, which, together with the dependent relationship between L.H.S. variable $\mathbf{y}_{t-1}$ and ε_{t-1} from the previous period, establishes a linkage between ε_t and $\mathbf{y}_{t-1}$ (now featuring as a R.H.S. regressor in the *current* period)[97]. As a dynamic model is not utilised here, this aspect will not be considered further.

The second instance relates to the problem of measurement error, or "errors in variables". It is frequently difficult or impossible to ensure that economic or financial data is gathered with absolute precision. The consequence of this fact is that a component of the measurement error ($\mathbf{u}_t$) in the *measured* value of the regressor ($\mathbf{x}_t$) (that component depending upon the sign and magnitude of the associated parameter estimate) appears additively in the residual (ε_t) of the regression of $\mathbf{y}_t$ upon $\mathbf{x}_t$. Relative to a given *true* value of the regressor ($\mathbf{w}_t$), the measurement error is negatively correlated with the *measured* value of the regressor, being constrained by the relation $\mathbf{w}_t = \mathbf{x}_t - \mathbf{u}_t$. Expressed alternately, for a given $\mathbf{w}_t$ an increase (decrease) in $\mathbf{u}_t$ must be accompanied by a decrease (increase) in $\mathbf{x}_t$. This is sufficient to establish the correlation between ε_t and $\mathbf{x}_t$.

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[97] See, e.g. Verbeek, (2000) for a more detailed exposition.

The third instance concerns the question of endogeneity within the regressor matrix, i.e. whether the values of a particular regressor are determined by forces exclusively external to the model, or whether there exist interrelationships between regressors which are indicative of a process of joint determination within the model[98]. In the latter case, unobservable factors, (which are equivalent to omitted variables[99]) may be correlated both with the dependent variable and with one or more of the independent variables in the regressor matrix. Since the unobservable influences are 'collected' within the error term, the latter is potentially correlated with the regressors. The use of the OLS estimator, which assumes (and indeed algebraically enforces) orthogonality between the error vector and the hyperplane in which the regressor vectors lie, will render inconsistent estimates under those conditions where the assumption is invalid.

The solution to this estimation problem requires a suitable set of instrumental variables (Z) such that an alternative defining moment condition is:

$$\mathbf{Z}\varepsilon = 0$$

where the chosen instrumental variables are i) uncorrelated with the error terms, and ii) as highly correlated as possible (in the interests of estimation efficiency) with the regressors (X). The variables which qualify as closely as possible to the above requirements (in the data set here) are lagged values of (X). A full and complete treatment of the econometric theory underlying the issue of instrumental variable estimators is given by **Greene (1997), Griffiths, Carter Hill, Judge (1993), Maddala (1977)** and many others. However, a useful conceptual simplification is to compare the OLS coefficient estimate (β) in the regression $y = \alpha + \beta x + \varepsilon$ as being given by the ratio of the covariance between (y) and (x) to the variance of (x); with (in the IV case) the ratio of the covariance between (y) and some instrument (i) to the covariance between (x) and the instrument (i) (See Verbeek (2000), pp. 128).

Of the two remaining possible causes of contemporaneous correlation in the current data set (having already eliminated the first, that of lagged dependent variables within the regressor matrix, when autocorrelation of the error terms is also present), neither the issue of

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98 Examples of such joint determination often include some restriction which defines the relationship; such as a macroeconomic identity (e.g. $Y = C + I$), or the enforcement of equilibrium in a supply-demand relationship, $Q_s = Q_d$.

99 Variables omitted simply because they *are* unobservable.

measurement error within the data-gathering process, nor the question of some degree of endogeneity, need be assumed away; given the availability of suitable instruments (see above). Further, the opportunity to compare the results of the Stage 1 and stage 2 results will inform as to the degree of these influences within the data set.

Accordingly, the chosen set of instruments for the Stage 2 GMM estimation are the one-period lagged versions of MKTXS, Div_Yld, LogCap and (where appropriate) Pay_Rat.

A comparison of the Stage 1 (see Tables 4.9.3 and 4.9.4) and Stage 2 (Tables 4.9.5 and 4.9.6) rolling period results indicates that, for the most part, values of coefficients and the complement of parameters remain substantially unchanged. A minor exception to this conclusion is that the coefficients of Dividend Yield (in the regressions which exclude Payout Ratio) are generally higher (between a factor of unity and two, depending on the particular ten-year period concerned) and with a correspondingly greater number of significant (at 5%) outcomes. The coefficients of MKTXS (the excess return on the market) are more variable, with generally higher standard errors. In the case of the regressions which include Payout Ratio, once again, the pattern of a diminished role for Dividend Yield is in evidence; additionally, the value of the Payout Ratio coefficients is generally higher, with greater evidence of significance. In this regard, the pattern follows that of the evidence related to Dividend Yield, in the regressions which exclude Payout Ratio.

The overall conclusion which encompasses the OLS and GMM (Stage 1 and Stage 2) regressions is that the more robust estimators result in a degree of 'fine tuning' of the estimates without, however, greatly changing the general view. The apparent dominance of payout ratio over dividend yield, a phenomenon which primarily affects the early periods, is confirmed; this is rendered more noteworthy by the fact that, whereas the method of portfolio formation specifically generated a wide 'spread' over the dividend yield continuum (in the interests of providing efficient coefficient estimates[100]), no such preference was (explicitly) accorded to Payout Ratio[101]. In spite of this fact, Payout Ratio provides a measure of explanatory power in the regressions, at least in the earlier periods.

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[100] A wide spread of regressor values provides more efficient estimates via the relationship $Var[b] = \sigma^2(X'X)^{-1}$. When X'X is large, the variation in [b], for a given error variance (σ^2) becomes smaller. Greene (1997) pp.258.

[101] However, due to the high correlation between Dividend Yield and Payout Ratio, the connection is likely to have been implicitly drawn.

Start Year	End Year	Constant	DJAN	DAPR	DSEP	MKTXS	DJ_MKT	DA_MKT	DS_MKT	DZERO	DJ_ZERO	DA_ZERO	DS_ZERO	Div_Yld	DJ_DIV	DA_DIV	DS_DIV	LOGCAP	DJ_CAP	DA_CAP	DS_CAP
58	67	-0.0007	0.0013	-0.0060	0.0036	1.0151	-0.0395	0.0023	-0.0336	0.0016	0.0024	0.0067	-0.0046	0.0235	0.0197	0.0354	-0.0413	-0.0016	-0.0032	0.0037	0.0000
59	68	-0.0007	-0.0006	-0.0061	0.0051	1.0396	-0.0565	-0.0298	-0.0349	0.0022	0.0023	0.0079	-0.0073	0.0264	0.0201	0.0347	-0.0517	-0.0020	-0.0007	0.0039	-0.0009
60	69	0.0000	-0.0017	-0.0055	0.0036	1.0660	-0.0444	-0.0621	-0.0715	0.0032	0.0049	0.0054	-0.0026	0.0220	0.0119	0.0317	-0.0597	-0.0022	-0.0001	0.0034	0.0006
61	70	0.0000	-0.0034	-0.0029	0.0016	1.0628	-0.0455	-0.0617	-0.0605	0.0046	0.0028	-0.0017	-0.0014	0.0291	0.0214	0.0100	-0.0606	-0.0025	0.0016	0.0027	0.0024
62	71	-0.0013	-0.0007	-0.0019	0.0008	1.0804	-0.0545	-0.0826	-0.0570	0.0087	-0.0002	-0.0076	-0.0047	0.0423	-0.0027	-0.0004	-0.0434	-0.0026	0.0005	0.0033	0.0022
63	72	-0.0008	-0.0058	-0.0037	0.0012	1.1062	-0.0357	-0.0866	-0.1063	0.0087	0.0130	0.0017	-0.0052	0.0374	0.0405	0.0462	-0.0380	-0.0029	0.0003	0.0010	0.0023
64	73	0.0017	-0.0051	-0.0043	-0.0028	1.0722	-0.0527	-0.0525	-0.0685	0.0056	0.0141	0.0014	0.0000	0.0231	0.0510	0.0411	-0.0164	-0.0031	0.0002	0.0011	0.0032
65	74	0.0019	-0.0033	-0.0054	-0.0012	1.0604	-0.0529	-0.0378	-0.0635	0.0056	0.0135	0.0057	-0.0004	0.0319	0.0088	0.0394	-0.0305	-0.0032	0.0009	0.0013	0.0022
66	75	0.0011	-0.0039	-0.0073	-0.0023	1.0035	-0.0494	0.0051	-0.0200	0.0046	0.0026	0.0088	0.0004	0.0480	0.0038	0.0653	0.0057	-0.0033	0.0040	0.0018	0.0015
67	76	0.0017	-0.0072	-0.0048	-0.0006	0.9948	-0.0396	0.0088	-0.0120	0.0024	0.0051	0.0088	-0.0005	0.0439	0.0270	0.0340	0.0172	-0.0034	0.0049	0.0015	-0.0003
68	77	0.0043	-0.0102	-0.0071	-0.0063	0.9962	-0.0371	0.0090	-0.0237	-0.0001	0.0093	0.0114	0.0913	0.0255	0.0350	0.0511	0.0760	-0.0042	0.0065	0.0020	0.0010
69	78	0.0048	-0.0020	-0.0071	-0.0068	0.9966	-0.0451	0.0130	-0.0221	-0.0014	0.0071	0.0127	0.0058	0.0263	0.0051	0.0572	0.0661	-0.0044	0.0025	0.0014	0.0013
70	79	0.0056	-0.0033	-0.0076	-0.0048	0.9931	-0.0417	0.0176	-0.0189	-0.0024	0.0055	0.0139	0.0024	0.0207	0.0188	0.0372	0.0615	-0.0044	0.0026	0.0023	0.0003
71	80	0.0051	-0.0056	-0.0131	-0.0027	0.9875	-0.0330	0.0298	-0.0139	-0.0020	0.0092	0.0213	0.0031	0.0170	0.0194	0.0373	0.0655	-0.0036	0.0036	0.0050	-0.0013
72	81	0.0045	-0.0050	-0.0140	0.0016	0.9814	-0.0255	0.0379	-0.0057	-0.0045	0.0101	0.0267	-0.0005	0.0209	0.0132	0.0905	0.0416	-0.0033	0.0031	0.0028	-0.0029
73	82	0.0027	-0.0064	-0.0129	0.0010	0.9554	0.0028	0.0492	0.0256	-0.0044	0.0006	0.0176	-0.0010	0.0330	0.0044	0.0597	0.0274	-0.0027	0.0048	0.0044	-0.0017
74	83	0.0015	-0.0044	-0.0145	0.0051	0.9593	-0.0072	0.0470	0.0219	-0.0014	0.0073	0.0233	-0.0061	0.0399	-0.0250	0.0718	0.0119	-0.0024	0.0048	0.0041	-0.0032
75	84	0.0025	-0.0045	-0.0134	0.0043	0.9453	-0.0004	0.0522	0.0313	-0.0029	0.0107	0.0192	-0.0074	0.0302	-0.0166	0.0665	0.0071	-0.0021	0.0044	0.0035	-0.0023
76	85	0.0021	-0.0016	-0.0074	0.0071	0.9919	-0.0074	0.0082	-0.0029	-0.0011	0.0198	0.0149	-0.0084	0.0261	0.0166	0.0393	-0.0045	-0.0019	-0.0009	0.0015	-0.0028
77	86	0.0026	0.0011	-0.0080	0.0074	0.9713	0.0166	0.0235	0.0070	0.0009	0.0156	0.0194	-0.0097	0.0317	-0.0064	0.0649	-0.0059	-0.0021	-0.0014	0.0008	-0.0028
78	87	0.0019	-0.0007	-0.0075	0.0123	1.0653	-0.0285	-0.0657	-0.0456	0.0037	0.0146	0.0202	-0.0137	0.0385	-0.0049	0.0664	-0.0354	-0.0024	-0.0011	0.0010	-0.0030
79	88	0.0030	-0.0033	-0.0086	0.0083	1.0605	-0.0374	-0.0567	-0.0418	0.0015	0.0156	0.0245	-0.0130	0.0357	-0.0290	0.0700	-0.0280	-0.0023	0.0009	0.0011	-0.0015
80	89	0.0017	-0.0053	-0.0089	0.0090	1.0549	-0.0426	-0.0680	-0.0361	0.0022	0.0163	0.0264	-0.0146	0.0434	-0.0359	0.1001	-0.0160	-0.0018	0.0018	0.0007	-0.0019
81	90	0.0009	0.0013	-0.0046	0.0083	1.0466	-0.0367	-0.0617	-0.0377	0.0007	0.0153	0.0222	-0.0157	0.0506	-0.0428	0.1054	0.0069	-0.0014	-0.0005	-0.0008	-0.0020
82	91	0.0021	-0.0020	-0.0040	0.0057	1.0415	-0.0289	-0.0268	-0.0479	-0.0008	0.0137	0.0191	-0.0105	0.0497	-0.0424	0.0565	0.0286	-0.0016	0.0006	-0.0002	-0.0018
83	92	0.0028	-0.0053	-0.0062	0.0006	1.0325	-0.0161	-0.0344	-0.0345	0.0005	0.0150	0.0218	-0.0085	0.0479	-0.0448	0.0911	0.0419	-0.0017	0.0016	0.0000	-0.0003
84	93	0.0032	-0.0028	-0.0027	-0.0015	1.0322	-0.0274	-0.0316	-0.0347	0.0001	0.0115	0.0194	-0.0065	0.0499	-0.0421	0.0716	0.0647	-0.0018	0.0008	-0.0008	0.0000
85	94	0.0041	-0.0004	-0.0014	0.0014	1.0288	-0.0298	-0.0319	-0.0326	0.0000	0.0142	0.0205	-0.0036	0.0453	-0.0337	0.0828	0.0871	-0.0019	-0.0004	-0.0013	-0.0013
86	95	0.0034	0.0019	-0.0017	0.0001	1.0304	-0.0365	-0.0351	-0.0306	-0.0006	0.0148	0.0176	-0.0003	0.0372	-0.0292	0.0928	0.0661	-0.0015	-0.0010	-0.0011	-0.0007
87	96	0.0024	0.0011	-0.0004	-0.0005	1.0324	-0.0403	-0.0291	-0.0322	-0.0003	0.0103	0.0148	-0.0015	0.0325	-0.0266	0.0462	0.0557	-0.0011	-0.0006	-0.0009	-0.0004
88	97	-0.0018	0.0081	0.0039	0.0002	1.0042	-0.0115	-0.0049	-0.0019	-0.0017	0.0096	0.0151	0.0008	0.0627	-0.0588	0.0536	0.0219	-0.0002	-0.0021	-0.0021	-0.0003
89	FULL	0.0010	0.0004	-0.0055	0.0012	1.0062	-0.0412	-0.0040	-0.0183	0.0020	0.0076	0.0119	-0.0039	0.0291	-0.0081	0.0378	0.0027	-0.0016	0.0000	0.0009	-0.0003
90	1st Half	0.0015	-0.0040	-0.0066	-0.0020	1.0024	-0.0458	0.0078	-0.0219	0.0008	0.0072	0.0086	-0.0008	0.0202	0.0452	0.0387	0.0245	-0.0028	0.0018	0.0028	0.0006
91	2nd Half	0.0012	0.0038	-0.0027	0.0060	1.0211	-0.0261	-0.0256	-0.0114	0.0006	0.0123	0.0171	-0.0060	0.0342	-0.0260	0.0483	-0.0076	-0.0011	-0.0015	-0.0005	-0.0014

Table 4.9.6 Summary of Extended Model Results (Rolling 10-year periods)

(Estimation using GMM; Payout Ratio variable omitted. Instrument list includes one-period lagged MKTXS, Div_Yld, LOGCAP)

* Shading indicates significance at the 5% level.

Start Year	End Year	Constant	DJAN	DAPR	DSEP	MKTXS	DJ_MKT	DA_MKT	DS_MKT	DZERO	DJ_ZERO	DA_ZERO	DS_ZERO	Div_Yld	DJ_DIV	DA_DIV	DS_DIV	LOGCAP	DJ_CAP	DA_CAP	DS_CAP	Pay_Rat
58	67	-0.0029	0.0014	-0.0056	0.0037	1.0300	-0.0698	-0.0089	-0.0539	0.0019	0.0027	0.0064	-0.0045	-0.0099	0.0244	0.0316	-0.0394	-0.0029	-0.0031	0.0037	0.0000	0.0033
59	68	-0.0027	-0.0006	-0.0057	0.0051	1.0536	-0.0859	-0.0428	-0.0566	0.0024	0.0027	0.0076	-0.0071	-0.0106	0.0277	0.0306	-0.0480	-0.0033	-0.0007	0.0038	-0.0008	0.0033
60	69	-0.0018	-0.0020	-0.0050	0.0035	1.0727	-0.0576	-0.0726	-0.0816	0.0033	0.0054	0.0050	-0.0024	-0.0216	0.0215	0.0276	-0.0568	-0.0035	-0.0001	0.0033	0.0006	0.0035
61	70	-0.0021	-0.0038	-0.0023	0.0011	1.0680	-0.0581	-0.0666	-0.0612	0.0048	0.0033	-0.0023	-0.0010	-0.0258	0.0307	0.0017	-0.0544	-0.0041	0.0016	0.0026	0.0025	0.0042
62	71	-0.0037	-0.0013	-0.0016	0.0000	1.0994	-0.0803	-0.0967	-0.0558	0.0090	0.0006	-0.0080	-0.0042	-0.0158	0.0115	-0.0067	-0.0353	-0.0042	0.0005	0.0032	0.0023	0.0045
63	72	-0.0038	-0.0067	-0.0035	0.0011	1.1391	-0.0593	-0.1053	-0.1564	0.0096	0.0137	0.0013	-0.0045	-0.0269	0.0530	0.0396	-0.0278	-0.0046	0.0003	0.0009	0.0023	0.0053
64	73	-0.0002	-0.0054	-0.0043	-0.0031	1.0842	-0.0744	-0.0538	-0.0937	0.0064	0.0146	0.0011	0.0005	-0.0279	0.0624	0.0360	-0.0078	-0.0043	0.0002	0.0010	0.0032	0.0040
65	74	0.0004	-0.0037	-0.0055	-0.0018	1.0670	-0.0675	-0.0347	-0.0770	0.0063	0.0139	0.0054	0.0002	-0.0116	0.0190	0.0347	-0.0213	-0.0042	0.0009	0.0013	0.0022	0.0034
66	75	-0.0003	-0.0037	-0.0072	-0.0027	1.0080	-0.0543	0.0079	-0.0253	0.0055	0.0024	0.0083	0.0007	0.0295	0.0022	0.0581	0.0112	-0.0038	0.0039	0.0018	0.0015	0.0020
67	76	0.0006	-0.0075	-0.0048	-0.0007	0.9947	-0.0399	0.0106	-0.0139	0.0033	0.0053	0.0087	-0.0004	0.0370	0.0301	0.0312	0.0193	-0.0036	0.0050	0.0015	-0.0003	0.0013
68	77	0.0029	-0.0103	-0.0069	-0.0065	0.9993	-0.0402	0.0076	-0.0261	0.0011	0.0093	0.0111	0.0015	0.0210	0.0356	0.0468	0.0782	-0.0046	0.0065	0.0019	0.0010	0.0016
69	78	0.0032	-0.0022	-0.0070	-0.0069	1.0019	-0.0512	0.0101	-0.0260	0.0001	0.0074	0.0125	0.0059	0.0229	0.0080	0.0541	0.0671	-0.0047	0.0025	0.0013	0.0013	0.0018
70	79	0.0048	-0.0034	-0.0076	-0.0048	0.9946	-0.0439	0.0160	-0.0191	-0.0017	0.0056	0.0139	0.0023	0.0188	0.0203	0.0361	0.0609	-0.0045	0.0026	0.0023	0.0003	0.0010
71	80	0.0053	-0.0056	-0.0132	-0.0027	0.9873	-0.0326	0.0318	-0.0143	-0.0023	0.0092	0.0214	0.0031	0.0178	0.0191	0.0381	0.0658	-0.0038	0.0036	0.0050	-0.0013	-0.0003
72	81	0.0051	-0.0050	-0.0142	0.0015	0.9796	-0.0228	0.0430	-0.0051	-0.0051	0.0101	0.0267	-0.0004	0.0231	0.0122	0.0917	0.0421	-0.0032	0.0032	0.0028	-0.0029	-0.0010
73	82	0.0035	-0.0064	-0.0131	0.0009	0.9506	0.0087	0.0585	0.0289	-0.0052	0.0005	0.0176	-0.0009	0.0369	0.0025	0.0602	0.0280	-0.0027	0.0048	0.0045	-0.0017	-0.0015
74	83	0.0019	-0.0044	-0.0147	0.0050	0.9570	-0.0040	0.0518	0.0231	-0.0017	0.0072	0.0233	-0.0060	0.0424	-0.0263	0.0727	0.0125	-0.0024	0.0048	0.0041	-0.0032	-0.0008
75	84	0.0020	-0.0043	-0.0132	0.0043	0.9387	0.0014	0.0538	0.0379	-0.0023	0.0109	0.0191	-0.0076	0.0225	-0.0143	0.0639	0.0061	-0.0022	0.0044	0.0035	-0.0023	0.0019
76	85	0.0033	-0.0022	-0.0076	0.0070	0.9852	0.0126	0.0111	0.0007	-0.0021	0.0195	0.0151	-0.0084	0.0394	0.0120	0.0433	-0.0052	-0.0018	-0.0009	0.0016	-0.0028	-0.0035
77	86	0.0030	0.0011	-0.0081	0.0075	0.9789	0.0134	0.0158	-0.0009	0.0003	0.0155	0.0195	-0.0097	0.0354	-0.0076	0.0668	-0.0057	-0.0021	-0.0014	0.0008	-0.0028	-0.0014
78	87	-0.0011	-0.0006	-0.0068	0.0129	1.0597	-0.0296	-0.0593	-0.0391	0.0068	0.0147	0.0194	-0.0143	0.0250	-0.0028	0.0558	-0.0444	-0.0024	-0.0011	0.0009	-0.0030	0.0071
79	88	-0.0004	-0.0040	-0.0077	0.0089	1.0530	-0.0360	-0.0487	-0.0346	0.0049	0.0164	0.0236	-0.0136	0.0199	-0.0167	0.0565	-0.0379	-0.0023	0.0009	0.0010	-0.0016	0.0078
80	89	-0.0034	-0.0065	-0.0075	0.0098	1.0457	-0.0338	-0.0583	-0.0284	0.0073	0.0174	0.0261	-0.0155	0.0207	-0.0180	0.0776	-0.0307	-0.0018	0.0019	0.0006	-0.0019	0.0112
81	90	-0.0044	0.0002	-0.0033	0.0093	1.0455	-0.0369	-0.0537	-0.0352	0.0059	0.0164	0.0209	-0.0165	0.0283	-0.0251	0.0810	-0.0078	-0.0013	-0.0005	-0.0008	-0.0021	0.0109
82	91	-0.0031	-0.0033	-0.0025	0.0067	1.0414	-0.0244	-0.0214	-0.0460	0.0044	0.0147	0.0176	-0.0114	0.0270	-0.0243	0.0282	0.0114	-0.0016	0.0007	-0.0002	-0.0018	0.0107
83	92	-0.0040	-0.0073	-0.0052	0.0032	1.0328	-0.0062	-0.0552	-0.0338	0.0073	0.0165	0.0210	-0.0108	0.0156	-0.0185	0.0594	0.0097	-0.0018	0.0018	0.0002	-0.0005	0.0139
84	93	0.0015	-0.0033	-0.0023	-0.0011	1.0286	-0.0248	-0.0356	-0.0307	0.0019	0.0120	0.0180	-0.0070	0.0398	-0.0337	0.0591	0.0552	-0.0018	0.0009	-0.0008	-0.0001	0.0036
85	94	0.0026	-0.0007	-0.0008	0.0021	1.0247	-0.0267	-0.0338	-0.0281	0.0016	0.0146	0.0199	-0.0042	0.0352	-0.0252	0.0655	0.0738	-0.0019	-0.0004	-0.0013	-0.0013	0.0032
86	95	0.0028	0.0019	-0.0015	0.0004	1.0286	-0.0353	-0.0355	-0.0287	0.0001	0.0149	0.0173	-0.0006	0.0326	-0.0253	0.0841	0.0594	-0.0015	-0.0010	-0.0011	-0.0007	0.0014
87	96	0.0021	0.0011	-0.0004	-0.0004	1.0313	-0.0395	-0.0292	-0.0309	0.0000	0.0104	0.0147	-0.0017	0.0299	-0.0244	0.0416	0.0516	-0.0011	-0.0006	-0.0009	-0.0004	0.0007
88	97	-0.0016	0.0083	0.0039	0.0001	1.0061	-0.0130	-0.0056	-0.0038	-0.0019	0.0094	0.0151	0.0008	0.0698	-0.0654	0.0550	0.0223	-0.0002	-0.0021	-0.0021	-0.0003	-0.0007
89	FULL	0.0018	0.0006	-0.0057	0.0011	1.0058	-0.0408	-0.0029	-0.0172	0.0012	0.0074	0.0120	-0.0039	0.0327	-0.0107	0.0399	0.0032	-0.0015	0.0000	0.0010	-0.0003	-0.0009
90	1st Half	-0.0002	-0.0041	-0.0064	-0.0021	1.0082	-0.0507	0.0064	-0.0274	0.0020	0.0073	0.0082	-0.0006	0.0090	0.0475	0.0338	0.0273	-0.0033	0.0018	0.0027	0.0006	0.0020
91	2nd Half	0.0000	0.0035	-0.0024	0.0065	1.0193	-0.0258	-0.0271	-0.0097	0.0019	0.0126	0.0170	-0.0064	0.0250	-0.0191	0.0433	-0.0133	-0.0011	-0.0015	-0.0005	-0.0015	0.0031

Table 4.9.6 Summary of Extended Model Results (Rolling 10-year periods)

(Estimation using GMM; Payout Ratio variable included. Instrument list includes one-period lagged MKTXS, Div_Yld, LOGCAP)

* Shading indicates significance at the 5% level.

4.8 The search for a more parsimonious model structure

The question of parsimony, and in particular, parsimonious encompassing, is covered in great detail in Hendry (1995). Encompassing implies that a model M_1 be capable of explaining the results generated by a model M_2; if this be the case, then M_1 is said to encompass M_2 ($M_1 \varepsilon M_2$). If M_1 is a more general model, of which M_2 is a subset, then M_1 will, by construction, encompass M_2. Parsimonious encompassing requires, however, the *smaller* model to be capable of explaining the results of the *larger* model within which it is nested (i.e. of which it is a subset)[102]. Taken together, these considerations amount to the two models possessing equivalent explanatory power. Another view of this scenario is that the smaller model arises by virtue of zero restrictions being placed on a subset of the parameters of the larger. For the stated equivalence in explanatory power, these zero restrictions must be valid. Following from such validity, then the efficiency of the smaller model (in terms of a reduced sampling variability in the parameters) is thereby greater. This is one argument in favour of parsimony; a second is the possible facilitation of interpretation of the smaller, more concise model.

It is appropriate to revisit the question of model mis-specification at this juncture (the issue first raised in section 4.6.2), within the context of the above discussion on the relationship of competing models. Whilst the elimination of irrelevant variables, in migrating from the larger to the smaller model, is likely to enhance efficiency, it does not influence the situation regarding parameter bias; quite simply, the presence of *irrelevant* variables does not induce bias (Griffiths, et al. (1993), pp. 309). This contrasts with the opposite scenario, in which *relevant* variables are *omitted*. Here, other than in the special case in which the omitted variables are orthogonal to those which remain included, bias is introduced into the parameter estimates. Suppose that the underlying, but unknown, Data Generation Process (DGP) is represented by model M_0, and model M_1 is selected for estimation. If relevant variables from M_0 fail to be represented within M_1, then the aforementioned mis-specification bias is likely, and with it the likely non-constancy of the parameter vector over time. In short, model M_1 is incapable of adequately explaining the results generated by the DGP (model M_0), and as such, does not encompass the DGP, parsimoniously or otherwise.

Whilst this clearly represents a problem in obtaining a representation of the (unknown) DGP, the sole recourse is to model the system as accurately as possible within the limits of data

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[102] Encompassing implies that there is no loss of information in the reduction to the smaller model.

availability, starting from a theory base whose purpose is to suggest a suitable set of parameters to be estimated as judiciously as possible.

Thus, following both OLS and GMM estimation of the 'full' equation, comprising either 19 variables (not including payout ratio) or 20 variables (including same), an investigation was carried out into the feasibility of establishing the desired parsimonious model structure[103]. Algorithms exist, (albeit more widely in the domain of OLS standard estimation software) for a structured approach to model reduction which, whilst being 'less than ideal', does offer a means of eliminating insignificant regressors which nevertheless falls short of an exhaustive search of all possible (regressor) combinations (or, expressed alternately, all possible combinations of zero restrictions on the larger model).

In the spirit of the 'general to specific' estimation approach of Hendry (1995), that of a reduction, based upon a 'backward elimination'[104] technique, was employed. This algorithm commences with the full set of regressors, eliminating one regressor (per re-estimation cycle) according to the candidate which displays the weakest case for inclusion. The criteria employed is related to the regressor having the smallest partial correlation with the dependent variable, subject to the probability of the (partial) F statistic (for the hypothesis that the coefficient is zero), being greater than a preset threshold value[105]. On this basis, weakly (partial) correlated regressors are eliminated on a one-by-one basis, followed by a re-estimation of the model containing the remaining regressors. This process, effectively one of sequentially imposing zero restrictions[106], continues until there exists a situation (model) in which no regressor fails the test at the chosen threshold level.

The above process proved successful in reducing the number of regressors in the model from 20 to 10. The reduced model was then subjected to re-estimation using GMM. Under the more precise (but stricter) inferential criteria associated with the GMM estimator (incorporating, as it does, correction both for heteroscedasticity and autocorrelation), the full

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[103] This type of initiative (establishing a parsimonious model structure) seems to feature more strongly in the domain of econometrics as applied to economic (rather than financial) modelling. However, the size of the current model (19/20 variables) would suggest it to be worthy of investigation.

[104] This methodology is an integral part of the SPSS software package. Although based upon the use of OLS, this was considered satisfactory for use as a first-level filtering tool, given the reasonable similarity between the OLS and GMM results reported above.

[105] The t-test and partial F-test (for the hypothesis that a coefficient is zero) are equivalent; here, the threshold is set to the SPSS default value of 0.10.

[106] The validity of each of which is tested via the partial F-test.

(40-year) sample retained eight regressors significant to <5% (see full sample results, Table 4.10.1). A ninth regressor (DA_DIV) exhibited significance just outside the 5% limit (5.6%); however, the significance of the seasonal (January) risk term (DJ_MARKET) disappeared.

Proceeding from the above, the 10-regressor model was estimated over multiple periods, as had been the case for the full model outlined earlier. Rolling regression results are not reported here, as no conclusive new evidence was generated[107]; however, the summary contrast revealed by a comparison of the two (20-year) half periods does succinctly reveal that the importance of the two variables PAY_RAT and DA_CAP (the payout ratio and seasonal (April) interaction dummy with market size) are replaced (in the second period) by the seasonal (January and April) interactions with the Zero-Dividend dummy variable. Only the coefficients for MKT_XS and LOGCAP remain significant over the course of the whole period. This evidence suggests that the ability of dividend paying firms to influence Returns through the medium of high payout ratios[108] pertains only in the earlier period. In the later period, the increasing influence, on Returns, of Zero-Dividend firms, and in particular, the seasonal nature of this effect, reveals itself. Indeed, a close study of the (full sample) rolling regressions would seem to suggest the possibility of a structural break; this may have been occasioned by the two large increases in the number of companies in the database occurring in the mid 1970's. If the characteristics of the new entrants differed materially from those originally in the dataset, then these (characteristics) may have influenced the parametric change. A second important influence, however, was the advent (in 1979) of the Conservative government of Margaret Thatcher, with significant policy changes, which was closely followed by the severe recession of 1980-81.

[107] Relative to the full sample results.

[108] Recall that once the model controls for Payout Ratio, the significance of Dividend Yield *per se* largely disappears (at least in the subsamples).

Table 4.10.1 GMM estimation on the reduced model (1)

EQUATION 1a: Current sample: 1 to 14400 (full sample)

GENERALIZED METHOD OF MOMENTS
============================

Number of Observations = 14400 (480 months over 30 DY/Size portfolios)

Parameter	Estimate	Standard Error	t-statistic		P-value
CONST	.252491E-02	.973104E-03	2.59470	**	[.009]
D_APR	-.620113E-02	.244875E-02	-2.53237	*	[.011]
MKT_XS	.992581	.010414	95.3113	**	[.000]
DJ_MKT	-.029528	.031553	-.935822		[.349]
DJ_ZERO	.856603E-02	.423233E-02	2.02395	*	[.043]
DA_ZERO	.013285	.375608E-02	3.53698	**	[.000]
DIV_YLD	.024256	.945209E-02	2.56618	*	[.010]
DA_DIV	.048227	.025243	1.91051		[.056]
LOGCAP	-.154136E-02	.192752E-03	-7.99659	**	[.000]
DA_CAP	.103454E-02	.487596E-03	2.12172	*	[.034]
PAY_RAT	-.802525E-03	.315551E-03	-2.54325	*	[.011]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Dependent variable: XSRET

Mean of dependent variable =	.011127	Std. error of regression =	.030158
Std. dev. of dependent var. =	.058431	R-squared =	.733789
Sum of squared residuals =	13.0872	Adjusted R-squared =	.733604
Variance of residuals =	.909525E-03	Durbin-Watson statistic =	1.77785

Table 4.10.2 GMM estimation on the reduced model (2)

EQUATION 1b: Current sample: 1 to 240, 481 to 720, ..., 13921 to 14160 (7200 obs.)
(First [20-year] half-period 1/58 - 12/77) (240 months over 30 DY/Size portfolios)

GENERALIZED METHOD OF MOMENTS
============================

Number of Observations = 7200

Parameter	Estimate	Standard Error	t-statistic		P-value
CONST	.638380E-03	.103582E-02	.616303		[.538]
D_APR	-.588837E-02	.318696E-02	-1.84764		[.065]
MKT_XS	.983850	.014929	65.9041	**	[.000]
DJ_MKT	-.020462	.038368	-.533315		[.594]
DJ_ZERO	.197622E-02	.688330E-02	.287104		[.774]
DA_ZERO	.010179	.615018E-02	1.65504		[.098]
DIV_YLD	.010739	.011402	.941847		[.346]
DA_DIV	.036029	.033779	1.06659		[.286]
LOGCAP	-.317259E-02	.374779E-03	-8.46524	**	[.000]
DA_CAP	.274463E-02	.909216E-03	3.01867	**	[.003]
PAY_RAT	.160391E-02	.470058E-03	3.41216	**	[.001]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Dependent variable: XSRET

Mean of dependent variable =	.013645	Std. error of regression =	.031922
Std. dev. of dependent var. =	.061806	R-squared =	.733612
Sum of squared residuals =	7.32578	Adjusted R-squared =	.733242
Variance of residuals =	.101903E-02	Durbin-Watson statistic =	1.91681

Table 4.10.3 GMM estimation on the reduced model (3)

EQUATION 1c: Current sample: 241 to 480, 721 to 960, ..., 14161 to 14400 (7200 obs.)
(Second [20-year] half-period 1/78 - 12/97) (240 months over 30 DY/Size portfolios)

GENERALIZED METHOD OF MOMENTS
============================

Number of Observations = 7200

Parameter	Estimate	Standard Error	t-statistic		P-value
CONST	.238169E-02	.163364E-02	1.45791		[.145]
D_APR	-.433180E-02	.340193E-02	-1.27333		[.203]
MKT_XS	1.00425	.014165	70.8955	**	[.000]
DJ_MKT	-.035998	.028027	-1.28441		[.199]
DJ_ZERO	.014983	.517932E-02	2.89294	**	[.004]
DA_ZERO	.017977	.467779E-02	3.84302	**	[.000]
DIV_YLD	.018346	.012517	1.46569		[.143]
DA_DIV	.059161	.033478	1.76715		[.077]
LOGCAP	-.133955E-02	.302682E-03	-4.42560	**	[.000]
DA_CAP	-.265519E-03	.529602E-03	-.501356		[.616]
PAY_RAT	.846545E-03	.775111E-03	1.09216		[.275]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Dependent variable: XSRET

Mean of dependent variable =	.860859E-02	Std. error of regression =	.028095
Std. dev. of dependent var. =	.054737	R-squared =	.736921
Sum of squared residuals =	5.67439	Adjusted R-squared =	.736555
Variance of residuals =	.789316E-03	Durbin-Watson statistic =	1.59115

****

Table 4.10.4 - GMM estimates (omitting Payout Ratio) (1)

EQUATION 2a: Current sample: 1 to 14400

GENERALIZED METHOD OF MOMENTS
============================

Number of Observations = 14400

Parameter	Estimate	Standard Error	t-statistic		P-value
CONST	.214350E-02	.911559E-03	2.35146	*	[.019]
D_APR	-.635630E-02	.244065E-02	-2.60434	**	[.009]
MKT_XS	.992604	.010416	95.2924	**	[.000]
DJ_MKT	-.029644	.031543	-.939813		[.347]
DJ_ZERO	.895580E-02	.423592E-02	2.11425	*	[.034]
DA_ZERO	.013826	.377606E-02	3.66159	**	[.000]
DIV_YLD	.019357	.857111E-02	2.25837	*	[.024]
DA_DIV	.048062	.024978	1.92415		[.054]
LOGCAP	-.158894E-02	.194874E-03	-8.15369	**	[.000]
DA_CAP	.106163E-02	.487678E-03	2.17690	*	[.029]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation TESTEQ
==================

Dependent variable: XSRET

Mean of dependent variable =	.011127	Std. error of regression =	.030164
Std. dev. of dependent var. =	.058431	R-squared =	.733666
Sum of squared residuals =	13.0932	Adjusted R-squared =	.733500
Variance of residuals =	.909882E-03	Durbin-Watson statistic =	1.77679

Table 4.10.5 - GMM estimates (omitting Payout Ratio) (2)

EQUATION 2b: Current sample: 1 to 240, 481 to 720, ..., 13921 to 14160 (7200 obs.)

GENERALIZED METHOD OF MOMENTS

Number of Observations = 7200

Parameter	Estimate	Standard Error	t-statistic		P-value
CONST	.158083E-02	.105742E-02	1.49499		[.135]
D_APR	-.568833E-02	.319446E-02	-1.78068		[.075]
MKT_XS	.982296	.014929	65.7963	**	[.000]
DJ_MKT	-.019458	.038239	-.508846		[.611]
DJ_ZERO	.155968E-02	.686443E-02	.227212		[.820]
DA_ZERO	.952482E-02	.615197E-02	1.54825		[.122]
DIV_YLD	.022987	.010516	2.18579	*	[.029]
DA_DIV	.036691	.033857	1.08370		[.278]
LOGCAP	-.269965E-02	.298618E-03	-9.04049	**	[.000]
DA_CAP	.271897E-02	.909127E-03	2.99074	**	[.003]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation TESTEQ

Dependent variable: XSRET

Mean of dependent variable	= .013645	Std. error of regression	= .031939
Std. dev. of dependent var.	= .061806	R-squared	= .733300
Sum of squared residuals	= 7.33436	Adjusted R-squared	= .732966
Variance of residuals	= .102008E-02	Durbin-Watson statistic	= 1.91476

Table 4.10.6 - GMM estimates (omitting Payout Ratio) (3)

EQUATION 2c: Current sample: 241 to 480, 721 to 960, ..., 14161 to 14400 (7200 obs.)

GENERALIZED METHOD OF MOMENTS

Number of Observations = 7200

Parameter	Estimate	Standard Error	t-statistic		P-value
CONST	.258724E-02	.158547E-02	1.63184		[.103]
D_APR	-.425102E-02	.340703E-02	-1.24772		[.212]
MKT_XS	1.00449	.014150	70.9878	**	[.000]
DJ_MKT	-.035933	.027992	-1.28369		[.199]
DJ_ZERO	.014721	.519644E-02	2.83291	**	[.005]
DA_ZERO	.017668	.469539E-02	3.76289	**	[.000]
DIV_YLD	.021171	.013257	1.59702		[.110]
DA_DIV	.060352	.033951	1.77760		[.075]
LOGCAP	-.130335E-02	.308484E-03	-4.22502	**	[.000]
DA_CAP	-.290705E-03	.529515E-03	-.549002		[.583]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation TESTEQ

Dependent variable: XSRET

Mean of dependent variable	= .860859E-02	Std. error of regression	= .028096
Std. dev. of dependent var.	= .054737	R-squared	= .736859
Sum of squared residuals	= 5.67573	Adjusted R-squared	= .736529
Variance of residuals	= .789392E-03	Durbin-Watson statistic	= 1.59063

4.9 Joint Estimation of the 30 Portfolios

Notwithstanding the potential efficiency gains to be realised from the techniques reported above, there is seen to be value in the application of a more sophisticated econometric approach capable of increasing estimation efficiency by a further increment. This methodology treats the 30 portfolios, and their associated model relationships, not as separate equations but as a *system* of equations subject, as a group, to a common set of shocks[109]. The basic intuition follows Zellner (1962), and in principle is that of the Seemingly Unrelated Regression (SUR) estimator. In practice, the nonlinear GMM (HAC) estimator used earlier is applied to the estimation of a time series comprising 480 monthly samples, each of which carries a set of regressors pertaining to each of the 30 portfolios, save that the excess return on the market (MKTXS) is a vector common to the system as a whole.

Ideally, it would have been desirable to maintain the split of the series as above, namely as an early and a later half-period; and to have incorporated all of the regressors found to be significant in the parsimonious (GMM estimated) model described earlier. However, data limitations required that the model be restricted to the use of four regressors plus the constant term (per equation); even this number being conditional upon the use of the full sample. The issue concerns the number of covariance terms which may be estimated using the available sample size.

With a total of five instruments (including the constant term) and thirty equations (one for each portfolio), there are thereby 5x30 orthogonality conditions to be satisfied; the resultant covariance matrix embodies 150 variance terms (along the diagonal) plus 11,175 covariance terms. With a total of 'only' 14,400 samples (480 months x 30 equations), any increase in the number of instruments would result in there being fewer samples than the number of unknowns to be estimated (note that this number also includes up to 140 parameters, prior to the imposition of cross-equation restrictions)[110].

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[109] This is tantamount to an efficiency-enhancing restriction on the error term.

[110] Strictly speaking, because of the inherent structure within the covariance matrix of orthogonality conditions, there should be fewer unknown terms, but the TSP algorithm appears to be too general in its application to be able to exploit this structure. Each 5x5 'block' has 15 unknowns (5 Var, 10 Covar), and of the 900 blocks in the 30x30 structure, only 465 are unique. This should result in 465x15 = 6975 unknown terms in the matrix, rather than 11,175.

4.9.1 Choice of Instruments

In order to further explore the relationships between Covariance Risk, Firm Size, Dividend Yield and Payout Ratio, these terms, together with a constant, were the regressors of choice in the joint estimations, given the limitations outlined in the previous paragraphs. One period lagged values of MKTXS, LogCap, DivYld and PayRat were obvious choices for instrumental variables; an important consideration in respect of the latter three variables, however, was the question of which portfolio's values should be chosen to fulfil this role.

After some experimentation with portfolio 13 as a source of instrumental variables (portfolio 13 lies at the centre of the Dividend Yield / Capitalisation matrix), it became evident that better estimates for each portfolio could be generated by focussing upon a particular portfolio, using that portfolio's variables as instruments, and discarding the joint estimates for the remaining portfolios; choosing instead to repeat the above procedure until a full set of estimates, one for each of the 30 portfolios, had been generated.

4.9.2 Comparison of Joint and Single Equation estimates

In order to assess whether the perceived theoretical advantage of joint estimation over single equation estimation was borne out in practice with the current dataset, a direct comparison was mounted between the results generated as described in the previous paragraph and their single-equation counterparts. These results are indicated in table 4.11. A measure of efficiency gain was provided by taking the ratio of the standard errors for the parameters of the joint estimates, to those of the corresponding parameters from the single equation estimates. Of the 140 parameters pertaining to the 30 portfolios[111], a total of 44 were significant at the 10% level when estimated jointly. In every one of these 44 significant cases, the standard error of the parameter estimate was lower in the case of the joint estimate than in the case of the single equation estimate; the ratio varying between 0.5 and 0.9. This would seem to be a clear statement of the advantage (in terms of precision of estimation) of the joint estimation approach.

[111] Note that the five Zero-Dividend portfolios are characterised by only three parameters each.

Table 4.11

Results of Joint and Single equation estimates
on 30 Dividend Yield and Size sorted portfolios

(presented on the following four sheets)

* R.H. column shows Standard Error reduction for significant (10%) results.

	Joint Estimation							Single Equation Estimation							
Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		SE Ratio	Sig<10%
ALPHA1	0.014614	0.00849	1.72135		[.085]		ALPHA1	0.015633	0.014339	1.09028		[.276]		0.592073	0.592073
BETA1	-0.430455	0.130692	-3.29366	**	[.001]		BETA1	-0.375013	0.157921	-2.37468	*	[.018]		0.827578	0.827578
GAMMA1	-0.001281	0.001051	-1.21897		[.223]		GAMMA1	-1.53E-03	1.55E-03	-0.98912		[.323]		0.678468	
DELTA1	-0.026987	0.022715	-1.18808		[.235]		DELTA1	-0.019884	0.046916	-0.423824		[.672]		0.484163	
EPSLON1	-4.35E-05	0.001189	-0.036607		[.971]		EPSLON1	-8.12E-04	1.64E-03	-0.494925		[.621]		0.72498	
ALPHA2	0.002078	0.002878	0.721996		[.470]		ALPHA2	2.42E-03	3.56E-03	0.678779		[.497]		0.807725	
BETA2	-0.025233	0.047719	-0.528771		[.597]		BETA2	-0.033528	0.062066	-0.540207		[.589]		0.768843	
GAMMA2	0.000216	0.000469	0.460235		[.645]		GAMMA2	2.48E-05	5.42E-04	0.045694		[.964]		0.865168	
DELTA2	-0.002842	0.002025	-1.4036		[.160]		DELTA2	-1.47E-03	2.75E-03	-0.53488		[.593]		0.736252	
EPSLON2	0.000255	0.001367	0.186579		[.852]		EPSLON2	-1.13E-04	1.68E-03	-0.067659		[.946]		0.815331	
ALPHA3	-0.007675	0.005859	-1.30986		[.190]		ALPHA3	-0.01417	6.55E-03	-2.16288	*	[.031]		0.894364	
BETA3	0.069548	0.05393	1.28961		[.197]		BETA3	0.117813	0.080292	1.4673		[.142]		0.671673	
GAMMA3	0.000542	0.000734	0.73787		[.461]		GAMMA3	8.07E-04	8.17E-04	0.987217		[.324]		0.897933	
DELTA3	0.042918	0.029012	1.47931		[.139]		DELTA3	0.064142	0.033901	1.89202		[.058]		0.855786	
EPSLON3	0.002806	0.002483	1.13015		[.258]		EPSLON3	5.72E-03	2.89E-03	1.98125	*	[.048]		0.8601	
ALPHA4	0.005821	0.007379	0.788776		[.430]		ALPHA4	4.40E-03	8.27E-03	0.532424		[.594]		0.891919	
BETA4	0.158051	0.067587	2.33847	*	[.019]		BETA4	0.170004	0.094238	1.80398		[.071]		0.717195	0.717195
GAMMA4	0.000151	0.00092	0.164495		[.869]		GAMMA4	4.75E-05	1.01E-03	0.046967		[.963]		0.910897	
DELTA4	0.01907	0.040463	0.471295		[.637]		DELTA4	-6.36E-03	0.049036	-0.129758		[.897]		0.825169	
EPSLON4	-0.006413	0.003172	-2.02136	*	[.043]		EPSLON4	-1.38E-03	4.36E-03	-0.315814		[.752]		0.727878	0.727878
ALPHA5	-0.005624	0.007349	-0.765245		[.444]		ALPHA5	1.61E-03	0.012499	0.129064		[.897]		0.587973	
BETA5	0.127209	0.094051	1.35256		[.176]		BETA5	0.174688	0.129272	1.35132		[.177]		0.727543	
GAMMA5	0.003405	0.001314	2.59242	**	[.010]		GAMMA5	1.67E-03	1.97E-03	0.847192		[.397]		0.665802	0.665802
DELTA5	0.149901	0.053478	2.80304	**	[.005]		DELTA5	0.06545	0.089064	0.734864		[.462]		0.600445	0.600445
EPSLON5	-0.003917	0.00189	-2.07215	*	[.038]		EPSLON5	-7.15E-04	2.60E-03	-0.275217		[.783]		0.727902	0.727902
ALPHA6	0.018559	0.02396	0.774572		[.439]		ALPHA6	1.13E-04	0.033468	3.38E-03		[.997]		0.715908	
BETA6	-0.588167	0.130666	-4.5013	**	[.000]		BETA6	-0.590311	0.177635	-3.32316	**	[.001]		0.735587	0.735587
GAMMA6	-0.001492	0.002119	-0.704112		[.481]		GAMMA6	-5.09E-04	2.92E-03	-0.174377		[.862]		0.726248	
DELTA6	-0.036903	0.149489	-0.246864		[.805]		DELTA6	0.13598	0.208868	0.651035		[.515]		0.71571	
EPSLON6	-0.000631	0.002013	-0.313576		[.754]		EPSLON6	-7.85E-04	3.02E-03	-0.25985		[.795]		0.666632	
ALPHA7	0.011287	0.00857	1.3171		[.188]		ALPHA7	7.77E-03	0.010873	0.714942		[.475]		0.78816	
BETA7	-0.15869	0.112067	-1.41603		[.157]		BETA7	-0.206689	0.109659	-1.88484		[.059]		1.021959	
GAMMA7	-0.000448	0.000951	-0.471271		[.637]		GAMMA7	-6.11E-04	1.14E-03	-0.535106		[.593]		0.832861	
DELTA7	-0.087283	0.063625	-1.37184		[.170]		DELTA7	-0.014664	0.075905	-0.193193		[.847]		0.838219	
EPSLON7	-0.002218	0.002242	-0.989115		[.323]		EPSLON7	-2.84E-03	2.86E-03	-0.991268		[.322]		0.783487	
ALPHA8	0.011721	0.007646	1.53284		[.125]		ALPHA8	4.91E-03	8.94E-03	0.549435		[.583]		0.855675	
BETA8	0.07889	0.042403	1.86048		[.063]		BETA8	0.070544	0.046711	1.51023		[.131]		0.907773	0.907773
GAMMA8	-0.000779	0.000907	-0.858103		[.391]		GAMMA8	-4.48E-04	9.77E-04	-0.458417		[.647]		0.929046	

	Joint Estimation							Single Equation Estimation							
Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		SE Ratio	Sig<10%
DELTA8	-0.061228	0.058934	-1.03894		[.299]		DELTA8	-2.02E-03	0.070911	-0.028551		[.977]		0.831098	
EPSLON8	-0.006363	0.001935	-3.28892	**	[.001]		EPSLON8	-4.07E-03	2.42E-03	-1.68118		[.093]		0.79902	0.79902
ALPHA9	0.003379	0.009377	0.360303		[.719]		ALPHA9	-1.99E-04	0.011643	-0.017113		[.986]		0.805397	
BETA9	0.175071	0.056585	3.09392	**	[.002]		BETA9	0.164822	0.063446	2.59784	**	[.009]		0.891861	0.891861
GAMMA9	-0.000111	0.000996	-0.111089		[.912]		GAMMA9	-2.33E-04	1.19E-03	-0.194942		[.845]		0.834302	
DELTA9	-0.050681	0.093791	-0.540358		[.589]		DELTA9	-0.021725	0.105455	-0.206009		[.837]		0.889394	
EPSLON9	-0.001129	0.003364	-0.33552		[.737]		EPSLON9	1.22E-03	5.51E-03	0.220576		[.825]		0.610465	
ALPHA10	0.011795	0.008967	1.31545		[.188]		ALPHA10	0.018757	0.01091	1.7192		[.086]		0.821895	
BETA10	0.317616	0.097137	3.26979	**	[.001]		BETA10	0.28372	0.129711	2.18732	*	[.029]		0.748872	0.748872
GAMMA10	0.0015	0.001101	1.3631		[.173]		GAMMA10	1.05E-03	1.10E-03	0.954374		[.340]		1.000509	
DELTA10	0.01423	0.090617	0.157039		[.875]		DELTA10	-0.069332	0.108705	-0.637798		[.524]		0.833605	
EPSLON10	-0.012866	0.003866	-3.32784	**	[.001]		EPSLON10	-0.012236	5.16E-03	-2.37329	*	[.018]		0.749859	0.749859
ALPHA11	-0.013622	0.029924	-0.455238		[.649]		ALPHA11	6.35E-03	0.040355	0.157274		[.875]		0.741519	
BETA11	-0.813803	0.121379	-6.70462	**	[.000]		BETA11	-0.813031	0.17214	-4.72307	**	[.000]		0.705118	0.705118
GAMMA11	0.001373	0.002848	0.481956		[.630]		GAMMA11	-1.81E-03	3.94E-03	-0.460803		[.645]		0.723069	
DELTA11	0.167929	0.221512	0.758103		[.448]		DELTA11	0.235639	0.272794	0.863801		[.388]		0.812012	
EPSLON11	0.001787	0.00267	0.669093		[.503]		EPSLON11	-2.48E-03	3.57E-03	-0.693945		[.488]		0.747355	
ALPHA12	-0.00671	0.010635	-0.630875		[.528]		ALPHA12	-2.37E-03	0.015076	-0.157084		[.875]		0.705426	
BETA12	-0.228808	0.084773	-2.69905	**	[.007]		BETA12	-0.227995	0.13638	-1.67176		[.095]		0.621594	0.621594
GAMMA12	0.000658	0.001304	0.50445		[.614]		GAMMA12	-2.79E-04	1.79E-03	-0.155996		[.876]		0.729912	
DELTA12	0.031264	0.095062	0.328878		[.742]		DELTA12	0.060361	0.140289	0.430261		[.667]		0.677615	
EPSLON12	0.002258	0.001458	1.54873		[.121]		EPSLON12	2.97E-05	2.05E-03	0.014504		[.988]		0.711882	
ALPHA13	0.019339	0.006141	3.14914	**	[.002]		ALPHA13	0.023503	7.83E-03	3.00115	**	[.003]		0.784192	0.784192
BETA13	0.053587	0.040705	1.31647		[.188]		BETA13	0.057088	0.044013	1.29706		[.195]		0.92484	
GAMMA13	-0.003581	0.000959	-3.73402	**	[.000]		GAMMA13	-4.20E-03	1.24E-03	-3.38563	**	[.001]		0.773517	0.773517
DELTA13	-0.132784	0.052354	-2.53628	*	[.011]		DELTA13	-0.166141	0.062907	-2.64107	**	[.008]		0.832244	0.832244
EPSLON13	-0.005297	0.001507	-3.51396	**	[.000]		EPSLON13	-5.86E-03	2.00E-03	-2.92591	**	[.003]		0.752937	0.752937
ALPHA14	-0.010648	0.008555	-1.24455		[.213]		ALPHA14	-7.80E-03	0.010084	-0.773142		[.439]		0.848415	
BETA14	0.109478	0.047352	2.31201	*	[.021]		BETA14	0.116615	0.057052	2.044	*	[.041]		0.82998	0.82998
GAMMA14	-0.000253	0.001308	-0.193401		[.847]		GAMMA14	-3.90E-04	1.52E-03	-0.25602		[.798]		0.859276	
DELTA14	0.114754	0.084623	1.35605		[.175]		DELTA14	0.08795	0.103219	0.852073		[.394]		0.819839	
EPSLON14	0.001694	0.003254	0.52067		[.603]		EPSLON14	3.33E-04	3.79E-03	0.087905		[.930]		0.857952	
ALPHA15	-0.024642	0.076163	-0.323537		[.746]		ALPHA15	-0.020522	0.058791	-0.349077		[.727]		1.295487	
BETA15	0.139922	0.196725	0.711254		[.477]		BETA15	0.085775	0.237965	0.360453		[.719]		0.826697	
GAMMA15	0.004735	0.009657	0.490257		[.624]		GAMMA15	4.31E-03	7.08E-03	0.608621		[.543]		1.363129	
DELTA15	0.185548	0.46593	0.398232		[.690]		DELTA15	0.116937	0.380942	0.306969		[.759]		1.2231	
EPSLON15	0.020554	0.067851	0.302924		[.762]		EPSLON15	0.0225	0.053381	0.4215		[.673]		1.27107	
ALPHA16	-0.012215	0.021459	-0.56922		[.569]		ALPHA16	3.45E-03	0.043068	0.080118		[.936]		0.498259	

	Joint Estimation							Single Equation Estimation							
Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		SE Ratio	Sig<10%
BETA16	-0.68846	0.117079	-5.8803	**	[.000]		BETA16	-0.740626	0.221614	-3.34196	**	[.001]		0.528301	0.528301
GAMMA16	0.001532	0.002305	0.664754		[.506]		GAMMA16	-1.69E-03	4.80E-03	-0.352685		[.724]		0.480078	
DELTA16	0.042964	0.207058	0.207497		[.836]		DELTA16	0.252754	0.343098	0.736682		[.461]		0.603495	
EPSLON16	0.003521	0.001715	2.05338	*	[.040]		EPSLON16	-1.52E-03	3.45E-03	-0.441525		[.659]		0.49761	0.49761
ALPHA17	-0.00916	0.010065	-0.910176		[.363]		ALPHA17	0.013374	0.018401	0.726798		[.467]		0.546981	
BETA17	-0.178416	0.060814	-2.93379	**	[.003]		BETA17	-0.201894	0.10116	-1.99578	*	[.046]		0.601166	0.601166
GAMMA17	0.000866	0.001455	0.595461		[.552]		GAMMA17	-3.12E-03	2.63E-03	-1.18536		[.236]		0.552101	
DELTA17	0.030071	0.109909	0.273601		[.784]		DELTA17	-0.011069	0.173746	-0.063706		[.949]		0.632584	
EPSLON17	0.002234	0.001144	1.95362		[.051]		EPSLON17	-2.80E-03	1.94E-03	-1.44708		[.148]		0.590736	0.590736
ALPHA18	-0.003441	0.008193	-0.420047		[.674]		ALPHA18	2.65E-03	9.25E-03	0.286925		[.774]		0.885891	
BETA18	0.028726	0.050741	0.566127		[.571]		BETA18	0.036992	0.057742	0.640643		[.522]		0.878754	
GAMMA18	-0.000827	0.001266	-0.652738		[.514]		GAMMA18	-1.96E-03	1.53E-03	-1.28172		[.200]		0.828799	
DELTA18	0.007444	0.117352	0.063435		[.949]		DELTA18	-0.024191	0.11996	-0.201656		[.840]		0.978259	
EPSLON18	0.001242	0.00124	1.00112		[.317]		EPSLON18	-1.17E-03	1.63E-03	-0.719423		[.472]		0.760697	
ALPHA19	-0.000907	0.006654	-0.136309		[.892]		ALPHA19	1.99E-03	7.47E-03	0.266608		[.790]		0.890782	
BETA19	0.089892	0.051405	1.7487		[.080]		BETA19	0.119011	0.059603	1.99673	*	[.046]		0.862457	0.862457
GAMMA19	-0.001456	0.001181	-1.23254		[.218]		GAMMA19	-1.80E-03	1.34E-03	-1.34956		[.177]		0.883837	
DELTA19	-0.026078	0.10465	-0.249191		[.803]		DELTA19	-0.041676	0.112536	-0.370333		[.711]		0.929925	
EPSLON19	0.000836	0.002012	0.415645		[.678]		EPSLON19	-1.35E-03	2.41E-03	-0.560596		[.575]		0.834106	
ALPHA20	-0.067958	0.726272	-0.093571		[.925]		ALPHA20	0.038642	0.265814	0.145371		[.884]		2.732256	
BETA20	0.270343	0.693674	0.389726		[.697]		BETA20	0.170591	0.290949	0.586326		[.558]		2.384177	
GAMMA20	0.005705	0.056172	0.101568		[.919]		GAMMA20	-1.53E-03	0.020736	-0.073596		[.941]		2.708912	
DELTA20	0.233965	1.97218	0.118633		[.906]		DELTA20	-0.124223	0.729766	-0.170223		[.865]		2.702483	
EPSLON20	0.071909	0.84457	0.085142		[.932]		EPSLON20	-0.04556	0.30946	-0.147225		[.883]		2.729173	
ALPHA21	-0.007234	0.01888	-0.383155		[.702]		ALPHA21	8.69E-03	0.03753	0.23156		[.817]		0.503064	
BETA21	-0.534208	0.127074	-4.20391	**	[.000]		BETA21	-0.528861	0.187419	-2.82181	**	[.005]		0.678021	0.678021
GAMMA21	0.001075	0.002569	0.418579		[.676]		GAMMA21	-2.13E-03	5.08E-03	-0.418813		[.675]		0.505245	
DELTA21	-0.088655	0.281084	-0.315402		[.752]		DELTA21	0.148788	0.449263	0.331183		[.741]		0.625656	
EPSLON21	0.004826	0.002163	2.23156	*	[.026]		EPSLON21	-1.27E-03	3.44E-03	-0.369487		[.712]		0.628169	0.628169
ALPHA22	-0.00641	0.01291	-0.496497		[.620]		ALPHA22	0.017994	0.015826	1.13699		[.256]		0.815746	
BETA22	-0.071204	0.078907	-0.902377		[.367]		BETA22	-0.140473	0.124905	-1.12464		[.261]		0.631736	
GAMMA22	-0.000836	0.00241	-0.347093		[.729]		GAMMA22	-5.04E-03	2.88E-03	-1.75336		[.080]		0.837964	
DELTA22	0.046245	0.266913	0.173258		[.862]		DELTA22	-0.087174	0.312437	-0.279011		[.780]		0.854294	
EPSLON22	0.005141	0.002767	1.85791		[.063]		EPSLON22	-2.54E-03	3.26E-03	-0.779322		[.436]		0.849251	0.849251
ALPHA23	-0.025188	0.006382	-3.94699	**	[.000]		ALPHA23	-0.021718	8.62E-03	-2.51903	*	[.012]		0.740196	0.740196
BETA23	0.034193	0.054688	0.625239		[.532]		BETA23	0.016049	0.060172	0.266721		[.790]		0.908861	
GAMMA23	0.002912	0.001525	1.9101		[.056]		GAMMA23	2.08E-03	2.00E-03	1.03977		[.298]		0.763305	0.763305
DELTA23	0.328016	0.112761	2.90894	**	[.004]		DELTA23	0.372465	0.160707	2.31766	*	[.020]		0.701656	0.701656

	Joint Estimation							Single Equation Estimation							
Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.		SE Ratio	Sig<10%
EPSLON23	0.004756	0.002284	2.08176	*	[.037]		EPSLON23	1.46E-03	2.66E-03	0.549728		[.583]		0.857534	0.857534
ALPHA24	-0.094823	0.562399	-0.168605		[.866]		ALPHA24	-0.033835	0.144124	-0.234766		[.814]		3.902188	
BETA24	-0.02788	0.331872	-0.084009		[.933]		BETA24	0.043565	0.11655	0.373789		[.709]		2.847465	
GAMMA24	0.00723	0.066558	0.108625		[.913]		GAMMA24	2.01E-03	0.016944	0.118457		[.906]		3.928116	
DELTA24	-0.962037	7.61289	-0.126369		[.899]		DELTA24	0.102193	1.99939	0.051112		[.959]		3.807606	
EPSLON24	0.159336	1.0208	0.156089		[.876]		EPSLON24	0.035619	0.264005	0.134919		[.893]		3.866593	
ALPHA25	-0.023648	0.005976	-3.95684	**	[.000]		ALPHA25	-0.015424	0.010228	-1.50803		[.132]		0.584326	0.584326
BETA25	0.356974	0.108562	3.28819	**	[.001]		BETA25	0.418325	0.122082	3.42657	**	[.001]		0.889255	0.889255
GAMMA25	0.015482	0.00306	5.05991	**	[.000]		GAMMA25	0.014771	4.66E-03	3.17069	**	[.002]		0.656792	0.656792
DELTA25	0.728083	0.224935	3.23686	**	[.001]		DELTA25	0.337075	0.379594	0.887986		[.375]		0.592567	0.592567
EPSLON25	0.010943	0.004589	2.3847	*	[.017]		EPSLON25	0.01317	6.18E-03	2.13096	*	[.033]		0.742491	0.742491
ALPHA26	-0.001021	0.003653	-0.279401		[.780]		ALPHA26	-4.34E-04	4.27E-03	-0.101874		[.919]		0.856587	
BETA26	0.008684	0.078533	0.110582		[.912]		BETA26	-0.109569	0.096802	-1.13189		[.258]		0.811275	
GAMMA26	-0.001563	0.001193	-1.31056		[.190]		GAMMA26	-1.52E-03	1.36E-03	-1.11328		[.266]		0.874588	
ALPHA27	-0.010678	0.002272	-4.69912	**	[.000]		ALPHA27	-0.011448	2.63E-03	-4.35177	**	[.000]		0.863838	0.863838
BETA27	0.218416	0.1143	1.91091		[.056]		BETA27	0.278585	0.183084	1.52162		[.128]		0.624304	0.624304
GAMMA27	-0.000457	0.001313	-0.348078		[.728]		GAMMA27	-7.52E-04	1.45E-03	-0.519736		[.603]		0.90732	
ALPHA28	-0.009116	0.002155	-4.22905	**	[.000]		ALPHA28	-7.83E-03	2.90E-03	-2.69723	**	[.007]		0.742778	0.742778
BETA28	0.44061	0.187099	2.35496	*	[.019]		BETA28	0.438951	0.302883	1.44925		[.147]		0.617727	0.617727
GAMMA28	0.000124	0.001412	0.088102		[.930]		GAMMA28	3.26E-05	1.54E-03	0.021152		[.983]		0.915402	
ALPHA29	-0.003649	0.003027	-1.20564		[.228]		ALPHA29	-3.43E-03	3.55E-03	-0.965277		[.334]		0.852102	
BETA29	0.455912	0.20069	2.27173	*	[.023]		BETA29	0.600745	0.279287	2.151	*	[.031]		0.71858	0.71858
GAMMA29	-0.001569	0.001729	-0.90705		[.364]		GAMMA29	-1.33E-03	1.90E-03	-0.702655		[.482]		0.912255	
ALPHA30	0.026545	0.00533	4.98063	**	[.000]		ALPHA30	0.030187	6.45E-03	4.67754	**	[.000]		0.825831	0.825831
BETA30	0.734804	0.217459	3.37905	**	[.001]		BETA30	0.697968	0.27592	2.5296	*	[.011]		0.788123	0.788123
GAMMA30	0.00305	0.002286	1.33471		[.182]		GAMMA30	3.68E-03	2.67E-03	1.38187		[.167]		0.857579	
														Min.	0.49761
														Max.	0.90777

4.9.3 Comparison of Joint and 'Full Sample' estimates

Although the joint estimation produced, for some portfolios, indications of significant parameter values (e.g. portfolio 25, the portfolio of the smallest, lowest-yielding companies, was significant in all parameters) it remains the case that, compared to the earlier estimates using the full sample of 14,400 samples in a *single* regression, and which generates a limited set of parameter values, the individual portfolio estimates (even when estimated jointly) produce only a minority of significant parameters. However, the comparison is not entirely reasonable, since the effective restriction (to a small number of parameters) in the full sample estimation produces the effect of an increase in the estimation efficiency of those (fewer in number) parameters[112].

The solution to this problem lies in determining a set of viable restrictions on the joint estimation which reduce the number of parameters required to efficiently summarise the available data. This process begins in the next section with a focus upon the constant term, which may be regarded as a measure of abnormal return after controlling for the various 'risk' factors.

4.9.4 Restrictions on the Constant Term

Linear combinations of parameter estimates and standard errors may be constructed in such a way as to produce 'confidence intervals' at any desired level of significance. Thus the parameter estimate +/- 1.96 x standard error produces, under the assumption of normality, an interval which may be assumed, with 95% confidence, to contain the true value of the parameter. If, in addition, that interval also includes zero, then it may be construed that the value of the parameter is "not significantly different to zero" - i.e. is insignificant.

It would, therefore, be a valid strategy to impose zero values upon all (n) insignificant values of the parameter, thus reducing the number of parameters to be estimated by (n); an alternative, which reduces the number of parameters to be estimated by (n-1), is to impose a single, common value among the insignificant group. This alternative has the advantage of enabling an assessment to be made as to whether the parameter, when re-estimated, remains insignificant.

[112] The effect may also be viewed as a 'sample size' effect, since each (of the multiple portfolios) possesses only 480 (as opposed to 14,400) samples, yet must deliver a similar number of parameter estimates.

Table 4.12 shows the 30 alpha coefficients, sorted by 'p' values[113] and assigned confidence intervals; it is evident that significance (of the constant terms) features mainly in respect of certain portfolios in the zero and lowest-yielding categories[114]; in addition, portfolio 13 has a highly significant alpha, and portfolio 1, that of the largest and highest-yielding firms, is admitted on the basis that it is significant at the 10% level. This leaves 23 portfolios sharing a common value of alpha.

When re-estimated (Table 4.13), the results conform largely to the expectation, namely that the values of the common' alpha0'[115] remain insignificant, while the values of the individual alphas remain significant. There is, however, one exception in each of these categories. Portfolio 3 exhibits a significant (at 5%) Alpha0, while the Value of Alpha1 (Portfolio 1) reverts to insignificance.

4.9.5 Restrictions on the value of Beta

Having reached the stage outlined above in relation to the constant terms, attention is now turned to the possibility of placing restrictions on the values of the covariance risk factor, beta. Here, the situation differs in the sense that far fewer portfolios reveal estimates for beta which are significantly different to unity (the null hypothesis in this case). Of those which do, four (portfolios 13,18,23 and 24) are located in contiguous positions within the Yield / Capitalisation mapping, and three (portfolios 2,5 and 26) occupy separate positions near the extremities of the map. It is also clear, however, that groupings of 'similar'[116] values of beta, again occupying contiguous positions within the mapping, are in evidence. Thus a strategy of grouping, based jointly upon the 'similarity' of estimates and also the portfolio topography, is to be adopted as a means of imposing restrictions. Table 4.14 illustrates the grouping of numerically and topographically 'similar' Beta values within the portfolio structure.

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[113] Equivalently, this may be regarded as an ordering by the modulus of the 't' statistic.

[114] Portfolios 27,28 and 30 are the mid- and smallest capitalisation stocks in the Zero-Dividend category, and portfolios 23 and 25 similarly relate to the lowest yielding category.

[115] Table 4.13 shows different values for Alpha0 for each portfolio. This arises by virtue of the different instrument sets used for each individual portfolio's re-estimation. For any given estimation, the Alpha0 is common to the 23 portfolios which originally exhibited insignificant abnormal returns.

[116] More formally in this context, by 'similar' it is implied that the relative positions of the confidence intervals around particular pairs of estimates allows them to be assigned common parameters.

Index	Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.	Upper Bnd	Lower Bnd
1	ALPHA30	0.026545	0.00533	4.98063	**	[.000]	0.037204	0.015886
15	ALPHA28	-0.00912	0.002155	-4.22905	**	[.000]	-0.0048	-0.01343
16	ALPHA27	-0.01068	0.002272	-4.69912	**	[.000]	-0.00613	-0.01522
23	ALPHA25	-0.02365	0.005976	-3.95684	**	[.000]	-0.0117	-0.0356
24	ALPHA23	-0.02519	0.006382	-3.94699	**	[.000]	-0.01243	-0.03795
2	ALPHA13	0.019339	0.006141	3.14914	**	[.002]	0.031621	0.007057
3	ALPHA1	0.014614	0.00849	1.72135		[.085]	0.031593	-0.00237
6	ALPHA8	0.011721	0.007646	1.53284		[.125]	0.027014	-0.00357
4	ALPHA10	0.011795	0.008967	1.31545		[.188]	0.029729	-0.00614
5	ALPHA7	0.011287	0.00857	1.3171		[.188]	0.028426	-0.00585
13	ALPHA3	-0.00767	0.005859	-1.30986		[.190]	0.004044	-0.01939
22	ALPHA14	-0.01065	0.008555	-1.24455		[.213]	0.006463	-0.02776
14	ALPHA29	-0.00365	0.003027	-1.20564		[.228]	0.002405	-0.0097
20	ALPHA17	-0.00916	0.010065	-0.91018		[.363]	0.01097	-0.02929
8	ALPHA4	0.005821	0.007379	0.788776		[.430]	0.020579	-0.00894
17	ALPHA6	0.018559	0.02396	0.774572		[.439]	0.066479	-0.02936
21	ALPHA5	-0.00562	0.007349	-0.76525		[.444]	0.009074	-0.02032
11	ALPHA2	0.002078	0.002878	0.721996		[.470]	0.007834	-0.00368
19	ALPHA12	-0.00671	0.010635	-0.63088		[.528]	0.01456	-0.02798
27	ALPHA16	-0.01222	0.021459	-0.56922		[.569]	0.030703	-0.05513
18	ALPHA22	-0.00641	0.01291	-0.4965		[.620]	0.01941	-0.03223
26	ALPHA11	-0.01362	0.029924	-0.45524		[.649]	0.046226	-0.07347
9	ALPHA18	-0.00344	0.008193	-0.42005		[.674]	0.012945	-0.01983
28	ALPHA21	-0.00723	0.01888	-0.38316		[.702]	0.030526	-0.04499
7	ALPHA9	0.003379	0.009377	0.360303		[.719]	0.022133	-0.01538
25	ALPHA15	-0.02464	0.076163	-0.32354		[.746]	0.127684	-0.17697
12	ALPHA26	-0.00102	0.003653	-0.2794		[.780]	0.006286	-0.00833
30	ALPHA24	-0.09482	0.562399	-0.16861		[.866]	1.029975	-1.21962
10	ALPHA19	-0.00091	0.006654	-0.13631		[.892]	0.012402	-0.01422
29	ALPHA20	-0.06796	0.726272	-0.09357		[.925]	1.384586	-1.5205

Table 4.12 Alpha estimates (sorted by p-value)

* Significant estimates (at the 10% level) are shown shaded

Table 4.13

1) Results of Unrestricted (Joint) estimations
First group of (6) columns.

2) Results of Alpha-restricted estimations
Second group of (6) columns.

3) Results of Alpha- and Beta- restricted estimations
Third group of (6) columns.

(presented on the following three sheets)

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
ALPHA1	0.014614	0.00849	1.72135		[.085]
BETA1	-0.43046	0.130692	-3.29366	**	[.001]
GAMMA1	-0.00128	0.001051	-1.21897		[.223]
DELTA1	-0.02699	0.022715	-1.18808		[.235]
EPSLON1	-4.4E-05	0.001189	-0.03661		[.971]
ALPHA2	0.002078	0.002878	0.721996		[.470]
BETA2	-0.02523	0.047719	-0.52877		[.597]
GAMMA2	0.000216	0.000469	0.460235		[.645]
DELTA2	-0.00284	0.002025	-1.4036		[.160]
EPSLON2	0.000255	0.001367	0.186579		[.852]
ALPHA3	-0.00767	0.005859	-1.30986		[.190]
BETA3	0.069548	0.05393	1.28961		[.197]
GAMMA3	0.000542	0.000734	0.73787		[.461]
DELTA3	0.042918	0.029012	1.47931		[.139]
EPSLON3	0.002806	0.002483	1.13015		[.258]
ALPHA4	0.005821	0.007379	0.788776		[.430]
BETA4	0.158051	0.067587	2.33847	*	[.019]
GAMMA4	0.000151	0.00092	0.164495		[.869]
DELTA4	0.01907	0.040463	0.471295		[.637]
EPSLON4	-0.00641	0.003172	-2.02136	*	[.043]
ALPHA5	-0.00562	0.007349	-0.76525		[.444]
BETA5	0.127209	0.094051	1.35256		[.176]
GAMMA5	0.003405	0.001314	2.59242	**	[.010]
DELTA5	0.149901	0.053478	2.80304	**	[.005]
EPSLON5	-0.00392	0.00189	-2.07215	*	[.038]
ALPHA6	0.018559	0.02396	0.774572		[.439]
BETA6	-0.58817	0.130666	-4.5013	**	[.000]
GAMMA6	-0.00149	0.002119	-0.70411		[.481]
DELTA6	-0.0369	0.149489	-0.24686		[.805]
EPSLON6	-0.00063	0.002013	-0.31358		[.754]
ALPHA7	0.011287	0.00857	1.3171		[.188]
BETA7	-0.15869	0.112067	-1.41603		[.157]
GAMMA7	-0.00045	0.000951	-0.47127		[.637]
DELTA7	-0.08728	0.063625	-1.37184		[.170]
EPSLON7	-0.00222	0.002242	-0.98912		[.323]
ALPHA8	0.011721	0.007646	1.53284		[.125]
BETA8	0.07889	0.042403	1.86048		[.063]
GAMMA8	-0.00078	0.000907	-0.8581		[.391]
DELTA8	-0.06123	0.058934	-1.03894		[.299]
EPSLON8	-0.00636	0.001935	-3.28892	**	[.001]
ALPHA9	0.003379	0.009377	0.360303		[.719]
BETA9	0.175071	0.056585	3.09392	**	[.002]
GAMMA9	-0.00011	0.000996	-0.11109		[.912]
DELTA9	-0.05068	0.093791	-0.54036		[.589]
EPSLON9	-0.00113	0.003364	-0.33552		[.737]
ALPHA10	0.011795	0.008967	1.31545		[.188]
BETA10	0.317616	0.097137	3.26979	**	[.001]
GAMMA10	0.0015	0.001101	1.3631		[.173]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
ALPHA1	6.00E-03	4.13E-03	1.4539		[.146]
BETA1	-0.29379	0.075111	-3.91146	**	[.000]
GAMMA1	-1.12E-04	6.06E-04	-0.18532		[.853]
DELTA1	-0.02035	0.013383	-1.52081		[.128]
EPSLON1	7.95E-04	6.21E-04	1.28175		[.200]
ALPHA0	5.26E-04	1.14E-03	0.460849		[.645]
BETA2	-0.01285	0.03374	-0.38079		[.703]
GAMMA2	2.11E-04	3.27E-04	0.647405		[.517]
DELTA2	-6.50E-03	1.40E-03	-4.63732	**	[.000]
EPSLON2	1.16E-03	8.05E-04	1.43656		[.151]
ALPHA0	-2.50E-03	1.11E-03	-2.25666	*	[.024]
BETA3	0.081528	0.037441	2.17749	*	[.029]
GAMMA3	-1.95E-04	4.04E-04	-0.48419		[.628]
DELTA3	0.02406	0.014269	1.68618		[.092]
EPSLON3	7.92E-04	9.20E-04	0.861112		[.389]
ALPHA0	-5.87E-04	1.28E-03	-0.45822		[.647]
BETA4	0.148097	0.055481	2.66931	**	[.008]
GAMMA4	4.26E-04	4.54E-04	0.938564		[.348]
DELTA4	0.045839	0.016366	2.80083	**	[.005]
EPSLON4	-3.17E-03	1.45E-03	-2.17833	*	[.029]
ALPHA0	6.71E-04	1.12E-03	0.598913		[.549]
BETA5	0.085006	0.076876	1.10575		[.269]
GAMMA5	2.60E-03	5.52E-04	4.71524	**	[.000]
DELTA5	0.114915	0.018985	6.05287	**	[.000]
EPSLON5	-4.54E-03	1.32E-03	-3.44256	**	[.001]
ALPHA0	-2.16E-04	9.17E-04	-0.23583		[.814]
BETA6	-0.55402	0.084801	-6.53322	**	[.000]
GAMMA6	7.19E-04	4.02E-04	1.78975		[.073]
DELTA6	0.017674	0.039715	0.445016		[.656]
EPSLON6	6.74E-04	6.42E-04	1.04907		[.294]
ALPHA0	-6.70E-04	9.73E-04	-0.68901		[.491]
BETA7	-0.1812	0.062733	-2.88839	**	[.004]
GAMMA7	8.25E-04	3.49E-04	2.36267	*	[.018]
DELTA7	-0.01266	0.0235	-0.5385		[.590]
EPSLON7	-7.80E-05	1.07E-03	-0.0731		[.942]
ALPHA0	-1.25E-03	1.33E-03	-0.94299		[.346]
BETA8	0.065774	0.034504	1.90627		[.057]
GAMMA8	3.68E-04	3.62E-04	1.01717		[.309]
DELTA8	0.025413	0.019245	1.32049		[.187]
EPSLON8	-2.08E-03	7.71E-04	-2.69269	**	[.007]
ALPHA0	-3.33E-04	1.41E-03	-0.23711		[.813]
BETA9	0.148455	0.038568	3.84918	**	[.000]
GAMMA9	-1.90E-04	4.54E-04	-0.41849		[.676]
DELTA9	1.24E-03	0.026486	0.046683		[.963]
EPSLON9	-1.07E-03	1.47E-03	-0.727		[.467]
ALPHA0	-8.78E-04	1.22E-03	-0.719		[.472]
BETA10	0.202053	0.057859	3.49215	**	[.000]
GAMMA10	2.09E-03	6.11E-04	3.414	**	[.001]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
ALPHA1	6.53E-03	3.33E-03	1.96194	*	[.050]
BETA1	-0.31632	0.046088	-6.86337	**	[.000]
GAMMA1	-1.68E-04	4.85E-04	-0.34658		[.729]
DELTA1	-0.01858	0.011418	-1.62725		[.104]
EPSLON1	7.84E-04	5.28E-04	1.48321		[.138]
ALPHA0	8.02E-04	9.66E-04	0.830987		[.406]
BETA2	-0.01152	0.026729	-0.43114		[.666]
GAMMA2	3.09E-04	2.67E-04	1.15756		[.247]
DELTA2	-6.77E-03	1.17E-03	-5.77013	**	[.000]
EPSLON2	8.78E-04	6.91E-04	1.27042		[.204]
ALPHA0	-2.18E-03	9.43E-04	-2.31738	*	[.020]
BETA3_12	0.07303	0.022534	3.24092	**	[.001]
GAMMA3	-2.22E-04	3.58E-04	-0.61855		[.536]
DELTA3	0.025292	0.012514	2.02104	*	[.043]
EPSLON3	4.11E-04	8.11E-04	0.506494		[.613]
ALPHA0	-1.51E-04	1.03E-03	-0.14696		[.883]
BETA4_14	0.15186	0.028088	5.40664	**	[.000]
GAMMA4	4.36E-04	4.32E-04	1.00919		[.313]
DELTA4	0.042981	0.015462	2.7798	**	[.005]
EPSLON4	-3.39E-03	1.29E-03	-2.62771	**	[.009]
ALPHA0	7.22E-04	9.48E-04	0.761347		[.446]
BETA5	0.078417	0.056669	1.38378		[.166]
GAMMA5	2.37E-03	4.71E-04	5.02761	**	[.000]
DELTA5	0.111167	0.017795	6.24699	**	[.000]
EPSLON5	-4.35E-03	1.13E-03	-3.83452	**	[.000]
ALPHA0	4.89E-04	7.47E-04	0.654856		[.513]
BETA6	-0.52558	0.055374	-9.49145	**	[.000]
GAMMA6	7.51E-04	3.57E-04	2.10211	*	[.036]
DELTA6	1.18E-03	0.031776	0.037206		[.970]
EPSLON6	8.82E-04	5.11E-04	1.72731		[.084]
ALPHA0	-3.22E-04	9.25E-04	-0.3476		[.728]
BETA2_24	-0.17415	0.027925	-6.23635	**	[.000]
GAMMA7	7.44E-04	2.92E-04	2.54749	*	[.011]
DELTA7	-0.01481	0.015832	-0.93524		[.350]
EPSLON7	-1.48E-04	7.43E-04	-0.19905		[.842]
ALPHA0	-8.03E-04	1.11E-03	-0.72556		[.468]
BETA3_12	0.082896	0.023222	3.56972	**	[.000]
GAMMA8	3.07E-04	3.45E-04	0.890511		[.373]
DELTA8	0.020418	0.017115	1.19299		[.233]
EPSLON8	-2.26E-03	6.92E-04	-3.27044	**	[.001]
ALPHA0	9.66E-05	1.16E-03	0.08326		[.934]
BETA4_14	0.13185	0.024436	5.39576	**	[.000]
GAMMA9	-2.18E-04	4.12E-04	-0.52824		[.597]
DELTA9	5.87E-03	0.021978	0.26725		[.789]
EPSLON9	-1.58E-03	1.18E-03	-1.34043		[.180]
ALPHA0	-3.45E-04	9.54E-04	-0.36198		[.717]
BETA5_24	0.165156	0.029202	5.65568	**	[.000]
GAMMA10	2.00E-03	5.39E-04	3.71586	**	[.000]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
DELTA10	0.01423	0.090617	0.157039		[.875]
EPSLON1(	-0.01287	0.003866	-3.32784	**	[.001]
ALPHA11	-0.01362	0.029924	-0.45524		[.649]
BETA11	-0.8138	0.121379	-6.70462	**	[.000]
GAMMA11	0.001373	0.002848	0.481956		[.630]
DELTA11	0.167929	0.221512	0.758103		[.448]
EPSLON1	0.001787	0.00267	0.669093		[.503]
ALPHA12	-0.00671	0.010635	-0.63088		[.528]
BETA12	-0.22881	0.084773	-2.69905	**	[.007]
GAMMA12	0.000658	0.001304	0.50445		[.614]
DELTA12	0.031264	0.095062	0.328878		[.742]
EPSLON1	0.002258	0.001458	1.54873		[.121]
ALPHA13	0.019339	0.006141	3.14914	**	[.002]
BETA13	0.053587	0.040705	1.31647		[.188]
GAMMA13	-0.00358	0.000959	-3.73402	**	[.000]
DELTA13	-0.13278	0.052354	-2.53628	*	[.011]
EPSLON1	-0.0053	0.001507	-3.51396	**	[.000]
ALPHA14	-0.01065	0.008555	-1.24455		[.213]
BETA14	0.109478	0.047352	2.31201	*	[.021]
GAMMA14	-0.00025	0.001308	-0.1934		[.847]
DELTA14	0.114754	0.084623	1.35605		[.175]
EPSLON1	0.001694	0.003254	0.52067		[.603]
ALPHA15	-0.02464	0.076163	-0.32354		[.746]
BETA15	0.139922	0.196725	0.711254		[.477]
GAMMA15	0.004735	0.009657	0.490257		[.624]
DELTA15	0.185548	0.46593	0.398232		[.690]
EPSLON1	0.020554	0.067851	0.302924		[.762]
ALPHA16	-0.01222	0.021459	-0.56922		[.569]
BETA16	-0.68846	0.117079	-5.8803	**	[.000]
GAMMA16	0.001532	0.002305	0.664754		[.506]
DELTA16	0.042964	0.207058	0.207497		[.836]
EPSLON1(	0.003521	0.001715	2.05338	*	[.040]
ALPHA17	-0.00916	0.010065	-0.91018		[.363]
BETA17	-0.17842	0.060814	-2.93379	**	[.003]
GAMMA17	0.000866	0.001455	0.595461		[.552]
DELTA17	0.030071	0.109909	0.273601		[.784]
EPSLON1	0.002234	0.001144	1.95362		[.051]
ALPHA18	-0.00344	0.008193	-0.42005		[.674]
BETA18	0.028726	0.050741	0.566127		[.571]
GAMMA18	-0.00083	0.001266	-0.65274		[.514]
DELTA18	0.007444	0.117352	0.063435		[.949]
EPSLON1	0.001242	0.00124	1.00112		[.317]
ALPHA19	-0.00091	0.006654	-0.13631		[.892]
BETA19	0.089892	0.051405	1.7487		[.080]
GAMMA19	-0.00146	0.001181	-1.23254		[.218]
DELTA19	-0.02608	0.10465	-0.24919		[.803]
EPSLON1	0.000836	0.002012	0.415645		[.678]
ALPHA20	-0.06796	0.726272	-0.09357		[.925]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
DELTA10	0.150122	0.027095	5.54068	**	[.000]
EPSLON10	-7.65E-03	1.38E-03	-5.52977	**	[.000]
ALPHA0	-3.56E-04	7.94E-04	-0.44804		[.654]
BETA11	-0.78436	0.08731	-8.98357	**	[.000]
GAMMA11	3.93E-04	5.53E-04	0.710181		[.478]
DELTA11	0.048744	0.063986	0.761789		[.446]
EPSLON11	8.39E-04	8.52E-04	0.984584		[.325]
ALPHA0	-8.03E-04	6.91E-04	-1.16146		[.245]
BETA12	-0.20434	0.052864	-3.86542	**	[.000]
GAMMA12	1.11E-04	3.83E-04	0.29009		[.772]
DELTA12	-0.02811	0.026308	-1.06832		[.285]
EPSLON12	1.61E-03	6.18E-04	2.60886	**	[.009]
ALPHA13	0.021057	4.27E-03	4.92575	**	[.000]
BETA13	0.046845	0.031617	1.48164		[.138]
GAMMA13	-3.76E-03	6.70E-04	-5.60959	**	[.000]
DELTA13	-0.16244	0.039742	-4.08726	**	[.000]
EPSLON13	-5.10E-03	1.14E-03	-4.47776	**	[.000]
ALPHA0	-7.34E-04	9.81E-04	-0.74783		[.455]
BETA14	0.121033	0.036248	3.33906	**	[.001]
GAMMA14	-1.43E-03	5.76E-04	-2.4733	*	[.013]
DELTA14	0.027638	0.026867	1.02869		[.304]
EPSLON14	-1.82E-03	1.33E-03	-1.36793		[.171]
ALPHA0	-3.18E-03	1.89E-03	-1.67858		[.093]
BETA15	0.174405	0.062662	2.78326	**	[.005]
GAMMA15	2.32E-03	8.23E-04	2.81706	**	[.005]
DELTA15	0.09491	0.052088	1.82211		[.068]
EPSLON15	-7.65E-04	4.54E-03	-0.16844		[.866]
ALPHA0	-5.00E-04	8.94E-04	-0.55896		[.576]
BETA16	-0.67651	0.078312	-8.63864	**	[.000]
GAMMA16	5.37E-04	4.84E-04	1.11049		[.267]
DELTA16	-0.06201	0.072844	-0.85124		[.395]
EPSLON16	2.66E-03	9.04E-04	2.94168	**	[.003]
ALPHA0	-5.27E-04	8.26E-04	-0.63824		[.523]
BETA17	-0.1917	0.046507	-4.12204	**	[.000]
GAMMA17	-3.04E-04	3.91E-04	-0.77811		[.437]
DELTA17	-0.05428	0.036939	-1.46945		[.142]
EPSLON17	1.60E-03	7.72E-04	2.0762	*	[.038]
ALPHA0	8.67E-06	7.89E-04	0.010977		[.991]
BETA18	0.040323	0.030342	1.32895		[.184]
GAMMA18	-1.17E-03	4.39E-04	-2.65527	**	[.008]
DELTA18	-0.06283	0.027511	-2.28371	*	[.022]
EPSLON18	1.12E-03	8.46E-04	1.32797		[.184]
ALPHA0	1.38E-03	8.98E-04	1.53921		[.124]
BETA19	0.110391	0.040431	2.73036	**	[.006]
GAMMA19	-1.76E-03	4.06E-04	-4.33673	**	[.000]
DELTA19	-0.05596	0.039025	-1.43397		[.152]
EPSLON19	-3.24E-04	1.40E-03	-0.23188		[.817]
ALPHA0	-7.05E-04	1.48E-03	-0.47714		[.633]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
DELTA10	0.145344	0.024714	5.88106	**	[.000]
EPSLON10	-7.62E-03	1.24E-03	-6.13188	**	[.000]
ALPHA0	1.89E-04	6.60E-04	0.286485		[.775]
BETA11	-0.72886	0.064454	-11.3082	**	[.000]
GAMMA11	4.14E-04	4.68E-04	0.884144		[.377]
DELTA11	0.029479	0.054207	0.54383		[.587]
EPSLON11	9.54E-04	7.14E-04	1.33499		[.182]
ALPHA0	-3.95E-04	6.23E-04	-0.63429		[.526]
BETA2_24	-0.16809	0.025882	-6.49429	**	[.000]
GAMMA12	8.16E-05	3.29E-04	0.247902		[.804]
DELTA12	-0.02829	0.021723	-1.30227		[.193]
EPSLON12	1.33E-03	4.92E-04	2.70319	**	[.007]
ALPHA13	0.019504	3.91E-03	4.98307	**	[.000]
BETA0	0.054933	0.019731	2.78407	**	[.005]
GAMMA13	-3.54E-03	6.09E-04	-5.81585	**	[.000]
DELTA13	-0.14714	0.033965	-4.33195	**	[.000]
EPSLON13	-4.99E-03	1.06E-03	-4.73227	**	[.000]
ALPHA0	-2.24E-04	7.74E-04	-0.28956		[.772]
BETA4_14	0.133473	0.025036	5.33125	**	[.000]
GAMMA14	-1.37E-03	5.24E-04	-2.6078	**	[.009]
DELTA14	0.029248	0.022606	1.29378		[.196]
EPSLON14	-2.69E-03	1.09E-03	-2.47319	*	[.013]
ALPHA0	-5.33E-04	2.61E-03	-0.20471		[.838]
BETA5_24	0.193394	0.084751	2.28192	*	[.022]
GAMMA15	1.82E-03	7.46E-04	2.4381	*	[.015]
DELTA15	0.067968	0.051341	1.32387		[.186]
EPSLON15	-2.10E-03	4.85E-03	-0.43199		[.666]
ALPHA0	-5.88E-05	8.31E-04	-0.07074		[.944]
BETA16	-0.64175	0.056018	-11.4561	**	[.000]
GAMMA16	5.17E-04	4.33E-04	1.19564		[.232]
DELTA16	-0.07271	0.06421	-1.13232		[.258]
EPSLON16	2.51E-03	7.97E-04	3.15505	**	[.002]
ALPHA0	-2.88E-04	7.68E-04	-0.37456		[.708]
BETA2_24	-0.1689	0.027031	-6.24814	**	[.000]
GAMMA17	-2.77E-04	3.53E-04	-0.78498		[.432]
DELTA17	-0.05892	0.032109	-1.83513		[.066]
EPSLON17	1.46E-03	6.97E-04	2.09142	*	[.036]
ALPHA0	2.89E-04	7.52E-04	0.383958		[.701]
BETA0	0.065449	0.019595	3.34007	**	[.001]
GAMMA18	-1.23E-03	4.30E-04	-2.8667	**	[.004]
DELTA18	-0.06351	0.024149	-2.62989	**	[.009]
EPSLON18	8.01E-04	7.96E-04	1.0063		[.314]
ALPHA0	1.59E-03	7.90E-04	2.01402	*	[.044]
BETA4_14	0.12726	0.022191	5.73472	**	[.000]
GAMMA19	-1.73E-03	3.90E-04	-4.44715	**	[.000]
DELTA19	-0.06571	0.034666	-1.89554		[.058]
EPSLON19	-2.35E-04	1.26E-03	-0.18602		[.852]
ALPHA0	4.01E-04	1.22E-03	0.327605		[.743]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
BETA20	0.270343	0.693674	0.389726		[.697]
GAMMA20	0.005705	0.056172	0.101568		[.919]
DELTA20	0.233965	1.97218	0.118633		[.906]
EPSLON2	0.071909	0.84457	0.085142		[.932]
ALPHA21	-0.00723	0.01888	-0.38316		[.702]
BETA21	-0.53421	0.127074	-4.20391	**	[.000]
GAMMA21	0.001075	0.002569	0.418579		[.676]
DELTA21	-0.08866	0.281084	-0.3154		[.752]
EPSLON2	0.004826	0.002163	2.23156	*	[.026]
ALPHA22	-0.00641	0.01291	-0.4965		[.620]
BETA22	-0.0712	0.078907	-0.90238		[.367]
GAMMA22	-0.00084	0.00241	-0.34709		[.729]
DELTA22	0.046245	0.266913	0.173258		[.862]
EPSLON2	0.005141	0.002767	1.85791		[.063]
ALPHA23	-0.02519	0.006382	-3.94699	**	[.000]
BETA23	0.034193	0.054688	0.625239		[.532]
GAMMA23	0.002912	0.001525	1.9101		[.056]
DELTA23	0.328016	0.112761	2.90894	**	[.004]
EPSLON2	0.004756	0.002284	2.08176	*	[.037]
ALPHA24	-0.09482	0.562399	-0.16861		[.866]
BETA24	-0.02788	0.331872	-0.08401		[.933]
GAMMA24	0.00723	0.066558	0.108625		[.913]
DELTA24	-0.96204	7.61289	-0.12637		[.899]
EPSLON2	0.159336	1.0208	0.156089		[.876]
ALPHA25	-0.02365	0.005976	-3.95684	**	[.000]
BETA25	0.356974	0.108562	3.28819	**	[.001]
GAMMA25	0.015482	0.00306	5.05991	**	[.000]
DELTA25	0.728083	0.224935	3.23686	**	[.001]
EPSLON2	0.010943	0.004589	2.3847	*	[.017]
ALPHA26	-0.00102	0.003653	-0.2794		[.780]
BETA26	0.008684	0.078533	0.110582		[.912]
GAMMA26	-0.00156	0.001193	-1.31056		[.190]
ALPHA27	-0.01068	0.002272	-4.69912	**	[.000]
BETA27	0.218416	0.1143	1.91091		[.056]
GAMMA27	-0.00046	0.001313	-0.34808		[.728]
ALPHA28	-0.00912	0.002155	-4.22905	**	[.000]
BETA28	0.44061	0.187099	2.35496	*	[.019]
GAMMA28	0.000124	0.001412	0.088102		[.930]
ALPHA29	-0.00365	0.003027	-1.20564		[.228]
BETA29	0.455912	0.20069	2.27173	*	[.023]
GAMMA29	-0.00157	0.001729	-0.90705		[.364]
ALPHA30	0.026545	0.00533	4.98063	**	[.000]
BETA30	0.734804	0.217459	3.37905	**	[.001]
GAMMA30	0.00305	0.002286	1.33471		[.182]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
BETA20	0.191867	0.059473	3.2261	**	[.001]
GAMMA20	2.66E-03	9.34E-04	2.84482	**	[.004]
DELTA20	0.147417	0.081542	1.80786		[.071]
EPSLON20	-9.51E-03	4.85E-03	-1.96249	*	[.050]
ALPHA0	-4.94E-04	1.05E-03	-0.47119		[.638]
BETA21	-0.46175	0.072191	-6.39618	**	[.000]
GAMMA21	6.98E-04	5.17E-04	1.35046		[.177]
DELTA21	-0.33686	0.13195	-2.55294	*	[.011]
EPSLON21	4.74E-03	1.62E-03	2.92756	**	[.003]
ALPHA0	9.85E-05	9.82E-04	0.100389		[.920]
BETA22	-0.09999	0.052841	-1.8922		[.058]
GAMMA22	-1.39E-03	5.65E-04	-2.46723	*	[.014]
DELTA22	-0.13888	0.112268	-1.23703		[.216]
EPSLON22	5.32E-03	1.90E-03	2.80059	**	[.005]
ALPHA23	-0.02245	3.24E-03	-6.93733	**	[.000]
BETA23	0.023111	0.049388	0.467939		[.640]
GAMMA23	2.56E-03	8.24E-04	3.10831	**	[.002]
DELTA23	0.271286	0.07563	3.58699	**	[.000]
EPSLON23	4.07E-03	1.67E-03	2.43293	*	[.015]
ALPHA0	9.70E-04	1.21E-03	0.803723		[.422]
BETA24	0.022207	0.052633	0.42192		[.673]
GAMMA24	-3.42E-03	8.42E-04	-4.06705	**	[.000]
DELTA24	0.213069	0.168862	1.2618		[.207]
EPSLON24	-0.01005	8.01E-03	-1.25538		[.209]
ALPHA25	-0.01731	4.80E-03	-3.60833	**	[.000]
BETA25	0.370166	0.080025	4.62562	**	[.000]
GAMMA25	0.013641	1.95E-03	7.0091	**	[.000]
DELTA25	0.528767	0.198905	2.65839	**	[.008]
EPSLON25	8.27E-03	1.58E-03	5.24633	**	[.000]
ALPHA0	-6.97E-04	1.13E-03	-0.61457		[.539]
BETA26	-0.08801	0.059953	-1.4679		[.142]
GAMMA26	-1.26E-03	5.03E-04	-2.49922	*	[.012]
ALPHA27	-9.55E-03	1.48E-03	-6.46269	**	[.000]
BETA27	0.179039	0.065546	2.73151	**	[.006]
GAMMA27	-9.78E-04	1.05E-03	-0.93371		[.350]
ALPHA28	-7.48E-03	1.57E-03	-4.75662	**	[.000]
BETA28	0.402177	0.115244	3.4898	**	[.000]
GAMMA28	4.23E-04	1.14E-03	0.370144		[.711]
ALPHA0	-5.18E-04	1.39E-03	-0.3733		[.709]
BETA29	0.407911	0.126791	3.21719	**	[.001]
GAMMA29	-1.51E-03	1.46E-03	-1.03703		[.300]
ALPHA30	0.02816	3.00E-03	9.37552	**	[.000]
BETA30	0.597726	0.169557	3.52522	**	[.000]
GAMMA30	2.38E-03	1.51E-03	1.57672		[.115]

Parameter	Estimate	Std. Error	t-statistic	Sig.	P-val.
BETA5_24	0.160195	0.036258	4.41818	**	[.000]
GAMMA20	2.57E-03	7.17E-04	3.58094	**	[.000]
DELTA20	0.174467	0.064055	2.72369	**	[.006]
EPSLON20	-0.0121	3.75E-03	-3.22848	**	[.001]
ALPHA0	-8.87E-05	8.99E-04	-0.09869		[.921]
BETA21	-0.42102	0.049903	-8.4367	**	[.000]
GAMMA21	6.86E-04	4.56E-04	1.50268		[.133]
DELTA21	-0.35152	0.114382	-3.07321	**	[.002]
EPSLON21	4.73E-03	1.52E-03	3.10739	**	[.002]
ALPHA0	2.86E-04	8.79E-04	0.325536		[.745]
BETA22	-0.07781	0.036896	-2.10891	*	[.035]
GAMMA22	-1.40E-03	5.38E-04	-2.59125	**	[.010]
DELTA22	-0.15971	0.103259	-1.54672		[.122]
EPSLON22	5.43E-03	1.78E-03	3.04944	**	[.002]
ALPHA23	-0.02258	3.09E-03	-7.31793	**	[.000]
BETA0	0.06078	0.019364	3.13888	**	[.002]
GAMMA23	2.51E-03	7.37E-04	3.41023	**	[.001]
DELTA23	0.244251	0.062338	3.91815	**	[.000]
EPSLON23	4.75E-03	1.50E-03	3.16412	**	[.002]
ALPHA0	1.17E-03	1.10E-03	1.06193		[.288]
BETA0	0.068843	0.019794	3.47796	**	[.001]
GAMMA24	-3.35E-03	7.37E-04	-4.54587	**	[.000]
DELTA24	0.196696	0.14273	1.3781		[.168]
EPSLON24	-0.01071	6.83E-03	-1.5684		[.117]
ALPHA25	-0.01785	4.15E-03	-4.29778	**	[.000]
BETA25	0.369837	0.054635	6.76925	**	[.000]
GAMMA25	0.013546	1.73E-03	7.81131	**	[.000]
DELTA25	0.558473	0.174835	3.19429	**	[.001]
EPSLON25	8.16E-03	1.36E-03	6.00283	**	[.000]
ALPHA0	-5.31E-04	9.48E-04	-0.55972		[.576]
BETA26	-0.07353	0.047418	-1.5506		[.121]
GAMMA26	-1.35E-03	4.40E-04	-3.07138	**	[.002]
ALPHA27	-1.00E-02	1.40E-03	-7.13007	**	[.000]
BETA27	0.183336	0.057188	3.20582	**	[.001]
GAMMA27	-1.06E-03	9.64E-04	-1.09826		[.272]
ALPHA28	-7.85E-03	1.19E-03	-6.60651	**	[.000]
BETA34_6	0.383555	0.065777	5.83112	**	[.000]
GAMMA28	-3.34E-05	9.83E-04	-0.03393		[.973]
ALPHA0	5.14E-05	1.15E-03	0.044479		[.965]
BETA34_6	0.312828	0.061675	5.07223	**	[.000]
GAMMA29	-1.81E-03	9.79E-04	-1.84351		[.065]
ALPHA30	0.02895	2.58E-03	11.206	**	[.000]
BETA30	0.657136	0.129646	5.06871	**	[.000]
GAMMA30	2.82E-03	1.29E-03	2.18102	*	[.029]

	Capitalisation Quintile						
DivStrata	1	2	3	4	5		Average
1	0.706207	0.987152	1.081528	1.148097	1.085006		1.001598
2	0.445978	0.818803	1.065774	1.148455	1.202053		0.936213
3	0.215643	0.79566	1.046845	1.121033	1.174405		0.870717
4	0.323488	0.808297	1.040323	1.110391	1.191867		0.894873
5	0.538254	0.900015	1.023111	1.022207	1.370166		0.970751
6	0.911995	1.179039	1.402177	1.407911	1.597726		1.29977
Average	0.523594	0.914828	1.10996	1.159682	1.270204		0.995654

Table 4.14 Matrix of Beta Estimates

(* following the imposition of Alpha restrictions, but prior to the imposition of Beta restrictions; shading shows grouping by both topography and insignificantly different values)

Beta		Capitalisation Quintile				
DivStrata	1	2	3	4	5	Average
1	0.683682	0.988476	1.073030	1.151860	1.078417	0.995093
2	0.474423	0.825849	1.082896	1.131850	1.165156	0.936035
3	0.271138	0.831914	1.054933	1.133473	1.193394	0.896970
4	0.358255	0.831105	1.065449	1.127260	1.160195	0.908453
5	0.578984	0.922189	1.060780	1.068843	1.369837	1.000127
6	0.926473	1.183336	1.383555	1.312828	1.657136	1.292666
Average	0.548826	0.930478	1.120107	1.154352	1.270689	

Gamma							
1	-0.000168	0.000309	-0.000222	0.000436	0.002368	0.000545	Sig@1%
2	0.000751	0.000744	0.000307	-0.000218	0.002001	0.000717	Sig@5%
3	0.000414	0.000082	-0.003545	-0.001368	0.001819	-0.000519	
4	0.000517	-0.000277	-0.001234	-0.001733	0.002567	-0.000032	
5	0.000686	-0.001395	0.002514	-0.003348	0.013546	0.002400	
6	-0.001351	-0.001059	-0.000033	-0.001805	0.002822	-0.000285	
Average	0.000142	-0.000266	-0.000369	-0.001339	0.004187		

Delta							
1	-0.018579	-0.006768	0.025292	0.042981	0.111167	0.030819	Sig@1%
2	0.001182	-0.014807	0.020418	0.005874	0.145344	0.031602	Sig@5%
3	0.029479	-0.028290	-0.147135	0.029248	0.067968	-0.009746	
4	-0.072706	-0.058924	-0.063509	-0.065711	0.174467	-0.017277	
5	-0.351518	-0.159712	0.244251	0.196696	0.558473	0.097638	
Average	-0.082428	-0.053700	0.015863	0.041818	0.211484		

Epsilon							
1	0.000784	0.000878	0.000411	-0.003390	-0.004346	-0.001133	Sig@1%
2	0.000882	-0.000148	-0.002262	-0.001580	-0.007622	-0.002146	Sig@5%
3	0.000954	0.001329	-0.004994	-0.002687	-0.002096	-0.001499	
4	0.002515	0.001459	0.000801	-0.000235	-0.012097	-0.001512	
5	0.004729	0.005433	0.004749	-0.010714	0.008163	0.002472	
Average	0.001973	0.001790	-0.000259	-0.003721	-0.003599		

Table 4.15 Matrix of Beta, Gamma, Delta & Epsilon Estimates

(* following the imposition of both Alpha and Beta restrictions;
shading shows grouping by both topography and insignificantly different values (Beta) and indicates significance (at 1% and 5% levels) for Gamma, Delta and Epsilon estimates)

Results of the re-estimation following the imposition of the restrictions on the beta parameter are indicated in Table 4.15. Whilst scope remains for a treatment of the parameters gamma, delta and epsilon[117] similar to that of alpha (above), the results up to this point will be analysed below.

4.9.6 The Constant Term re-visited

Following re-estimation, Table 4.13 shows that portfolios 1, 13 and 30 exhibit positive abnormal returns[118], while portfolios 23, 25, 27 and 28 exhibit negative abnormal returns. These were the portfolios originally selected to have free coefficients. Of the remainder, (Alpha0 coefficients) only those for portfolios 3 and 19 remain significant.

4.9.7 The Beta coefficients

Beta coefficients show an increasing trend with decreasing firm size, and a 'U' shaped characteristic with changing Dividend yield, with the minima generally in the third and fourth ranking (mid-range) yield strata. Minimum beta (0.27) occurs with portfolio 11 (largest capitalisation quintile, third ranking yield strata); Maximum beta (1.66) occurs with portfolio 30 (smallest size Zero-Dividend portfolio).

4.9.8 The coefficients of Log Size

Whilst earlier results were indicative of a generally negative coefficient of Log Size, examination of the portfolio map for the joint estimation of Gamma indicates *positive* and significant coefficients for all yield strata among the *smallest* size quintile. Significant coefficients are approximately confined to the lower right triangle of the portfolio map (tending to low yield, low size portfolios); interestingly, all other significant coefficients, other than those associated with the smallest size quintile, are *negative*. The latter clearly dominate, and result in the overall negative 'size' coefficient highlighted earlier; however, the effect identified (by permitting free individual portfolio coefficients) in the case of the smallest firms' portfolios contrasts interestingly with the overall pattern.
The general trend across size quintiles (among dividend-paying stocks) is one of decreasing coefficient values with decreasing size, but with an upturn into the smallest size quintile. By

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[117] The coefficients of Log Size, Dividend Yield and Payout Ratio respectively.

[118] In the spirit of Jensen's (1968) 'Alpha', whilst controlling for Covariance Risk, Log Size, Dividend Yield and Payout Ratio.

contrast, the trend among Zero-Dividend stocks approximates to a linearly *increasing* pattern of coefficient values with decreasing size, changing from negative to positive values in the process.

4.9.9 The coefficients of Dividend Yield

The coefficients of Dividend Yield (Delta) demonstrate clear trends. The significant coefficients increase (and change sign) with decreasing Log Size; the within-strata *range* of coefficient values are greatest for the lowest-yielding category of stocks, which features both the most negative (and significant) coefficient for the largest lowest-yielding portfolio, and the most positive (and significant) coefficient for the smallest lowest-yielding portfolio.

4.9.10 The coefficients of Payout Ratio

The pattern of significant responses in the case of the Payout Ratio coefficient (Epsilon) is similar to that of Log Size (Gamma), in that it is the lower right hand triangle which features the majority of significant coefficients. The lowest yielding category exhibits the greatest sensitivity (of Returns) to payout ratio, with a generally increasing trend with decreasing firm size. Within the other yield categories, however, there is a moderate trend in the opposite direction. The variation of the coefficients across dividend yield strata is less clear-cut, but is once again of a 'U' shaped form.

4.10 Summary

The models developed in Chapter 4 sought to control, specifically, not only for covariance risk according to the CAPM, but also dividend yield and (Zero-Dividend) status, as well as size, earnings and seasonality effects. The evidence of these results indicates that the wider risk factors perceived by the investment community clearly extend beyond the simple covariance risk captured by the one-period CAPM. The scope of viable explanatory models has a need to adequately encompass the perceived risk of default and failure, not specifically addressed by the CAPM, and which is generally seen to affect smaller companies in a manner disproportionate to the market as a whole. Hence it is not surprising to find that the 'size' effect (Banz (1981)) features strongly in the context of the UK stock market. The effects of earnings also feature in a manner which might be expected, given the evidence from the US market (Fama and French (1992)).

The original assignments of firms to portfolios had been carried out according to the twin criteria of yield and size, in order to provide a wide cross-sectional spread of these values in the interests of estimation efficiency within the earlier regressions detailed in sections prior to 4.9.[119]. In moving to the estimation of individual portfolios, it is naturally the case that the augmentation of between-portfolio variation can only be at the expense of within-portfolio variation (**Berk (1997)**). Notwithstanding these considerations, the invocation of efficient and robust (joint) estimators finds sufficient temporal variation within the portfolio samples (together with the relationship linking their error terms) to render efficient estimation possible, as evidenced by the preceding sections. The benefit which this brings is to shed light on the patterns of coefficient variation across the portfolio mapping, which in its turn brings a greater understanding of the differing characteristics of the various types of stocks, as outlined above. By way of example, the above discussion has highlighted not only certain of the particular characteristics which set apart Zero-Dividend stocks, but also those which relate to, in particular, the smallest (quintile) firms. Evidence also exists as to the relationship which obtains as between Zero- and High-Dividend paying stocks, a factor which is closely examined in the next chapter (5), in terms in which a modified view of the portfolio structure is adopted, in the light of the observed variation across the portfolio mapping.

[119] A second benefit underlying portfolio methods is the reduction in the extent of the 'errors in variables' problem; this [benefit] arises due to the averaging effect of combining individual securities. However, the advantage is less apparent once estimators more sophisticated than OLS are invoked.

5.0 Dynamic Migration Patterns among Yield Strata

5.1. Introduction

In much of the literature, and indeed in the discussion in earlier sections of this paper, the term 'U' shaped characteristic has been applied to the distribution of Returns across dividend yield groups. The effect is evident in the results presented here (Ch.4, Table 4.5). Keim (1985), using U.S. data, identifies his overall result as being driven primarily by effects which occur in January. Christie (1990), using a different (portfolio matching) methodology for assessing excess returns, also finds the non-linearity to be a feature of January returns, but finds the effect absent for other months.

The concept of the 'U - shaped' relationship is, however, predicated upon the notion that Zero-Dividend and high dividend-paying stocks are at opposite extremities of a continuum along the yield axis. Whilst in a strict sense this has some validity, since the otherwise monotonic relationship between Returns and Yield for positive yields is breached when Zero-Dividend stocks are included, there would seem to be room for an alternative interpretation. This finds strong links between the categories of Zero- and High-Yielding stocks, therefore suggesting that, in a different sense, the two categories are 'adjacent'. Indeed, in terms of the growth and perhaps later decline of companies toward cessation of trading (or alternatively, merger / take-over)[120], the typical life-cycle characteristics of firms may well carry them through the stages of initial Zero-Dividend payment as they retain cash for growth, followed by a period of high dividend payment as early product lines mature to 'cash cow' status; concurrent to this phase, firms may be seeking to appeal to the investment community through good dividend performance. Declining firms, on the other hand, may relegate themselves through the capitalisation 'league tables' as the onset of poor earnings, profit warnings, etc. engenders a fall in the share price, sufficient in itself to give rise to high dividend yield (assuming a constant dividend stream, at least in the short term). Thus yield may be as much a 'price' effect in the denominator, at least as much as an earnings effect in the numerator, of the yield equation. Eventually, as pointed out by MT(1998), when declining high-yielding companies are no longer able to sustain the payment of dividends, they fall naturally into the Zero-Dividend category.

[120] The average 'lifetime' of individual stocks in the London Share Price Database is 141 months, or 11¾ years.

Following the notion of re-positioning Zero-Dividend firms (by way of re-ranking Table 4.4, risk - adjusted Returns), it is clear that linearity / monotonicity may be established by placing small Zero-Dividend firms *above* high dividend firms in the two smallest capitalisation quintiles. In the case of capitalisation quintile 3, a suitable ranking would reverse the ordering of the High- and Zero-Dividend stock portfolios, but leave them still adjacent. Only for the largest capitalisation Zero-Dividend stocks would the ordering place them near the 'conventional' position - even then they would remain above the 'low' dividend paying stock portfolios in the ranking.

Further evidence in support of the contention of 'adjacency' is that of Ch. 4 Table 4.3. While dividend-paying categories 5 (Low) to 2 (second-highest yielding) share broadly similar market capitalisation distributions, these are markedly distinct from the distributions of both Zero- and High-Yielding stocks. Whilst the latter pair differ one to another (Zero-Dividend stocks are clearly smaller, on average, than High-Yielding stocks), their market size distributions nevertheless do set them apart from the remaining groups. Keim (1985), pp. 478 highlights his finding, in relation to US Stocks:

> *"the smallest firms on the NYSE (those firms with the largest average returns) are concentrated in the zero dividend yield group and the highest dividend yield group."*

In order to further test the 'Adjacency' hypothesis, i.e. that the relationship between the Zero- and High-yielding categories is one of 'closeness' rather than separation across a continuum, and that their constituent stocks share common characteristics, a study of the migration patterns of stocks between categories over time is proposed.

In summary, rather than being an open-ended linear spectrum, the universe of stocks may possibly be regarded as forming a closed system which places Zero- and High-Dividend stocks adjacently. As indicated above, firms may frequently effect the transition directly from one category to the other, in either direction. The possibility of subsequent recovery of previously 'failing' firms may signal the start of a further 'revolution' around the closed circle. These considerations form the basis for a hypothesis of firms' characteristics which will be investigated in this chapter, through the medium of examining the ways in which, through time, firms position themselves within this classification structure

5.2. Methodology specific to the migration study

5.2.1 The Data

The data held in the 'Year' files (see Ch.3) provides the basis for the migration study, since the process of sorting stocks into positive yield quintiles and into the zero-yield sub-category is complete. A total of 655,770 valid[121] records are available in the 40 'Year' files covering the period January 1958 to December 1997[122]. These are brought together in a single, dedicated database file, and are then split into records for particular months (e.g. all files for the month of January, etc.). This facilitates the comparison of records exactly one year apart, in terms of their migration behaviour. The choice of this interval is based upon two considerations:

1) The calculation of dividend yield is based upon the application of a 12-month rolling average; this effectively imposes a 'low-pass' filter upon the data. Using an interval of commensurate length in order to monitor migration, ensures consistency in terms of the frequency characteristics of the 'filters' through which the data are viewed.

2) Over a 12-month period, the effects of seasonal variation present in migration patterns tend to be attenuated by the process of integration.[123]

The data in the newly-constructed 'Month' files includes a column ('K') holding the dividend category identifier (1 - 6). To this is added a new data column ('M') which places, on each record, a cell containing information as to the location (dividend yield category) of the *stock exactly one year previously* (where this datum exists for that time). The formula used to create the column is outlined below, (in the case of record #3):

[121] 'Validity' in this context implies the application of the same criteria for inclusion as for the regression study of Chapter 4.

[122] Although some data is available prior to 1958, it is convenient to choose the same 40-year period as for the regression study of Chapter 4.

[123] Nevertheless, a distinct non-random pattern remains, in terms of the month to month interval chosen versus the calendar year. This is addressed in detail below.

=IF(A3<>A2,0,IF(B3-B2<>1,0,K2))

Expressed in words, this formula states: "if the company number (Field 'A') is not equal to that of the previous record (as in the case of a new block of data for the next company record), then place the designator 'zero' in the cell[124]. Otherwise, proceed to check that the Field 'B' (Year) is contiguous. If not [indicating a break in the company's Returns record], again place a zero in the cell. If both of these tests are passed, load the cell with the previous year's dividend category identifier".

The effect of the above is to create records which embody both the source (previous) and destination (current) dividend categories for each stock over each (12-month) interval. The additional '0' category provides for year - year comparisons which are not possible due either to initialisation (the first dividend yield category in the existence of a stock cannot be compared with a predecessor), or due to non-continuous records.

The migration information contained in the source and destination fields is summarised by cross-tabulation; a matrix of 7 columns (including the '0' category) x 6 rows is formed, with individual cells containing the count of the number of migrations from a particular source to a particular destination. Thus the number of migrations along a particular path, e.g. from dividend yield category '6' (the Zero-Dividend category) to category '1' (the 'High' yield category) is indicated by the data at the intersection of the *column* headed '6' and the *row* headed '1'. Inclusion of the '0' category, which is not used further, serves to provide a 'checksum' on the total number of records scanned. In this way, transitions may be regarded as *entering* via columns, and *exiting* via rows, with a count being maintained at the intersection.

Table 5.1(a) shows the matrix as described, containing the raw numbers of transitions, together with row and column totals. Table 5.1(b) shows the data normalised to reflect a correspondence between the 593,338 valid records (excluding 62,432 records in the '0' category)[125], expressed as 100% in the 'Corner Total' cell.

[124] The first record in a new block will have a 'current' dividend category associated with it, but not a migration path from a 'previous' category. The latter is therefore assigned the designator 'zero'.

[125] Approximately 9.5% of samples are not associated with a prior migration path. This figure is consistent with the average company lifetime of 11¾ years, which would account for 8.5%, to which must be added a proportion to account for discontinuous returns records.

TABLE 5.1(a)	ALL Stocks							
Count of NRET	Mig_FROM							
D_Quintile	0	1	2	3	4	5	6	Grand Total
1	10667	52761	25888	10879	5726	5493	3883	115297
2	9811	25191	37887	25032	10178	5596	1979	115674
3	10160	11044	23264	35491	24679	9086	2027	115751
4	10415	6208	10196	23021	40772	22489	2615	115716
5	11834	6166	6502	8912	21351	56059	5704	116528
6	9545	4091	2599	2852	3513	7184	47020	76804
Grand Total	62432	105461	106336	106187	106219	105907	63228	655770
		52700	68449	70696	65447	49848	16208	

TABLE 5.1(b)								
Overall %	Mig_FROM							
Mig_TO	0	1	2	3	4	5	6	Grand Total
1	1.80	8.89	4.36	1.83	0.97	0.93	0.65	17.63
2	1.65	4.25	6.39	4.22	1.72	0.94	0.33	17.84
3	1.71	1.86	3.92	5.98	4.16	1.53	0.34	17.80
4	1.76	1.05	1.72	3.88	6.87	3.79	0.44	17.75
5	1.99	1.04	1.10	1.50	3.60	9.45	0.96	17.64
6	1.61	0.69	0.44	0.48	0.59	1.21	7.92	11.34
Grand Total	10.52	17.77	17.92	17.90	17.90	17.85	10.66	100.00

TABLE 5.1(c)			% of departures from groups (Columns)					
Count of NRET	Mig_FROM		(Expressed as % of its own group)					
Mig_TO	0	1	2	3	4	5	6	
1		50.03	24.35	10.25	5.39	5.19	6.14	
2		23.89	35.63	23.57	9.58	5.28	3.13	
3		10.47	21.88	33.42	23.23	8.58	3.21	
4		5.89	9.59	21.68	38.38	21.23	4.14	
5		5.85	6.11	8.39	20.10	52.93	9.02	
6		3.88	2.44	2.69	3.31	6.78	74.37	
		100.00	100.00	100.00	100.00	100.00	100.00	

TABLE 5.1(d)			% of arrivals into groups (Rows)					
Count of NRET	Mig_FROM		(Expressed as % of its own group)					
Mig_TO	0	1	2	3	4	5	6	
1		50.43	24.74	10.40	5.47	5.25	3.71	100.00
2		23.80	35.79	23.65	9.61	5.29	1.87	100.00
3		10.46	22.03	33.61	23.37	8.60	1.92	100.00
4		5.90	9.68	21.86	38.72	21.36	2.48	100.00
5		5.89	6.21	8.51	20.39	53.55	5.45	100.00
6		6.08	3.86	4.24	5.22	10.68	69.91	100.00

TABLE 5.1(e)		99% Confidence Intervals based on Table 1(c)					(+/- %)	
D_Quintile	0	1	2	3	4	5	6	Z(a/2)
1		0.396	0.339	0.240	0.178	0.175	0.246	2.575
2		0.338	0.378	0.335	0.233	0.177	0.178	
3		0.243	0.326	0.373	0.334	0.222	0.180	
4		0.187	0.233	0.326	0.384	0.324	0.204	
5		0.186	0.189	0.219	0.317	0.395	0.293	
6		0.153	0.122	0.128	0.141	0.199	0.447	

TABLE 5.1(f)		99% Confidence Intervals based on Table 1(d)					(+/- %)	
D_Quintile	0	1	2	3	4	5	6	
1		0.398	0.344	0.243	0.181	0.178	0.150	
2		0.337	0.379	0.336	0.233	0.177	0.107	
3		0.243	0.328	0.374	0.335	0.222	0.109	
4		0.187	0.235	0.328	0.387	0.325	0.123	
5		0.187	0.192	0.222	0.321	0.397	0.181	
6		0.237	0.191	0.200	0.221	0.307	0.455	

Tables 5.1(c) and 5.1(d) re-express the data as percentages of the column and row totals, respectively. This presentation assists the interpretation of the proportion of migrations *from* a given dividend yield category (table 5.1(c)), and *into* a given dividend yield category (table 5.1(d)). The need for this distinction arises for two reasons. Firstly, and most importantly, the table represents a transition process not yet in equilibrium (see discussion in section 5.4); the differences between the percentages in 5.1(d) vs. 5.1(c) largely arise out of the one-period differences along a (corrective) path toward equilibrium. This form of presentation also assists in handling the imbalance between the number of stocks (and therefore migration samples) in the Zero-Dividend-paying category, compared to the number of stocks in each of the other categories. (The latter are approximately balanced (one to another) by construction, since they represent fractile subdivisions of their class). Here, the Zero-Dividend-paying category comprises approximately 11% of the migration sample count, as compared to 17.8% for each of the (quintile) groups.

Secondly, there exists a further complication in that, uniquely for Zero-Dividend stocks, there is (over the full period) a net *positive* migration (i.e. an excess of *arrivals* over *departures*) into the Zero-Dividend category amounting to 4,031 samples. All *dividend-paying* categories experience negative net migrations, individually and collectively, the absolute total of which, of course, equals 4,031. The two effects combined account for the differing relative size of Zero-Dividend category *arrivals* (11.34%, Table 5.1(b) versus *departures* (10.66%), and in turn therefore, affects normalisations based upon these two values which appear in subsequent tables.

Tables 5.1(e) and 5.1(f) present confidence intervals (at 99%) corresponding to the (point estimate) percentages in corresponding cells of Tables 5.1(c) and 5.1(d), expressed in the same units (%). Thus they should be interpreted as +/- additions to the values presented in the tables 5.1(c) and 5.1(d). The calculation of these intervals is based upon the (large sample) normal approximation to the underlying binomial distribution which results from a proportion (p) of a sample of (n) observations *leaving* a given category (column) of Table 5.1(c), or, similarly, *arriving* in a given category (row) of Table 5.1(d). Proportions are obtained from the percentage values in the individual cells of 5.1(c) and 5.1(d), while the values of (n) are derived from the column totals of Table 5.1(a) (departing) or the row totals of Table 5.1(a) (arriving); in the latter case, these *exclude* the non-valid sample 'migrations' from column heading '0'.

The +/- intervals are computed as:

Population proportion (P) {lies in the range} Sample proportion (p) +/- :

$$Z_{\alpha/2} . \sqrt{(p(1-p)/n)}$$

Where $Z_{\alpha/2}$ is the critical value corresponding to $Prob(Z > Z_{\alpha/2}) = \alpha/2$, $\{100(1-\alpha)\% = 99\%\}$

$$= 2.575$$

5.3 Analysis of results (presented in Table 5.1 (a-f))

The principal diagonal of the 6x6 matrices (which tabulate valid migration paths) reflects data associated with non-transitioning samples. Among these, the Zero-Dividend category stands out as being the most 'isolated', since approximately ¾ of migration samples in this group indicate no movement out of the category. The next-ranked groups in this regard are the 'Low' and 'High' dividend yield categories, situated at the extremities of their class, where approximately one-half remain and one half migrate. The middle three yield groups are seen to be the more fluid, with just over one third remaining in place, the majority migrating. However, in all cases, the proportion of samples remaining 'in place' is greater than the proportion migrating to any one particular alternative category - as indeed would be expected.

The second significant observation is that, in all cases, the *second highest* proportion of samples indicate migration to their *next-highest* dividend yield category, excepting, of course, category 1, which is not dominated in this regard. The *third-highest* proportion of samples indicate migration to their *next-lowest* dividend yield category. Expressed alternately, it is the *adjacent* categories to which 'out of category' migration preferentially takes place. Again, this is what might reasonably be expected.

Turning attention now to the 'extreme' categories - Highest- and Zero-yield; how do these fit the pattern which is being suggested by the data? If the 'continuum' concept holds, they have only a single adjacent category, and the description above largely suffices. However, the alternative concept, that of 'Adjacency' between these extreme categories, is substantially supported by the (full-sample)[126] migration data as well as by the market capitalisation distribution (see table 4.3).

Considering the migration to and from the Zero-Dividend category; in both of these cases, the second-highest migrating proportion (i.e. excluding those remaining 'in category') are those which are associated with the highest yielding group. Thus 6.14% of samples leaving the Zero-Dividend group are destined for the high-yield category; and 6.08% of samples arriving in the Zero-Dividend group are from the high-yield category. As a proportion of the 'movers', these represent almost one quarter, in each case.

Viewed from the perspective of the High-Dividend category, there would appear to be a monotonic relationship between the migrating proportions (both arriving and leaving) and the linear 'distance' between the categories, along the supposed continuum. However, it should be stressed that the normalisations which give rise to these proportions do not take account of the smaller size of the Zero-Dividend group relative to each of the individual quintiles. For this reason, the evidence presented in the previous paragraph is considered to be the stronger, in terms of the probability (relative frequency) of events occurring in relation to the Zero-Dividend category.

5.4 Expanding versus Contracting companies

The above form of analysis lends itself to the examination of a further dimension to the investigation. The 'valid' samples may be subdivided into two classes, namely those which exhibit strictly positive year-on-year size (i.e. market capitalisation) increases (Expanding companies) versus those which demonstrate either decreasing, or no change in (nominal) size ('Contracting' companies).

A simple extension to the methodology described above suffices to implement this supplementary investigation. Two additional columns are generated alongside the originally added column ('M' - see above) in the 'Month' files. The formulae for these are as follows:

1) 'Expanding' stocks: =IF(M3=0,0,IF(L3>L2,M3,0))

The logic here is that if the 'M' field of the record was previously invalid ('0'), then it remains so. If the Market Capitalisation (Field 'L') indicates year-on-year expansion, then the category data in field 'M' is copied; otherwise '0' is inserted into the field.

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[126] This conclusion is weaker for more recent data - see section 5.4.

TABLE 5.2(a)	Expanding Stocks							
Count of NRET	Mig_FROM							
D_Quintile	0	1	2	3	4	5	6	Grand Total
1	40633	36360	18704	8164	4355	4178	2903	115297
2	46976	15352	24537	16733	6853	3843	1380	115674
3	50600	5770	13962	22599	15604	5892	1324	115751
4	53159	2969	5237	13488	25206	13843	1814	115716
5	59987	2762	2897	4230	11339	31854	3459	116528
6	42161	1592	993	1150	1382	2962	26564	76804
Grand Total	293516	64805	66330	66364	64739	62572	37444	655770
		28445	41793	43765	39533	30718	10880	
TABLE 5.2(b)								
Overall %	Mig_FROM							
Mig_TO	0	1	2	3	4	5	6	Grand Total
1	11.22	10.04	5.16	2.25	1.20	1.15	0.80	20.61
2	12.97	4.24	6.77	4.62	1.89	1.06	0.38	18.96
3	13.97	1.59	3.85	6.24	4.31	1.63	0.37	17.98
4	14.67	0.82	1.45	3.72	6.96	3.82	0.50	17.27
5	16.56	0.76	0.80	1.17	3.13	8.79	0.95	15.61
6	11.64	0.44	0.27	0.32	0.38	0.82	7.33	9.56
Grand Total	49.47	17.89	18.31	18.32	17.87	17.27	10.34	100.00
TABLE 5.2(c)			% of departures from groups (Columns)					
Count of NRET	Mig_FROM		(Expressed as % of its own group)					
Mig_TO	0	1	2	3	4	5	6	
1		56.11	28.20	12.30	6.73	6.68	7.75	
2		23.69	36.99	25.21	10.59	6.14	3.69	
3		8.90	21.05	34.05	24.10	9.42	3.54	
4		4.58	7.90	20.32	38.93	22.12	4.84	
5		4.26	4.37	6.37	17.51	50.91	9.24	
6		2.46	1.50	1.73	2.13	4.73	70.94	
		100.00	100.00	100.00	100.00	100.00	100.00	
TABLE 5.2(d)			% of arrivals into groups (Rows)					
Count of NRET	Mig_FROM		(Expressed as % of its own group)					
Mig_TO	0	1	2	3	4	5	6	
1		48.70	25.05	10.93	5.83	5.60	3.89	100.00
2		22.35	35.72	24.36	9.98	5.59	2.01	100.00
3		8.86	21.43	34.69	23.95	9.04	2.03	100.00
4		4.75	8.37	21.56	40.29	22.13	2.90	100.00
5		4.88	5.12	7.48	20.05	56.34	6.12	100.00
6		4.60	2.87	3.32	3.99	8.55	76.68	100.00
TABLE 5.2(e)		99% Confidence Intervals based on Table 2(c)					(+/- %)	
D_Quintile	0	1	2	3	4	5	6	Z(a/2)
1		0.502	0.450	0.328	0.254	0.257	0.356	2.575
2		0.430	0.483	0.434	0.311	0.247	0.251	
3		0.288	0.408	0.474	0.433	0.301	0.246	
4		0.211	0.270	0.402	0.493	0.427	0.286	
5		0.204	0.204	0.244	0.385	0.515	0.385	
6		0.157	0.121	0.130	0.146	0.219	0.604	
TABLE 5.2(f)		99% Confidence Intervals based on Table 2(d)					(+/- %)	
D_Quintile	0	1	2	3	4	5	6	
1		0.471	0.408	0.294	0.221	0.217	0.182	
2		0.409	0.471	0.422	0.294	0.226	0.138	
3		0.287	0.414	0.480	0.431	0.289	0.142	
4		0.219	0.285	0.423	0.505	0.427	0.173	
5		0.233	0.239	0.285	0.434	0.537	0.260	
6		0.290	0.231	0.248	0.271	0.387	0.585	

TABLE 5.3(a)	Contracting Stocks							
Count of NRET	Mig_FROM							
D_Quintile	0	1	2	3	4	5	6	Grand Total
1	85331	16401	7184	2715	1371	1315	980	115297
2	78509	9839	13350	8299	3325	1753	599	115674
3	75311	5274	9302	12892	9075	3194	703	115751
4	72972	3239	4959	9533	15566	8646	801	115716
5	68375	3404	3605	4682	10012	24205	2245	116528
6	44188	2499	1606	1702	2131	4222	20456	76804
Grand Total	424686	40656	40006	39823	41480	43335	25784	655770

TABLE 5.3(b)								
Overall %	Mig_FROM							
Mig_TO	0	1	2	3	4	5	6	Grand Total
1	36.93	7.10	3.11	1.17	0.59	0.57	0.42	12.97
2	33.97	4.26	5.78	3.59	1.44	0.76	0.26	16.08
3	32.59	2.28	4.03	5.58	3.93	1.38	0.30	17.50
4	31.58	1.40	2.15	4.13	6.74	3.74	0.35	18.50
5	29.59	1.47	1.56	2.03	4.33	10.47	0.97	20.84
6	19.12	1.08	0.69	0.74	0.92	1.83	8.85	14.11
Grand Total	71.58	17.59	17.31	17.23	17.95	18.75	11.16	100.00

TABLE 5.3(c)			% of departures from groups (Columns)					
Count of NRET	Mig_FROM		(Expressed as % of its own group)					
Mig_TO	0	1	2	3	4	5	6	
1		40.34	17.96	6.82	3.31	3.03	3.80	
2		24.20	33.37	20.84	8.02	4.05	2.32	
3		12.97	23.25	32.37	21.88	7.37	2.73	
4		7.97	12.40	23.94	37.53	19.95	3.11	
5		8.37	9.01	11.76	24.14	55.86	8.71	
6		6.15	4.01	4.27	5.14	9.74	79.34	
		100.00	100.00	100.00	100.00	100.00	100.00	

TABLE 5.3(d)			% of arrivals into groups (Rows)					
Count of NRET	Mig_FROM		(Expressed as % of its own group)					
Mig_TO	0	1	2	3	4	5	6	
1		54.73	23.97	9.06	4.58	4.39	3.27	100.00
2		26.47	35.92	22.33	8.95	4.72	1.61	100.00
3		13.04	23.00	31.88	22.44	7.90	1.74	100.00
4		7.58	11.60	22.30	36.42	20.23	1.87	100.00
5		7.07	7.49	9.72	20.79	50.27	4.66	100.00
6		7.66	4.92	5.22	6.53	12.94	62.72	100.00

TABLE 5.3(e)		99% Confidence Intervals based on Table 3(c)					(+/- %)	
D_Quintile	0	1	2	3	4	5	6	Z(a/2)
1		0.627	0.494	0.325	0.226	0.212	0.307	2.575
2		0.547	0.607	0.524	0.343	0.244	0.242	
3		0.429	0.544	0.604	0.523	0.323	0.261	
4		0.346	0.424	0.551	0.612	0.494	0.278	
5		0.354	0.369	0.416	0.541	0.614	0.452	
6		0.307	0.253	0.261	0.279	0.367	0.649	

TABLE 5.3(f)		99% Confidence Intervals based on Table 3(d)					(+/- %)	
D_Quintile	0	1	2	3	4	5	6	
1		0.469	0.402	0.271	0.197	0.193	0.168	
2		0.433	0.471	0.409	0.280	0.208	0.124	
3		0.340	0.425	0.470	0.421	0.272	0.132	
4		0.272	0.330	0.429	0.495	0.414	0.140	
5		0.278	0.285	0.321	0.439	0.541	0.228	
6		0.368	0.299	0.308	0.342	0.464	0.669	

2) 'Contracting' stocks: =IF(M3=0,0,IF(L3<=L2,M3,0))

The above logic differs only in terms of the inequality; thus the treatment of 'invalid' data is identical in that '0' entries are transferred as above; however, the treatment of 'valid' data is, by contrast, the *complement* of that in the above case. Therefore, 'Contracting' samples' category data is transferred.

From this point, the treatment of the data is similar to that of the earlier investigation; the effect of these latter manipulations is to channel the 'unwanted' data (i.e. 'Contracting' samples in (1), 'Expanding' samples in (2)) into the 'invalid' group. Tables 5.2 (a-f) show summary data for the 'Expanding' set, Table 5.3 (a-f) show that for the 'Contracting' set.

5.4.1. Analysis of 'Expanding' and 'Contracting' data.

Before discussing the direct comparisons between corresponding parameters *within* the three sets of tables, it is useful to examine an additional parameter which describes a relationship which exists *between* the tables. This concerns the percentages of 'Expanding' (valid) samples (in each category) relative to 'All' (valid) samples. Here, an interesting finding emerges. There is indeed a monotonic relationship between the Dividend Yield category and the percentage of 'Expanding' samples. This remains the case, moreover, even when Zero-Dividend samples are included. This is expressed in Table (5.4) below:

Table 5.4: Percentage of 'Expanding' samples

D_Quintile		% Expanding
(High)	1	71.36
	2	64.89
	3	61.70
	4	59.41
(Low)	5	54.01
(Zero)	6	51.51
Overall		61.05

The implications of this table are interesting. While the characteristic of increasing Returns with increasing Dividend Yield may be partially explained by the increasing proportion of

'Expanding' stocks[127], the implication for the high Returns of Zero-Dividend stocks (determined in the analysis of Chapter 4)[128], given the fact that these comprise only 51.5% of 'Expanders', is that the latter subdivision deliver *exceptional* Returns performance. This is so since they must compensate for an almost equal number of 'Contracting' samples before contributing to the positive Returns performance of their category. For investors, the value of a 'reliable' measure capable of identifying 'Expanding' stocks is clear.

Returning to the comparison within the three tables, the overall findings are similar to the case of 'All' (valid) samples, in that the migration patterns are ranked 1) to remain in place, 2) to migrate to the adjacent category with higher dividend yield; and 3) to migrate to the adjacent category with lower dividend yield. The main differential finding to emerge is seen most markedly in relation to the migration from Zero-Dividend category 6 to high-yield category 1, which is now more pronounced, at 7.75% (vs. 6.14%), and from 1 to 6, at 4.60% (vs. 6.08%). (N.B. both sets of figures are expressed in relation to the column / row totals for category 6, as before).

The above result is to be expected among 'Expanding' samples; more expanding companies will initiate dividend payments, many of which will therefore migrate from 6 to 1. Fewer will cease dividend payments, moving from 1 to 6. Nevertheless, the concept of 'Adjacency', developed in the last section, continues to apply; as evidenced by the figures presented here.

Finally, Table 5.3 ('Contracting' samples) is considered. The equivalent percentages to those presented in Table 5.2 are not shown; trivially, they are represented as (100-a) %, where a % is the corresponding value in Table 5.2. For all categories excepting 5 (Lowest dividend-paying quintile), the rankings 2) and 3) (above) are reversed, such that the most frequent tendency among declining 'migrators' is to move to the adjacent category with *lower* dividend yield[129].

As to the Zero-Dividend category, there are fewer 'departures' (20.66%), and more 'arrivals' (37.28%). Again, however, the hypothesis of 'Adjacency' to the high-yield category is

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[127] Among Dividend Paying stocks, it is possible for 'Contracting' cases to deliver positive returns if the Dividend component over-compensates for the Capital loss. It is also the case that (for all stocks) the simple Market Capitalisation measure implies that a minority of samples are influenced by capital changes as well as by returns.

[128] See Section 4.4.

[129] For this to be the case, mathematically, the proportional reduction in the dividend payment must be greater than any reduction in share price brought about by the contraction (on average).

supported; whilst migration from 6 to 1 is reduced to 3.80% (vs. 6.14%) and that from 1 to 6 increased to 7.66% (vs. 6.08%), these values remain the second highest among 'movers', after category 5 (Low yield).

5.5 Long-Run Equilibrium and Speed of Adjustment

5.5.1. The Transition matrix as a Markov Process

The table 5.1(c) represents historical data over the 40-year period, expressed in terms of the relative frequencies of transition of stocks between categories in a 12-month period. The following section addresses the question of the future patterns of migration, based upon the assumption that the relative frequencies (m) may provide an estimate of transition probabilities in the future. Before proceeding in this direction, however, it is prudent to verify the extent to which the relative frequencies over the entire sample period are sufficiently stable to be taken as reliable estimates of current probabilities.

In order to motivate this particular line of inquiry, a time dimension is appended to the data represented in table 5.1(c), to allow the consideration of temporal variation. The number of transitions in each calendar year (from 1959 - 1997) along each transition path involving the Zero-Dividend category is computed, and plotted as Figure 5.2.

From this, it is apparent that an assumption of stationarity prior to 1981 would be difficult to justify; the transition path directly from the Zero-Dividend category to the High-Dividend category, in particular, is volatile in the first decade, and shows a consistent downward trend in the second decade.[130] Only after the second oil price shock of 1979[131] does the characteristic settle sufficiently for reasonable estimates to be made.

As a consequence of the above, the assumption is made that the best estimate of future probabilities derives from the 17-year period 1981-1997, following the 'regime shift' implied by the second oil price shock. The transition matrix is re-computed, restricted to this period.

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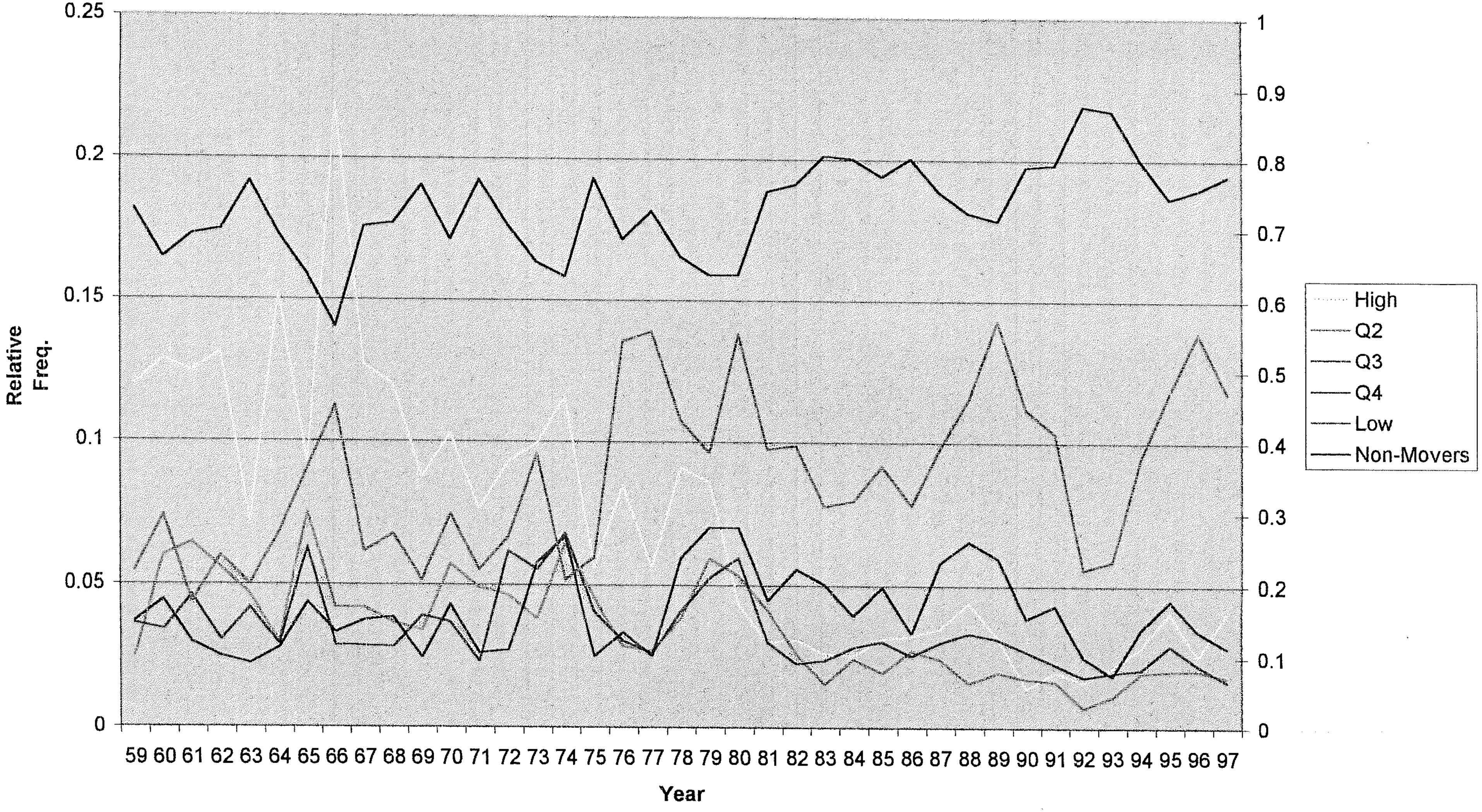
[130] There is a significant transient occurring shortly after the 1965 imposition of Capital Gains Tax in the UK, which is discussed more fully later.

[131] This particular 'time marker' also post-dates the two large step increases in the number of companies in the database (Chapter 4, Section 4.8), which have the effect of re-defining the constitution of the database to its 'current' composition.

Figure 5.2 - Proportions leaving the Zero Dividend category



In this form, the table constitutes a Markov matrix, i.e. a system of equations defining a Markov Process:

$$\begin{Bmatrix} x^1_{t+1} \\ . \\ . \\ x^6_{t+1} \end{Bmatrix} = \begin{Bmatrix} m_{11} \ldots\ldots\ldots m_{1k} \\ \ldots\ldots\ldots \\ \ldots\ldots\ldots \\ m_{61} \ldots\ldots\ldots m_{66} \end{Bmatrix} \begin{Bmatrix} x^1_t \\ \\ \\ x^6_t \end{Bmatrix}$$

i.e. $\mathbf{x}_{t+1} = \mathbf{M}\,\mathbf{x}_t$

Where $\mathbf{x}_{t+1}$ is a (6x1) vector defining the population states of the six yield categories at time (t+1), as a function of the equivalent vector $\mathbf{x}_t$ for time (t) and the Markov matrix (**M**).

As the process continues into a second period (year), the following equation applies:

$$\mathbf{x}_{t+2} = \mathbf{M}\,\mathbf{x}_{t+1} = \mathbf{M.M}\,\mathbf{x}_t \quad \text{i.e. } \mathbf{M}^2\,\mathbf{x}_t$$

and, in general, over n periods, $\mathbf{x}_{t+n} = \mathbf{M}^n\,\mathbf{x}$

In order to ascertain the long-run equilibrium state brought about by the current transition probabilities (as expressed by **M**), we require to examine the state as $n \to \infty$. This is facilitated by factoring **M** , using the non-singular transformation matrix **P** to create a diagonal matrix **D**, using the relation:

$$\mathbf{M} = \mathbf{PDP}^{-1}, \qquad (\text{whence } \mathbf{D} = \mathbf{P}^{-1}\mathbf{MP})$$

Here, the factorisation is such that the matrix **P** is a matrix formed from the *eigenvectors* of **M**, and **D** is the diagonal matrix of *eigenvalues* of **M**.

Also, $\mathbf{M}^n = \mathbf{PD}^n\mathbf{P}^{-1}$

The elements of D^n are such that they are formed directly by raising each of the individual (diagonal) elements of D to the n^{th} power. Since it is a property of a Markov matrix that its largest eigenvalue is unity **(Simon and Blume (1994), pp. 581)**, the structure of D^n is such that it retains the unit eigenvalue, but its remaining eigenvalues tend to zero as n tends to infinity.

The long-run proportions associated with each of the six categories may be determined by examination of the eigenvector associated with the unit eigenvalue. The former is determined up to a scale factor; since the proportions inherently sum to unity, scaling may be performed to accord to this restriction. As an alternative, the matrix multiplication $\mathbf{PD^nP^{-1}}$ may be evaluated (for $n = \infty$), whereupon any of the (identical) columns provides the solution. Table 5.5 (below) summarises the computations.

Table 5.5 Computed and Modelled Time Traces of Migration

Number of Years	Computed value m_{66}	Modelled value m_{66}	Error (%)
0	1.00000*	1.00000*	
1	0.78671*	0.78671*	
2	0.63164	0.62820	-0.55
3	0.51737	0.51040	-1.37
4	0.43238	0.42286	-2.26
5	0.36872	0.35780	-3.05
6	0.32080	0.30945	-3.67
7	0.28460	0.27351	-4.05
8	0.25716	0.24681	-4.19
9	0.23633	0.22696	-4.13
10	0.22049	0.21222	-3.90
Long Run	0.16954*	0.16954*	

* These values are equal by construction - see below.

* 'One period later' percentage distributions at time t_1 are taken from the row totals of Table 5.1(c); however, they check precisely when calculated as: $\mathbf{x}_{t+1} = \mathbf{M}\,\mathbf{x}_t$, where $\mathbf{x}_t$ is % distributions at time t_0

5.5.2 The Dynamics of the Process

Table 5.5 provides an introduction to the dynamics of the process in that it displays proportions of the aggregated sample in the various categories initially, one year later, and finally, projected toward the long run. The more detailed analysis that follows seeks to quantify the speed of adjustment of the process toward that long run. It does so by measuring the time trajectory of the cell 'm_{66}' in the Markov Matrix **M**, which exhibits the widest dynamic range and which relates specifically to the category of primary interest in this context, namely the Zero-Dividend Category. Table 5.5 (Column B) lists the values of this quantity as computed by evaluating $\mathbf{M}^n = \mathbf{P}\mathbf{D}^n\mathbf{P}^{-1}$ for a range of values of (**n**). Column (C) models the trajectory with an exponential function (see below), and column (D) displays the (%) error expressed as 1- (Computed / Modelled).

Table 5.6 Average percentage distribution among yield categories with time.
(across 17-year sample)

Dividend Yield Cat.	Avg. % @ Time t_0	Avg. % @ Time t_1^*	Long Run (%)
1 (High Dividend)	17.45	17.32	16.60
2	17.62	17.51	16.71
3	17.47	17.30	16.52
4	17.50	17.17	16.50
5 (Low Dividend)	17.29	16.95	16.72
6 (Zero-Dividend)	12.68	13.76	16.95

5.5.2.1 Model Design

The functional form of the required model was expected to be exponential in nature, given the nature of the process by which the computed values (Column B) were generated. This was verified by evaluation of the following function relating successive computed values:

$$a = \mathrm{Ln}((x_{t+2} - x_{t+1}) / (x_{t+1} - x_t)) \qquad t = 0,1,\ldots..,8.$$

The value of (a) was found to be substantially constant at a mean value of -0.289, which confirmed the expectation of an exponential function with an exponent coefficient of this magnitude. Rather than arranging for a 'best fit' based on this value, the coefficient was chosen to drive the fitted exponential curve through the (measured) co-ordinate (1, 0.7867), the implied co-ordinate (0, 1) and the computed long-run co-ordinate (LR, 0.1695). This resulted in an exponent value of -0.297, which was accepted as definitive, based as it was on the chosen co-ordinates, and producing acceptably small errors, albeit all negative (Column D).

The model equation was derived as follows:

$$e^a = (0.7876 - 0.1695) / (1 - 0.1695) \quad \Rightarrow \quad a = -0.297$$

from which: $f(t) = e^{-0.297t}(1 - 0.1695) + 0.1695$, the equation of the model generating the values of Column (C).

5.5.2.2 Interpretation of the exponent

The exponent (at) is dimensionless, implying that the multiplier (a) has the dimensions of T^{-1} (inverse Time). Taking the (negated) reciprocal of (a) as T = 3.37, this is interpreted as the exponential time constant (expressed in years) required for the process to complete 63% ($1 - e^{-1} = 0.63$) of its transition from any arbitrary point along its trajectory toward the long-run asymptote. This parameter therefore summarises the speed of adjustment towards the long-run equilibrium.

5.6 Extending the analysis to include the 'Time' dimension

The above analysis has largely treated the migration data as being 'time homogeneous'[132], in the sense that the samples have been hitherto considered without regard to their temporal ordering. The next part of the analysis will utilise this information in order to study the way in which the pattern of migration varies with time. Of primary interest in this context is the relationship between the Zero-Dividend and Dividend-Paying categories. Figure 5.2 shows the proportions of stocks *leaving* the Zero-Dividend category, as a function of both time[133] and of destination category (L/h scale), and the proportion of non-migrating stocks (R/h scale). Figure 5.3 shows the analogous information for stocks *arriving* in the Zero-Dividend category. Figures 5.4 and 5.5 show the *monthly* migration patterns between the Zero- and High dividend categories (Zero to high, and high to zero respectively), expressed as percentages of the whole (valid) sample. Figure 5.6 indicates the net (difference) migration between the same two categories, on the same basis.

Inspection of the Figures leads to the following observations; after the 1981 'regime shift', the proportion of stocks leaving the Zero-Dividend category in favour of the HD category is not dissimilar to the migration from the Zero-Dividend category to the 'middle' categories (3) and (4). Only the migration to the low yield category dominates. The same conclusion is true of the 'arriving' stocks (Figure 5.3); however, the volatility of the 'arriving' stocks pattern is clearly higher, and may be seen to follow the pattern of the business cycle, with local maxima coinciding with the recessions of 1981/2 and 1991/2. The net migration characteristic (Figure 5.6) indicates a positive mean migration of 0.107% from the HD to the Zero-Dividend

[132] Excepting for the subdivision of the period into an earlier and a later sub-period, for the purposes of the estimation of migration probabilities.

[133] Data is aggregated by calendar year.

Figure 5.3 - Proportions arriving in the Zero Dividend category

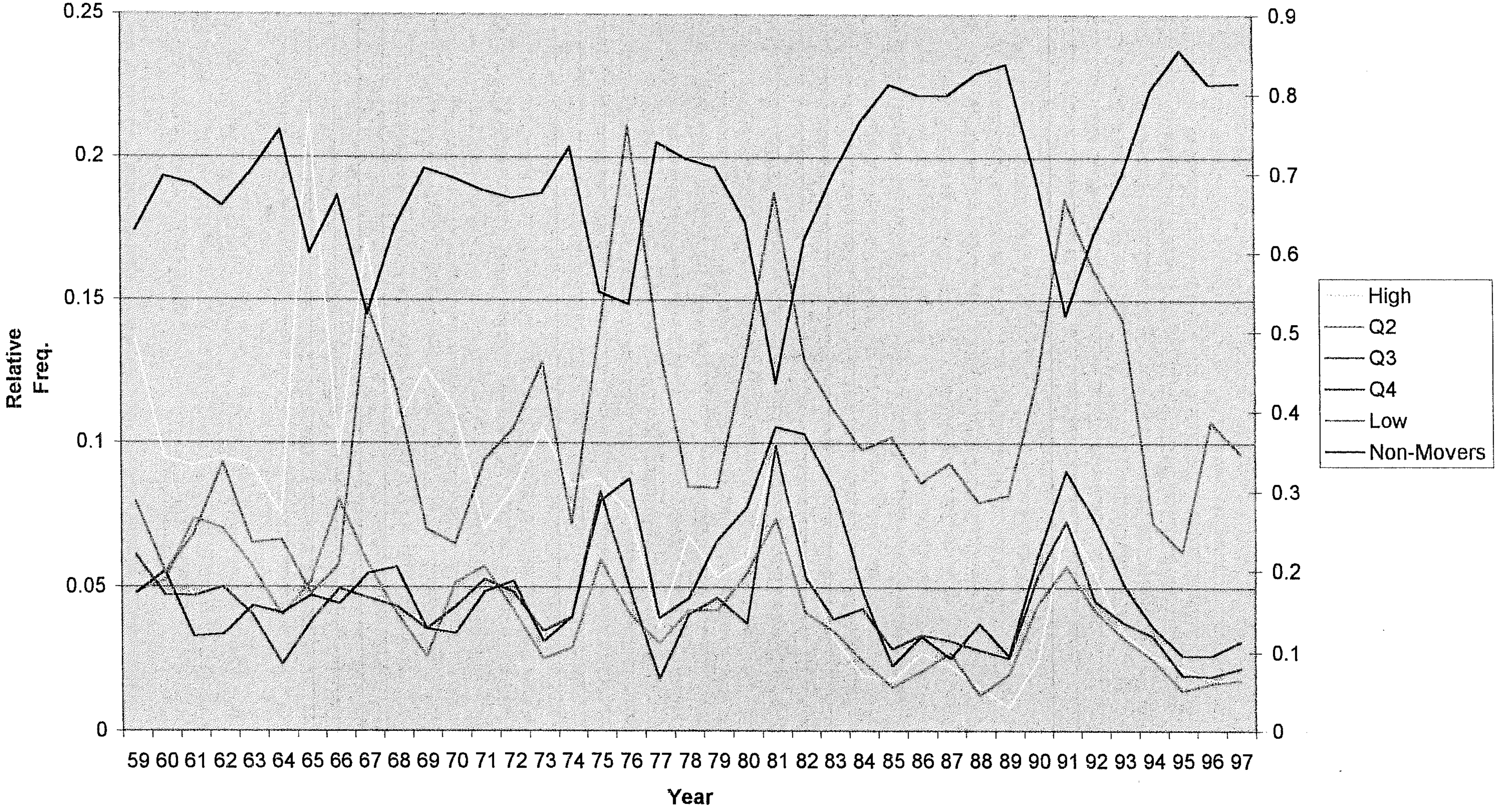


Figure 5.4 - Monthly Migration: Zero-Dividend -> High-Dividend categories (1959-1997)

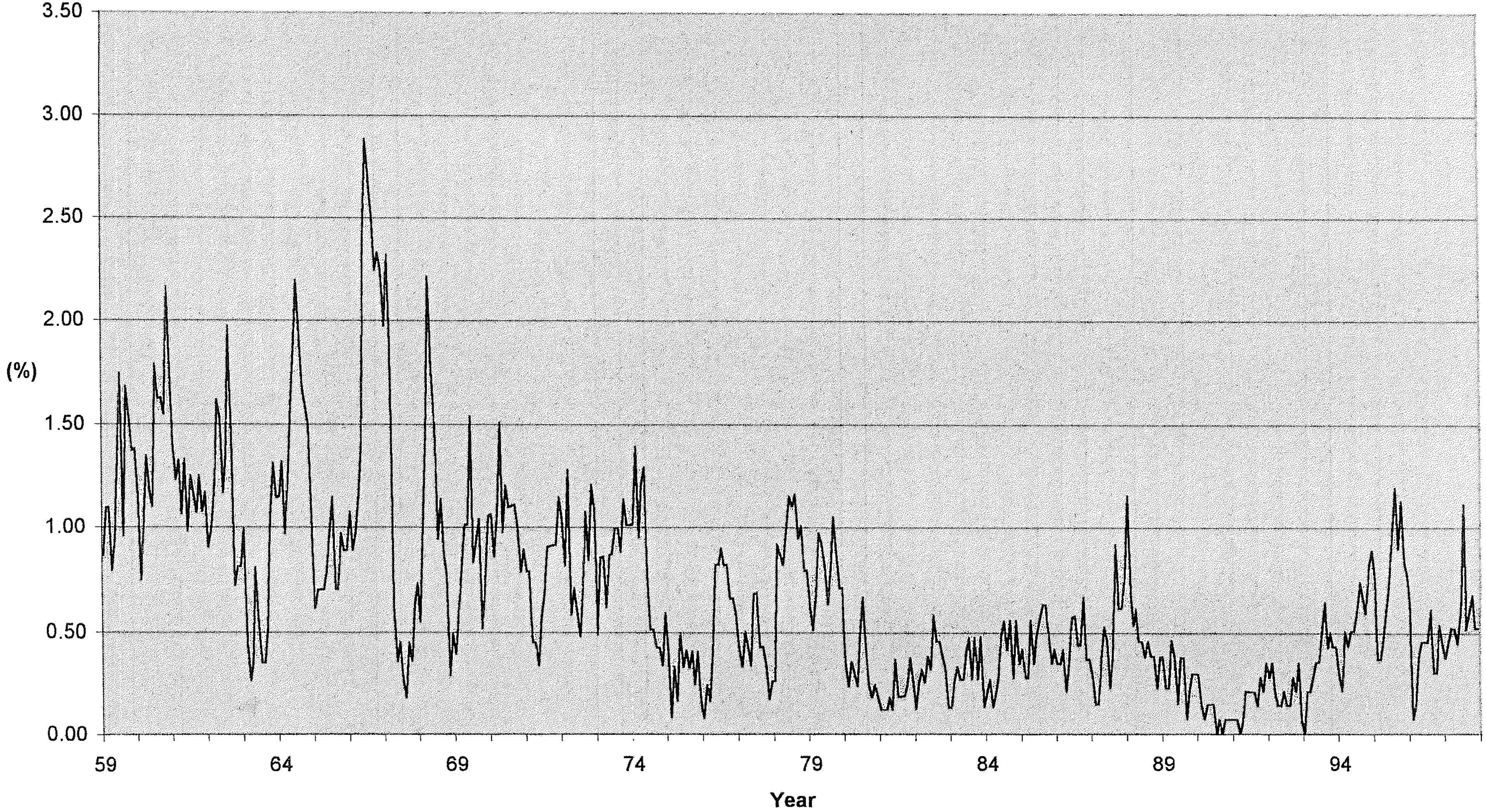


Figure 5.5 - Monthly Migration: High-Dividend -> Zero-Dividend categories (1959-1997)

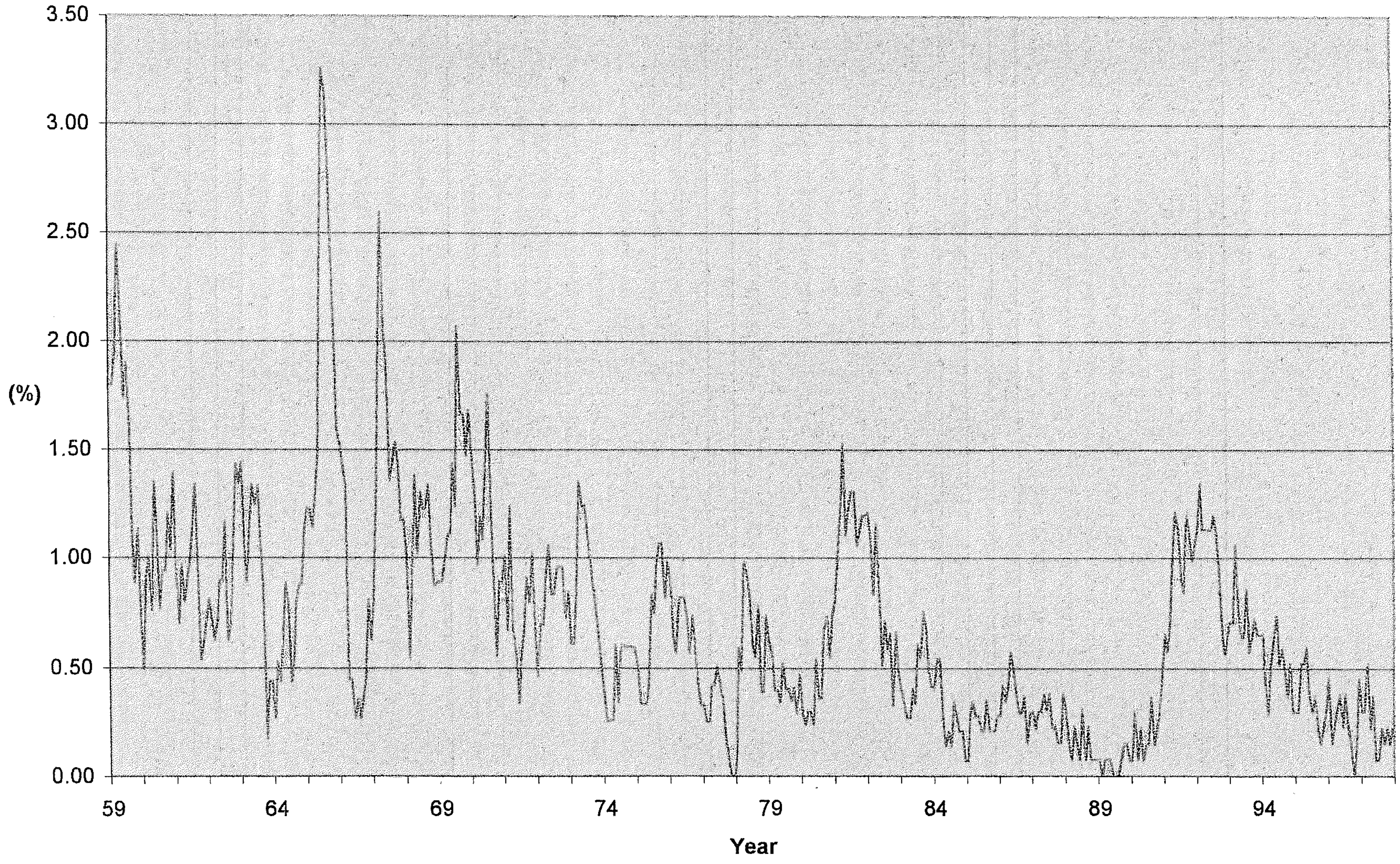
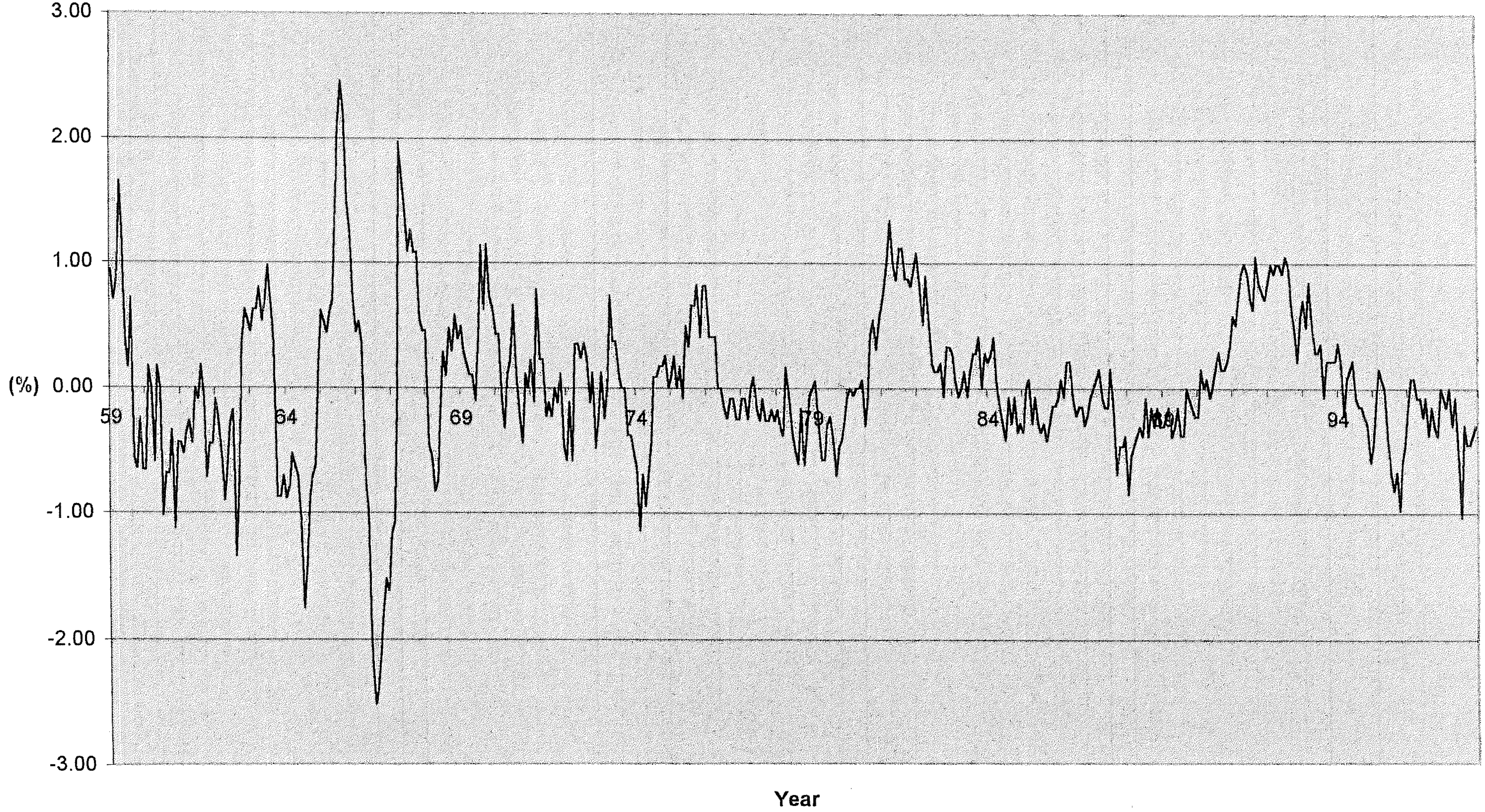


Figure 5.6 - Net Monthly Direct Migration between High-Dividend and Zero-Dividend Categories (1959-1997)



category over the period Jan. 1981 to Dec.1997. In effect, the stocks captured by the Zero-Dividend category during periods of recession were not fully relinquished in periods of economic 'boom'.

The close linkage of stock characteristics to the economic cycle also manifests itself in terms of the ratio of Expanding stocks[134] to all stocks, over time (Figure 5.7). Clearly, this parameter is bounded (by construction) in the range $0<\eta<1$; empirically, it traverses this range almost fully, with a maximum of 0.979 (August, 1987) and minimum 0.0239 (October 1974). Figure 5.7 also constructs a total Returns index (Dec.1958 = 1) and compares this with the index resulting from a naïve, perfect-foresight trading rule which switches between the stock index and treasury bills:

```
=IF(S15=0,T14*(1+M15/100)^(1/12),T14*(1+L15/100))
```

In words, if bonds are held (S=0), then factor the previous month's index by the growth (over the month) of T-bills; otherwise, factor by the growth of the stock index. The investment state (S= 0 or 1, bonds or stocks) is determined by the switching rule:

```
=IF(S14=0,IF((G15>$R$9),0,1),IF((G15<$S$9),1,0))
```

If bonds are currently held, check the ratio (η) against the *lower* threshold; if above, stay in bonds, otherwise switch to stocks. If stocks are held, check the ratio (η) against the *upper* threshold; if below, stay in stocks, otherwise switch to bonds.

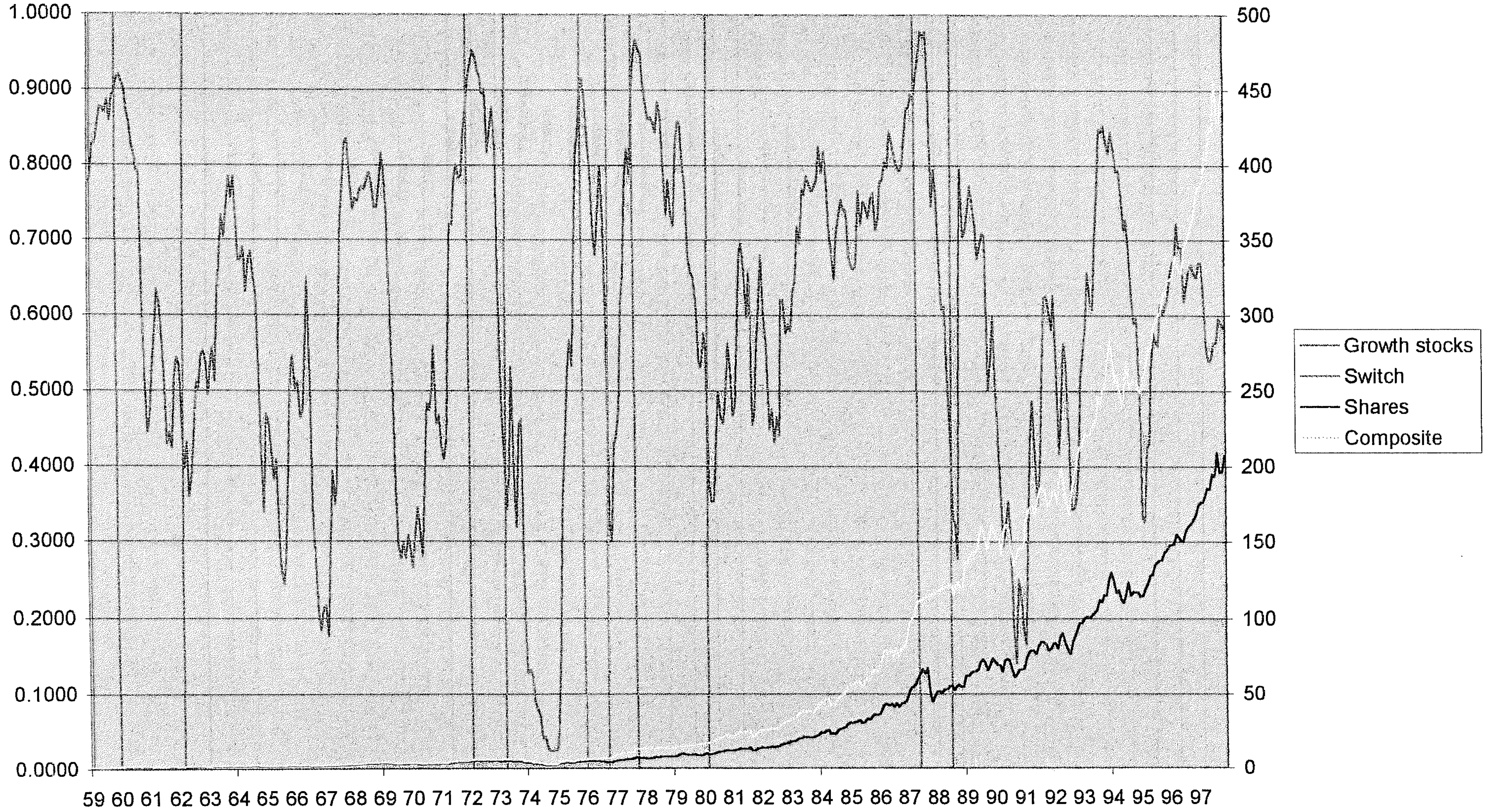
Optimum values for the switching thresholds were determined by grid search to be (0.4,0.9), resulting in a factor 2.19 increase in the index from 207 to 453.

5.7 Summary of Chapter 5

Based on the full sample of data, it is possible to conclude that the concept of the 'U - shaped' relationship between Returns and dividend yield may be based upon an over-simplified view of the true relationship between Zero-Dividend and Dividend paying stocks. The full - sample migration evidence presented above, taken together with the market capitalisation distribution evidence of Chapter 4, would suggest that a more apposite model might be a

[134] Defined in terms of stocks exhibiting strictly positive year on year increase in Market Capitalisation.

Figure 5.7 - Ratio of (Year - on -Year) Growth stocks to all stocks (1959-1997)



circular, rather than a linear one. This would continue to place categories in an ordered fashion, but with categories 1 and 6 adjacent, much as the figures on a clock face place 12 and 1 adjacent.

Such a model would reflect the degree of qualitative similarity between members of the two - formerly regarded as 'extreme' - categories; both in terms of their general size characteristics and in terms of the way in which changes in their evolution with time give rise to a significant proportion of direct inter-migration of their constituents (in either direction).

In the light of the evidence as presented, it is possible to conjecture as to the mechanisms which stimulate migration between these two categories, taking account of the influences also of Expansion and Contraction. Given the generally smaller size of the companies in these two groups, it would seem probable that, in the case of Expanding companies, they reach a point in their evolution whereby maturing product life cycles produce an excess of revenue over and above that required for investment. This provides the opportunity to pay dividends; payment of a relatively high dividend may attract the attention of investors in the market, and pave the way for future continued expansion.

In contrast, declining firms may elect to maintain dividends even in the face of financial distress, in order to avoid the 'stigma' associated with cutting dividends. As the share price falls, in the face of such distress, the yield will rise; thereby assuring their place, eventually, in the high yield category. There will inevitably come a time, in many instances, when this policy simply cannot be maintained, due to lack of earnings capacity. The fall into the Zero-Dividend category is then equally assured. Nevertheless, in some instances, the removal of the drain on resources caused by the perceived obligation to continue dividends may initiate a recovery; should this happen, and dividends be resumed, a low share price would militate toward a high yield - the cycle potentially repeats.

The analysis of the transition matrix indicates that the proportion of Zero-Dividend stocks among the universe of all UK quoted stocks is increasing in such a way as to gravitate toward a state in which over one in six stocks (at any one time) will pay no dividend (assuming no change in the migrating proportions within the transition matrix). This represents an increase of approximately one-quarter in that proportion. Moreover, the dynamics of this process are such that an exponential process with a time constant of approximately three years describes the speed of adjustment.

6.0 Returns on Zero-Dividend Stocks: The influence of Payment History and Market Capitalisation Changes.

6.1. Introduction

Previous chapters have examined Stock Return Behaviour in the context of firms with all possible Dividend-Paying characteristics, albeit having invoked a special category status for Zero-Dividend stocks, and having drawn attention to the latter's differential performance within the wider context of all stocks (cf. also Christie (1990)). The present chapter draws heavily from the (mutually) very different perspectives of the issues presented in Chapters 4 and 5, and also from a recent influential paper (Fama and French (2001), hereafter FF(2001), discussed in Chapter 2 (Section 2.1.9). These influences have prompted further ways of viewing Zero-Dividend stocks, and, in particular, establishing whether these alternative perspectives present any useful new ways of examining the Returns behaviour of this unique category of stocks. This consideration then defines the theme and becomes the primary aim of the current chapter.

FF(2001) subdivide the universe of stocks into (Dividend) 'Payers', 'Former Payers' and 'Never' Payers, for the purposes of examining their differential characteristics and with a view to determining trends in the investor reward process referred to above. This chapter utilises the mutually exclusive distinction (in the context of Zero-Dividend stocks) between 'Former' and 'Never' payers, in order to determine whether Returns behaviour is in any way influenced by this novel classification. This subdivision also relates to the conjecture, noted earlier, as to (possibly) differing characteristics between prosperous firms which refrain from the practice of dividend payment in order to harness financial resources for internal investment; versus 'distressed' firms which suffer, quite simply, from an inability to pay dividends. It seems plausible that a significant proportion of firms in the 'Never' category fit the former description, and that a significant proportion of firms in the 'Former' category fit the latter. If this is so, then there may be grounds for believing that these distinctions may have a bearing upon Returns performance. Alternatively, an 'Efficient Markets' perspective may hold that, once risk is corrected for, then the pricing of stocks in the different categories will militate toward a situation of no such difference (in Returns performance). This leads to the formation of the hypothesis (6a) that: *the classification status (Former / Never) influences Returns behaviour.*

In Chapter 5, the analysis revealed a second important potential sub-classification which distinguished between the stocks of firms which were 'Expanding', in the sense of whose year-on-year Market Capitalisation revealed an increase, versus 'Contracting' firms whose capitalisation was in process of decreasing (or, in the limit, remaining static). This was seen to be particularly important in the category of Zero-Dividend stocks, where there existed the smallest ratio of 'Expanding' stocks to all stocks, yet at the same time this (Zero-Dividend) class was exhibiting the most striking Returns performance. This apparent contradiction led to the conclusion (Chapter 5) that the contribution (to Returns performance) of the 'Expanding' stocks must be exceptional. Of course, the same caveat in relation to 'Efficient Markets' as stated in the previous paragraph must apply. Nevertheless, the formation of hypothesis (6b) follows: *the classification status (Expanding Stocks / Contracting Stocks) influences Returns behaviour.*

In the study to be outlined below, the above distinctions are combined with Market (covariance) Risk, Firm Size, changing firm size, Seasonality considerations and also a measure of the Earnings performance of Zero-Dividend stocks, which replaces the (now-inappropriate) Payout Ratio metric which was found to be important in the analysis described in Chapter 4.

6.2 Methodology

With ample evidence, both from the literature (see review, Chapter 2) and from the foregoing empirical studies (reported in Chapter 4), of the need to control for Market Capitalisation, the ongoing study retains the important 'Size' consideration within the sub-classification structure; indeed, the breakdown of individual stocks into size-related portfolios remains the primary sort characteristic, and the portfolio structure developed earlier (at this level) is retained. Separate subdivisions of each of the size quintiles are then incorporated to 'split' each 'Size' quintile into two separate portfolios (for each month); in the first analysis, according to the Former / Never distinction; and in a second, separate study[135], along the Expanding / Contracting dimension. (As before, portfolios are re-balanced according to the criteria each month; again, as before, candidate firms for inclusion in the portfolios are those

[135] Whilst the two studies may have been combined by establishing a three-dimensional portfolio structure, the simpler two-dimensional (Size / Former-Never, or Size / Expander-Contractor) structure was retained both in the interests of clarity and implementation. In addition, the moderate size of the Zero-Dividend sample militated against the creation of more portfolios with smaller numbers of firms - indeed, even with the simpler structures, not all portfolios are represented in all months).

which qualify for inclusion in the ways discussed in Chapter 3). Thus, discussion will focus around 10 portfolios in each of the two studies.

As alluded to briefly in the introduction to this chapter (Section 6.1), other firm characteristics which are believed, on *a priori* grounds to be important, are included as controlling / explanatory variables. Thus Earnings, which in the earlier study of Chapter 4 were impounded as Payout Ratio (for the reasons discussed in that chapter), are included here as a result of their demonstrated importance in the results of that study. For Zero-Dividend stocks, Payout Ratio is clearly inapplicable as a carrier of Earnings information. Instead, a (monthly) Earnings Yield (EY) measure is generated in a similar fashion to that of Dividend Yield (Chapter 4, section 4.2), by summing individual firms' earnings over the 12- month period *preceding* the 'current' month, followed by a summation over the constituent firms within the individual portfolio. A subsequent division by (current) total Market Capitalisation (of the portfolio) realises the (monthly) EY metric for the portfolio.

In a similar fashion, a measure of the year-on-year change in Market Capitalisation is generated; firstly in regard to individual firms, subsequently (following aggregation) at the level of individual portfolios. This is then expressed in the form of a ratio by dividing by (current) total Market Capitalisation (of the portfolio). This measure is intended to relate closely to that which determined (in Chapter 5) the status of 'Expanding' versus 'Contracting' firms.

Control for Market (covariance) Risk follows exactly the procedures used previously in Chapter 4. There, the 'Market' Return was taken to be the return on an equally weighted portfolio comprising all qualifying stocks (including 'Payers'). The same (all stocks) time-series vector is used here without alteration; similarly, the same vector of Returns on the 'riskfree' asset (one-month Treasury bills) is used unchanged from the previous study. Thus consistency among the evolving studies in regard to the 'economic environment' is assured.

Provision for seasonality influences also draws from the results of previous work, which rejected, for example, the presence of a seasonally variable Beta (in common with Morgan and Thomas (1998)). Provision for such interaction is therefore excluded here also. However, provision for seasonal dummy variables, and seasonal interaction variables with size, for the months of January and April[136] are included.

[136] These were the influences found to be significant in the Chapter 4 study.

The initial approach to the estimations in question was based upon an extension to the Joint estimation techniques employed in the latter stages of the Chapter 4 study (Section 4.8). Such an approach allows (initially) the freedom to assign individual, unrestricted parameters to each equation (corresponding to each of the 10 portfolios), followed by a structured sequence of introducing parameter restrictions (those permitted by the data) in order to improve the precision of the estimates. Such techniques, however, become problematical in cases (as in this instance) where some portfolios have a zero population of firms at certain points in time[137]. Whilst there do exist procedures for dealing with such 'missing variables' (in terms of the aggregated, or grouped data), such as the 'Zero order' regression technique[138] (Maddala (1977)), these appeared less satisfactory than the alternative of using a pooled cross-sectional and time series approach.

The modelling approach chosen is similar in principle to that used in Chapter 4 (Section 4.4), in which a rich set of interaction variables allows the necessary freedom for the data to express differences in parameter values across relevant dimensions. A difficulty remains, in that the number of possible interactions varies virtually as a function of the square of the number of the underlying regressors, and potentially gives rise to complex equations with many terms. Here, the use of *a priori* information, as alluded to above, provides a guide to mitigate this effect. A compensating advantage, however, is that inferences allowing the imposition of zero restrictions on insignificant parameters are relatively more straightforward than is the case with the joint estimation technique.

The model to be estimated is defined below, and has similarities to Equation (4.3) of section 4.4, excepting that, where in the earlier case, the emphasis was on the application of Seasonal dummy and interactive variables, here the focus is primarily on Size dummy and interaction variables:

Defining δ_n as: $\{ \beta_n + \beta_{n1}.D1_t + \beta_{n2}.D2_t + \beta_{n4}.D4_t + \beta_{n5}.D5_t \}$ .... n = 0,1,2,3,4

[137] For example, while all portfolios of 'Former' payers were complete, in some months, certain portfolios had no 'Never' payers. The proportion of Company*Month samples characterised as 'Never' payers is only 19.1% of the total - 12,843 of 67,259. Similarly, neither 'Expanders' nor 'Contractors' were complete (though here, the number of zero-populated portfolios was fewer). In the latter case, the proportion is 51.7% - 34,756 of 67,259 samples are characterised by Expansion.

[138] This approach requires the substitution of mean values for missing variables; it suffers from the fact that the variance of the explanatory variable is depressed, making inference more difficult.

Where $D1_t$, $D2_t$, $D4_t$ and $D5_t$ are (size) dummy variables pertaining to month (t) indicating membership of size portfolios (capitalisation quintiles 1, 2, 4 and 5); and β_{nm} are parameters.

The model is concisely recorded as:

$$R_{pt} - R_{ft} = \delta_0 + \delta_1 . (R_{mt} - R_{ft}) + \delta_2 . N_{0p} + \delta_3 . MROC_{pt} + \delta_4 . LSIZE_{pt} + \\ + \pi_0 . DJ_t + \pi_1 . DJ_t . LSIZE_{pt} + \kappa_0 . DA_t + \kappa_1 . DA_t . LSIZE_{pt} + u_{pt}$$

Equation.......(6.1)

where p = 1 to 10, t = 1 to 468[139]; N_{0p} is a dummy variable taking the value 1 if the portfolio comprises those firms who have never paid a dividend, and takes the value 0 otherwise; $MROC_{pt}$ is the monthly return on (market) capital for portfolio (p) in month (t); and $LSIZE_{pt}$ is the natural logarithm of the average Market Capitalisation (£M) of the portfolio in a given month[140]. DJ_t and DA_t are dummy variables taking the value 1 in January and April respectively, and zero otherwise. When their respective products are formed with the size variable $LSIZE_{pt}$, the required vectors for estimating the interaction coefficients are realised. π_0, π_1, κ_0 and κ_1 are the associated parameters.

The above formulation, whilst not quite exhaustive in terms of all possible interactions, is intended to capture (based upon *a priori* considerations) the important possible influences affecting Returns, within the limits of available data.

Estimation of the above model is carried out using Generalised Method of Moments, in conjunction with the Heteroscedasticity - consistent estimator of White (1980) and Autocorrelation correction of Newey and West (1987). Estimation in the first instance produces no fewer than 30 parameters; however, the process of applying zero restrictions to insignificant parameters follows the algorithm used in Chapter 4, whereby the parameter with the least case for inclusion (i.e. having the highest p- value) is eliminated; whereupon the

[139] The period estimated is shorter by one year than that estimated in Chapter 4; this enables the generation of 12 months prior earnings and year-on-year size changes.

[140] This represents a small deviation from the size variable used in Chapter 4, and corresponds to the use of an arithmetic, rather than a geometric average for the portfolio capitalisation figure. The reason for the change is that the output from the portfolio grouping procedure required the use of non-logarithmic quantities for the calculation of the 'proportionate change in size' and the 'Earnings Yield' variables pertaining to the portfolio.

process is repeated until only those parameters having levels of significance at the chosen level remain in the equation[141].

Following the completion of the estimation process for portfolios formed on the basis of the Former / Never distinction, then new portfolios based upon the sub-classification according to the Expansion / Contraction distinction are formed and estimated. The procedure associated with this second, separate exercise is otherwise identical, however. In both cases, the expected number of samples in each regression is 4,680 (468 months[142] * 10 portfolios); however, in practice this number is potentially reduced by the existence of a small number of zero-populated portfolios (as discussed in section 6.2).

6.3 Results of the Estimations

6.3.1 Estimation based upon the Former / Never sub-classification

The results of the estimation of the first series of regressions, based upon the Former / Never sub-classification, are shown in table 6.1, below. Seven parameters (of the original 30) are tabulated, having included the Size / Risk interaction parameter BETA5, which just fails to be significant at the 10% level (10.5%). All parameters associated with the NEVER dummy variable (and its related interaction variables) were found to be insignificant, and were eliminated at an early stage in the backward elimination process. *This evidence indicates rejection of hypothesis (6a)*. It is evident from the modest value of R^2, however, (22%) that the Zero-Dividend returns model explains a relatively small degree of the variance of the dependent variable. Parameters remaining in the equation are as follows:

ALPHA: this is the constant term in the equation, which (under certain conditions[143]) may be regarded as a measure of the average excess return earned by the three highest- capitalisation portfolios over the period of the regression. The negative value indicates lower average values for the largest size portfolios, offset by progressively higher values toward the

[141] The constant term, whatever its level of significance, remains in the equation.

[142] i.e. 39 years, 1959 - 1997 inclusive.

[143] Commonly referred to as Jensen's (1968) 'Alpha', this parameter was shown by Merton (1973) to be indistinguishable from zero in a well-specified asset pricing model when the explanatory variables are expressed in the form of excess returns (as here, in the case of the Market Portfolio) or as returns on zero-investment portfolios. In the case of characteristic-based models, the use of mean-zero explanators should realise the same effect. Informal tests here, using mean-zero explanators, produced little change in the values of the parameters, indicating that the Alphas realised by the above regressions may be considered as reliable measures of the excess returns generated by the portfolios, assuming the validity of the associated models.

smallest capitalisation portfolio (5)[144], as is indicated by the positive values for the coefficients of the interaction variables ALPHA4 and ALPHA5. These three measures bear direct comparison with the mean value of the dependent variable (0.015, see lower part of the table).

Table 6.1. Regression output from reduced Former / Never model (Model 1)

```
Number of Observations =    4517

                              Standard
Parameter  Estimate            Error        t-statistic         P-value
ALPHA      -.474267E-02   .185556E-02   -2.55593       *    [.011]
ALPHA4     .011779        .508441E-02   2.31672        *    [.021]
ALPHA5     .036637        .440030E-02   8.32610        **   [.000]
BETA       1.04954        .047317       22.1809        **   [.000]
BETA5      -.250588       .154456       -1.62240            [.105]
DELTA      .014112        .476639E-02   2.96072        **   [.003]
EPSLON2    -.396030E-02   .164842E-02   -2.40248       *    [.016]

Standard Errors computed from    heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation:  NMA=12,  Kernel=Bartlett)

                              Equation    UPRTEQ1
                              ===================

Dependent variable: XSRET

 Mean of dependent variable = .015239        Std. error of regression = .097089
Std. dev. of dependent var. = .109975                       R-squared = .221649
   Sum of squared residuals = 42.5126              Adjusted R-squared = .220613
      Variance of residuals = .942630E-02     Durbin-Watson statistic = 1.91163
```

Values of Beta for the four largest- firm portfolios is not significantly different from 1, at a value of 1.05. However, the Beta- value of the smallest- firm portfolio, as indicated by the interaction term with the portfolio 5 dummy variable is lower by 0.25, at a value of 0.8. This low value is consistent with that determined by the simple exploratory OLS regressions of Section 4.3, but differs markedly from the high (1.66) estimate arising from the joint estimation of Section 4.8. This discrepancy is, at this juncture, a puzzle.

The value of DELTA, the coefficient operating on the (monthly updated) Earnings Yield metric, is both positive and statistically significant. However, its economic significance is relatively small. Given that the mean monthly per-unit EY figure (over all portfolios over the full period of the regression) is 0.0285, a large change, of similar magnitude, would produce *ceteris paribus*, an increase in excess return of only 0.04% per month, or 0.48% per annum.

In the model being investigated here, the 'Size Effect' is chiefly expressed by the variables ALPHA 4 and ALPHA5, since these relate to the excess returns on size- sorted portfolios;

---

[144] Portfolio 5 (in the classification used in this chapter) corresponds to the smallest-stock Zero-Dividend portfolio, and was previously classified as portfolio 30 in Chapter 4.

moreover, this expression of variation is characteristic of the magnitude of the 'Between-Portfolio' variation (Berk (1997)) which captures the greater part of any variation induced by such an effect. However, the 'Within Portfolio' variation in Portfolio 2 is captured by the coefficient EPSILON 2, which has the expected negative sign, indicating greater realised Returns for smaller companies.

6.3.2 Estimation based upon the Expansion / Contraction sub-classification

The results of the estimation of the second series of regressions, based upon the year-on-year Expansion / Contraction sub-classification, are shown in table 6.2, below. On this occasion, sixteen parameters (of the original 30) are tabulated, including all parameters significant at or below the 10% level, and including the (now insignificant) ALPHA (24.9%); the sign of whose coefficient has changed, accompanied also by an increase in its associated Standard Error. Although the values have shifted slightly, the situation regarding the remaining ALPHA and BETA parameters is essentially the same as that of the previous analysis.

Table 6.2. Regression output from reduced Expansion / Contraction model (Model 2)

Number of Observations = 4622

Parameter	Estimate	Standard Error	t-statistic		P-value
ALPHA	.440385E-02	.381817E-02	1.15340		[.249]
ALPHA4	.903370E-02	.377299E-02	2.39431	*	[.017]
ALPHA5	.042727	.849099E-02	5.03200	**	[.000]
BETA	1.01407	.051282	19.7745	**	[.000]
BETA5	-.281337	.131469	-2.13995	*	[.032]
GAMMA	-.017298	.577898E-02	-2.99321	**	[.003]
GAMMA1	.018100	.580004E-02	3.12070	**	[.002]
GAMMA2	.011385	.554012E-02	2.05496	*	[.040]
GAMMA5	-.025485	.010440	-2.44106	*	[.015]
DELTA	.011287	.447580E-02	2.52177	*	[.012]
EPSLON1	-.192880E-02	.638760E-03	-3.01960	**	[.003]
EPSLON2	-.285625E-02	.909674E-03	-3.13986	**	[.002]
EPSLON5	.339889E-02	.200266E-02	1.69718		[.090]
PHI	.012283	.455761E-02	2.69509	**	[.007]
KAPPA1	.305180E-02	.734219E-03	4.15653	**	[.000]
THETA	.880422E-02	.477622E-02	1.84335		[.065]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation UPRTEQ1
==================

Dependent variable: XSRET

Mean of dependent variable =	.014024	Std. error of regression =	.079540
Std. dev. of dependent var. =	.094456	R-squared =	.293188
Sum of squared residuals =	29.1404	Adjusted R-squared =	.290886
Variance of residuals =	.632663E-02	Durbin-Watson statistic =	1.84822

Table 6.3. Absolute values for the Gamma parameters
(of Model 2)

(n)	GAMMA	GAMMA(n)	NET
1	-0.017298	0.018100	0.000802
2	-0.017298	0.011385	-0.005913
3	-0.017298	0	-0.017298
4	-0.017298	0	-0.017298
5	-0.017298	-0.025485	-0.042783

The interpretation of the situation associated with GAMMA(n), the coefficients of the EXPAND dummy variable (and its related interaction variables) is extremely interesting. In order to more clearly assess its effects, a subsidiary table (Table 6.3) is shown above, the purpose of which is to compute the (net) absolute coefficient values for each size portfolio (by summing the coefficients of the dummy variable and the associated interaction variables). This table indicates that the absolute coefficients associated with the EXPAND Dummy variable for the two largest portfolios are insignificantly different from zero, taking account of the Standard Errors reported in Table 6.2. However, the absolute coefficients associated with the three smaller 'size' portfolios are significantly negative, and decrease sharply toward the 'smallest' portfolio. *On the basis of this evidence, hypothesis (6b) cannot be rejected* (at least, in the case of the three smaller portfolios). Furthermore, the negative coefficients indicate a Returns penalty for (smaller) expanding firms, suggesting that a degree of overpricing (of these firms) may be in evidence.

A closer examination reveals that the situation is more complex, however. The coefficient (THETA) of the DELCAP variable (the proportionate year-on-year change in the market capitalisation of the portfolio) is positive and significant, indicating the precise converse to a Returns penalty for expanding firms. Clearly, although the two sets of variables set out to convey different information to the equation, they do in practice act as confounding and competing variables.

The effect of omitting the DELCAP variable is to (approximately) halve the value of the GAMMA coefficient, while leaving the differential effects captured by the (EXPAND) interaction variables substantially unchanged. Table 6.4 indicates the shift from the values displayed in table 6.3. An overall upward shift in the values of the absolute coefficients gives rise to a situation in which the 'largest' portfolio has a marginally significant positive value, with the same decreasing trend occurring through to the 'smallest' portfolio. All other coefficients in the equation remain substantially unchanged. Addressing the issue of the confounding variables by adopting the opposite approach, namely excluding the EXPAND Dummy and interaction variables and re-introducing the DELCAP variable produces a negative coefficient (-0.00345) at a significance level of 18.4%. This provides weak supporting evidence of the Returns penalty effect, but the model using the EXPAND Dummy and interaction variables is preferred, since it provides more detailed information across the 'size' dimension. Summing up, therefore, it seems reasonable to conclude that the Returns penalty effect prevails among the smaller firms portfolios, with weak evidence of the opposite being true of the largest firms portfolio.

Table 6.4. Absolute values for the Gamma parameters
(After re-estimation of Model 2 following the elimination of the DELCAP variable)

(*n*)	GAMMA	GAMMA(*n*)	NET
1	-0.009436	0.016542	0.007106
2	-0.009436	0.011730	0.002294
3	-0.009436	0	-0.009436
4	-0.009436	0	-0.009436
5	-0.009436	-0.023433	-0.032869

The final choice of model is obtained, therefore, by eliminating the DELCAP variable, together with the elimination of the (now insignificant) EPSILON5 variable:

Table 6.5. Regression output from final Expansion / Contraction model (Model 3)

Number of Observations = 4622

Parameter	Estimate	Standard Error	t-statistic		P-value
ALPHA	-.459568E-03	.276683E-02	-.166099		[.868]
ALPHA4	.873636E-02	.387124E-02	2.25674	*	[.024]
ALPHA5	.044003	.816993E-02	5.38592	**	[.000]
BETA	1.01569	.051344	19.7819	**	[.000]
BETA5	-.277209	.131744	-2.10415	*	[.035]
GAMMA	-.943549E-02	.390923E-02	-2.41364	*	[.016]
GAMMA1	.016550	.576927E-02	2.86871	**	[.004]
GAMMA2	.011777	.563840E-02	2.08873	*	[.037]
GAMMA5	-.024885	.010442	-2.38323	*	[.017]
DELTA	.900264E-02	.447017E-02	2.01394	*	[.044]
EPSLON1	-.171492E-02	.632129E-03	-2.71293	**	[.007]
EPSLON2	-.295122E-02	.932207E-03	-3.16584	**	[.002]
PHI	.012106	.456453E-02	2.65227	**	[.008]
KAPPA1	.318167E-02	.737521E-03	4.31400	**	[.000]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation UPRTEQ1
==================

Dependent variable: XSRET

Mean of dependent variable =	.014024	Std. error of regression =	.079630
Std. dev. of dependent var. =	.094456	R-squared =	.291278
Sum of squared residuals =	29.2192	Adjusted R-squared =	.289279
Variance of residuals =	.634097E-02	Durbin-Watson statistic =	1.83651

The comparison of Model 3 (above) with the earlier model 1 (Table 6.1) is interesting. It represents an extension of the earlier model, sharing as common variables those associated with coefficients ALPHA(0,4,5), BETA(0,5), DELTA and EPSILON(2); and adding to this common core the additional significant explanators with coefficients GAMMA(0,1,2,5), EPSILON(1), PHI and KAPPA2. Model 3 is thus a superset of Model 1, and clearly *encompasses* the latter (in the sense of Hendry (1995)). In so doing, its explanatory power is increased, as evidenced by the increase in the value of R^2 from 22% to 29%. Whereas Model 1 accounted for excess returns (ALPHAn), market risk (BETAn), the effect of the Earnings Yield metric (DELTA) and a single size effect variable (EPSILON2); but found no role for the Dummy variable NEVER, Model 3 finds a significant role for the Dummy variable EXPAND and its associated interaction variables. In addition, it finds evidence of a January seasonal term (coefficient PHI), and an April seasonal linked to the (largest) size portfolio 1.

6.4 Estimation of Expansion / Contraction sub-classification sub-periods

It now remains to perform a sub-period analysis on the available data, in order to examine the parameter stability of the model. Model 3 is used to estimate, separately, the two sub-periods 1959 - 1977 and 1978 - 1997. Tables 6.6 and 6.7 show the results of the estimations.

Table 6.6 Regression output for the sub-period 1959 - 1977 (Model 3)

Number of Observations = 2241

Parameter	Estimate	Standard Error	t-statistic		P-value
ALPHA	.441327E-02	.445271E-02	.991143		[.322]
ALPHA4	.013488	.638231E-02	2.11340	*	[.035]
ALPHA5	.031671	.813718E-02	3.89213	**	[.000]
BETA	.843078	.072643	11.6058	**	[.000]
BETA5	-.293696	.151637	-1.93683		[.053]
GAMMA	-.019368	.644670E-02	-3.00426	**	[.003]
GAMMA1	.027425	.930467E-02	2.94741	**	[.003]
GAMMA2	.014157	.889750E-02	1.59114		[.112]
GAMMA5	-.899176E-02	.013267	-.677732		[.498]
DELTA	.058240	.041516	1.40285		[.161]
EPSLON1	-.342142E-02	.131595E-02	-2.59997	**	[.009]
EPSLON2	-.383224E-02	.273306E-02	-1.40218		[.161]
PHI	.015159	.698636E-02	2.16982	*	[.030]
KAPPA1	.376353E-02	.181745E-02	2.07078	*	[.038]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation UPRTEQ1
==================

Dependent variable: XSRET

Mean of dependent variable	.016338	Std. error of regression	.086382
Std. dev. of dependent var.	.097323	R-squared	.216763
Sum of squared residuals	16.6177	Adjusted R-squared	.212190
Variance of residuals	.746191E-02	Durbin-Watson statistic	1.88488

Table 6.7 Regression output for the sub-period 1978 - 1997 (Model 3)

Number of Observations = 2381

Parameter	Estimate	Standard Error	t-statistic		P-value
ALPHA	-.481865E-02	.439496E-02	-1.09640		[.273]
ALPHA4	.371851E-02	.443230E-02	.838957		[.401]
ALPHA5	.055040	.013931	3.95102	**	[.000]
BETA	1.23728	.039595	31.2482	**	[.000]
BETA5	-.292439	.203291	-1.43852		[.150]
GAMMA	-.110645E-02	.440793E-02	-.251014		[.802]
GAMMA1	.992688E-02	.746926E-02	1.32903		[.184]
GAMMA2	.011197	.688352E-02	1.62663		[.104]
GAMMA5	-.041567	.015232	-2.72890	**	[.006]
DELTA	.600807E-02	.373536E-02	1.60843		[.108]
EPSLON1	-.116258E-02	.835123E-03	-1.39211		[.164]
EPSLON2	-.300551E-02	.114612E-02	-2.62234	**	[.009]
PHI	.676429E-02	.572877E-02	1.18076		[.238]
KAPPA1	.241625E-02	.818745E-03	2.95116	**	[.003]

Standard Errors computed from heteroscedastic-consistent matrix
(Robust-White)
(also robust to autocorrelation: NMA=12, Kernel=Bartlett)

Equation UPRTEQ1
==================

Dependent variable: XSRET

Mean of dependent variable	.011846	Std. error of regression	.071400
Std. dev. of dependent var.	.091642	R-squared	.396289
Sum of squared residuals	12.0670	Adjusted R-squared	.392973
Variance of residuals	.509801E-02	Durbin-Watson statistic	1.75785

All three cases, the Full- and two Sub-periods, exhibit insignificant coefficients of ALPHA; these cases also have in common, highly significant coefficients of ALPHA5, with the value in the later period being almost double that of the earlier. The full period coefficient is approximately the average of the two sub-period values. The value of ALPHA4 drops to insignificance in the later period.

The value of BETA rises from 0.84 in the early sub-period to 1.23 in the later, with the value of the standard error reducing by one half (approximately). The value of BETA5 remains virtually constant, but with an increase in the standard error in the second period, remains significant only at 15%.

The GAMMA coefficients, all significant (at 5%) in the full period, show differing characteristics in the sub-periods. GAMMA is significantly negative in the early sub- period, with only GAMMA1 indicating a significant differential effect, serving essentially to negate the effect of the 'base' GAMMA coefficient. In the later period, only GAMMA5 reveals a significant differential effect, measured against a 'base' coefficient indistinguishable from zero. This evidence suggests the 'Expansion / Contraction' effect to be a feature of the early period, not persistent into the later, excepting for the smallest stock portfolio. Even here, the effect is much reduced.

The second period DELTA coefficient just fails to be significant at 10%; however, its value falls to one-tenth of that in the first period (significance level 16%), and is indicative of a substantial decline in the magnitude of the 'Earnings Yield' effect.

With the 'size effect' for the smallest stock portfolio having expressed itself through the 'between portfolio' ALPHA5, that for the two largest stock portfolios is expressed via the 'within portfolio' coefficients of EPSILON1 and EPSILON2, which have the expected signs, but whose significance alters (in opposite directions with time) from high significance (<1%) to low significance (~16%).

The 'January effect', expressed through the coefficient PHI, appears to dissipate in the later period. In contrast, the 'April effect' linked to the largest stock portfolio remains (with increasing significance), though the value of its coefficient decreases.

Finally, it is interesting to note that the explanatory power of the model rises substantially in the second sub- period, to a value close to 40%.

6.5 Conclusions

The preceding discussion would seem to suggest a degree of reduction in levels of anomalous behaviour with the passage of time into the second sub- period; with the possible implication that the Market, insofar as Zero-Dividend stocks are concerned, became more efficient in pricing this class of securities. Whilst the ALPHA5 coefficient provides the greatest challenge to this conclusion, the liquidity and friction problems (e.g. higher bid-ask spreads) associated with trading these securities would tend to drive up the expected returns demanded by investors, leaving traces in the data to be captured by, in particular, the ALPHA5 coefficient. Even the much-vaunted January effect, a particular feature among small stocks in the U.S. Market (Keim (1985), Christie(1990)) appears, from the above evidence, to be in decline, though a small 'April effect' does persist among the larger Zero-Dividend stocks.

Although the analysis firmly rejected the 'Former / Never' effect, evidence of the 'Expansion / Contraction' and 'Earnings Yield' effects did initially appear strong; however, the evidence from the sub- period analyses shows conclusively that the effects fail to be persistent into the later period. However, a caveat is in order here. The changing nature of the effects noted may not have been due entirely to changes in the performance of markets over time; as already noted in Chapter 4, there occurred a significant influx of new firms[145] into the database in 1975[146]. Any differential characteristics associated with the incoming firms (relative to those firms analysed in the first sub- period) would have impacted the second sub- period analysis in a way additional to any changing characteristics of firms or markets over time.

[145] The LSPD database accepted "all British quoted companies" into the database.

[146] After a 24- month qualifying period, these first appeared in the analyses above in 1977.

7.0 Conclusions

The preceding chapters have examined a range of Returns-generating models, the majority of which may be regarded as encompassing models relative to the Capital Asset Pricing Model of Sharpe (1964), Lintner (1965) and Mossin (1966), and which are designed to provide enhanced explanatory power relative to the 'pure' CAPM, as defined in Chapter 2.

Essentially, the models which were reviewed in that survey of prior literature could be construed as falling into two broad categories, namely Characteristic-based or Factor-based models. Such a distinction is drawn by Lewellen (1999); moreover, the distinction sits neatly in line with the debate regarding the 'Efficient Markets Hypothesis' Fama (1976) versus the 'Behavioural' school of Finance, epitomised by Thaler (1999).

In the 'Behavioural' argument, the need to enhance the 'pure' CAPM to take account of, for example, the 'Size' effect (Banz (1981)) merely requires the model to incorporate some form of size-defining variable (usually the logarithm of Market Capitalisation) as a Characteristic which impounds the necessary information in order to take account of what is considered to be a pricing 'anomaly'. In this sense, the anomalous behaviour is that of the investor, who is postulated to be prone to mispricing the stock of small firms.

In contrast, the 'Efficient Markets School' postulates an additional pervasive Risk Factor, (related to firm size) which serves to increase the dimensionality of the mean-variance space, and which gives rise to the concept of a Multifactor Mean Variance form of Efficiency (Fama and French (1996)). In models based upon this hypothesis, the 'Size Effect' is captured by a zero-investment portfolio long on small firms and short on large firms[147]. A third factor, which impounds Book to Market ratio through the creation of a zero-investment portfolio constructed in an analogous fashion, completes the FF(1992) three-factor model and provides an enhanced description of the data. Such a factor model provides for covariation in returns not captured by the market return, but which is captured by the additional factors.

Whilst remaining cognisant of the debate between the opposing schools of thought in these matters, the argument put forward in section 2.2 in favour of modelling on the basis of Characteristics rather than Factors has guided this investigation into the properties of U.K. quoted stocks in general, and those of Zero-Dividend stocks in particular. The subset of

147 Equivalently, the difference between the return on a portfolio of small stocks and that on a portfolio of large stocks.

models selected in Chapter 4 for estimation have produced convincing evidence of a pervasive size effect in the U.K. Market, over all sub-periods; similar evidence is offered for a Dividend-Yield effect, excepting that this is weaker in later sub-periods and is weakened still further when earnings information, encapsulated in the form of Payout Ratio, is included as a competing explanatory variable.

Zero-Dividend stocks exhibit significant seasonal responses for the key months of January and April in the later periods, reflecting the greater influence of this class of stock following the inclusion of 'All British Quoted Companies' in the LSPD database in 1975. This finding is entirely consistent with that of Keim (1985) in relation to the U.S. Stock market, excepting that the 'April' effect does not feature in that market since the month of April, in the context of the U.S. market, is not endowed with the 'end of tax-year' connotation as it is in the U.K. Thus the U.S. evidence is suggestive of a tax-year end effect related to the month of January; the U.K. evidence generated in this Thesis is suggestive of a similar tax-year end effect related to the month of April, but with a January effect which may be the result of a large number of corporate 'year-ends' corresponding to the calendar year end, coupled with the possibility of international arbitrage tending to synchronise prices between markets.

The findings of the joint portfolio estimation, which allow (prior to the imposition of data-determined restrictions) freedom for all coefficients to be independently determined, (whilst effectively imposing a restriction across the error terms) were summarised in detail in sections 4.9.7 to 4.9.10. An interesting finding which emerged from the analysis was the apparent reversal of the size effect coefficient in the limited context of the smallest size quintile. However, a caveat associated with this finding is the elevated value attached to the small firm betas, which contradict the findings both of the preliminary (OLS) market model estimates of Chapter 4, section 4.4, and those of Chapter 6, section 6.4 (in relation to the Zero-Dividend stocks). This must stand as an anomalous result, the reason for which remains a puzzle.

The results of the migration study (of Chapter 5) appear to support the hypothesis of 'adjacency' between the High- and Zero-Dividend portfolios, and in so doing, place limits on the usefulness of the notion of a 'U'- shaped relationship (of Returns against Dividend Yield) across a supposed yield spectrum. The study also confirms the nature of the increasing trend toward a higher proportion of Zero-Dividend stocks within the U.K. market, and provides some indication of the speed of adjustment to this increased level. It remains the case, however, that the U.K. market is likely to remain dominated by Dividend-Paying stocks in the foreseeable future, a fact which contrasts with that of the U.S. market, which is dominated in numbers of quoted Zero-Dividend stocks, though not in terms of market value (Fama and French (2001), see discussion, section 2.1.9).

Finally, from Chapter 6, there is clear evidence in support of the significance and explanatory power of a variable (year-on-year market capitalisation increase) which encapsulates the concept of 'Expansion'. In this regard, it reinforces the findings (in relation to this variable) of the migration study of Chapter 5, regarding the differential migration properties of 'Expanding' versus 'Contracting' stocks; (this in the context, illustrated in that Chapter, that the proportion of Zero-Dividend 'Expanding stocks' to 'All stocks' has the lowest proportion of that of any dividend group). In one sense, the 'Expansion' variable may convey similar information to the model as does the 'Asset Growth Rate' measure of FF(2001), which is used (alongside Book to Market Ratio) as alternative measures of a firm's investment potential.

Unfortunately, the lack of 'Book' value information in the chosen database precludes the latter two variables being separately identified; the 'Expansion', or 'Market-value Growth rate' measure representing a particular and specific combination of the two constituent variables used by FF(2001), (namely their ratio). If indeed, there exists a sense in which the two alternative variables proxy for each other to some degree (as appears implicit in the FF(2001) treatment), then clearly their ratio would be (prospectively) less effective as an explanator[148]. Nevertheless, such explanatory power has been demonstrated here, and the variable appears to have merit in identifying 'Growth' stocks, at least to some degree. (Here, using the term 'Growth' in the usual sense of the 'Value' versus 'Growth' distinction, i.e. companies who invest heavily and generally have high ratios of Research and Development expenditure relative to their 'Book' values).

If it is the case, however (that the 'Expansion' variable as constituted above does indeed proxy for 'Growth', in the usual sense of that term), then its generally negative coefficients, which decrease (i.e. become increasingly negative) with decreasing firm size (see Table 6.3) suggests that for the (exclusively) Zero-Dividend stocks examined in Chapter 6, Returns performance for such 'Growth' stocks is inferior. Although not specifically examined in this Thesis, the same conclusion is conventionally accepted as the norm for stocks in general (i.e. 'Value' stocks exhibit superior returns, as a rule; Fama and French (1998), Lakonishok,

[148] Strictly speaking, FF(2001) utilise the reciprocal of Book / Market (i.e. M/B) as an explanatory variable. However, this non-linear transformation should not materially alter the argument outlined above in terms of the conveyance of information into the equation.

Schleifer and Vishny (1994), Haugen (1995)). Moreover, Table 6.3 clearly shows that the distinction becomes sharper with decreasing firm size.

In contrast, the distinction between 'Former' payers and 'Never' payers fails to exhibit any significant bearing on Returns performance, in spite of the informed conjecture (informed, that is, by the FF(2001) study) that 'Former' payers are correlated with a level of 'distress', whereas 'Never' payers are associated with 'Growth'. Insofar as the association between the dimensions of Expansion / Contraction versus Never / Former (in this study) is concerned, there does exist a statistically significant association between the two (in both sub-periods) such that the fact of 'Expansion' implies a greater probability of having 'Never' paid[149]. However, it is clear from the regression results that the Never / Former distinction is at best a very weak proxy for the Expansion / Contraction distinction, and that the latter dominates in explaining Returns in the context of the U.K. Stock Market.

It is clear from all of the above that the role of Zero-Dividend stocks is far less dominant in the U.K. market than is that of their counterparts in the U.S. market, despite the fact that, in both markets, the numbers and proportions of such stocks exhibit increasing trends, (notwithstanding their influence being much less when expressed in market-value weighted terms). The trend toward Zero-Dividend status in the U.K. market, stable over the last 17 years of the study, appears to be heading for a long-run proportion of 1 in 6 Zero-Dividend stocks (from a current 1 in 8), with an associated exponential time constant of approximately 3 years. Thus, in the absence of a significant cultural shift, and with this modest level of drift, the U.K. stock market is unlikely to ever see the numerical dominance (of the Zero-Dividend category) which is asserted by its U.S. counterpart. Whatever the theoretical and practical merits or demerits of the payment of dividends, the majority of U.K. firms are likely to maintain this form of shareholder reward into the foreseeable future, (driven, it would seem, by shareholder preference), and the vast majority of Zero-Dividend firms are likely to remain firmly rooted at the lower extremities of the firm size continuum.

[149] In the first sub-period (prior to 1978) the overall proportion of 'Never' payers was 16%. Among 'Expanding' stocks, this rose to 17.9% (and fell to 14.3% among 'Contracting stocks). The corresponding χ^2 value (1 d.f.) evaluated to 55.1 for the 2x2 contingency table, rejecting the Null Hypothesis (of no association) overwhelmingly. (sample size 22,854 Company*Months). Corresponding figures for the second sub-period (1978-1997) were: 20.7%; 21.7%; 19.4%; 36.6 and 44,405.

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