UNIVERSITY OF SOUTHAMPTON

FACULTY OF LAW, ARTS & SOCIAL SCIENCES
School of Management

Exploring Issues in Empirical Finance:

- **International Evidence on Payout Ratio, Returns, Earnings and Dividends**
- **Investigating Duration Dependence in Bull and Bear Markets**
- **Using Survival Analysis Approach to Model the Duration of Sovereign Debt Default**

by

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ABSTRACT

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EXPLORING ISSUES IN EMPIRICAL FINANCE:

- INTERNATIONAL EVIDENCE ON PAYOUT RATIO, RETURNS, EARNINGS AND DIVIDENDS
- INVESTIGATING DURATION DEPENDENCE IN BULL AND BEAR MARKETS
- USING SURVIVAL ANALYSIS APPROACH TO MODEL THE DURATION OF SOVEREIGN DEBT DEFAULT

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This study focuses on three areas of empirical finance where additional research could be undertaken to explore the financial markets sector and where new methodologies could be investigated. The dissertation is made up of three papers which, individually, add unique insight to new methodological techniques. The first paper titled "International Evidence on Payout Ratio, Returns, Earnings and Dividends" deals with the relationship between payout ratios, earnings, dividends, and returns in an international context. We examine whether, contrary to popular belief, a positive relationship exists between expected future earnings growth and current payout ratios in eleven international markets. In addition, we consider the role of the payout ratio in predicting future real dividend growth and returns. The findings suggest that higher payout ratios do indeed lead to higher real earnings growth, although not to higher real dividend growth. There is also evidence that the payout ratio is a poor predictor of future returns.

The second paper, "Investigating Duration Dependence in Bull and Bear Markets" proposes a new approach to studying time series dependence in stock prices by modelling the probability that a bull or bear market terminates as a function of its age. One distinctive aspect of this paper is using survival analysis as the methodological technique on the identical eleven international markets used in the first paper. Several parametric models, namely, lognormal, loglogistic, Weibull and exponential models are used to study duration dependence in daily stock prices. The findings demonstrate that our models depict predominantly negative duration dependence for both bull and bear markets. Negative duration dependence implies than more mature bull and bear markets are more robust to failure than younger bull and bear markets.

With the increasing attention focused on survival analysis in the financial world, we chose for our third paper to study how well the application of survival analysis in the sovereign debt default sector would work. The third paper titled "Using Survival Analysis Approach to Model the Duration of Sovereign Debt Default" uses the Cox Proportional Hazards model to assess the relation between the distribution of the survival time and the independent variables. This paper adds a new dimension to the existing literature in that it focuses on the length, or more specifically, the duration of a default period. The paper investigates the effect of certain macroeconomic and balance sheet variables on the duration of three types of debt, namely foreign currency bank debt, local currency debt and foreign currency bond debt. The findings indicate that both macroeconomic and balance sheet variables contribute to some extent in predicting the length of default of the three types of debt. In addition, for all three types of debt, the fit of the model is improved by combining macroeconomic and balance sheet variables in one model. However, the explanatory power of this model as illustrated by the likelihood ratio statistic is best for foreign currency bank debt default.

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1. Introduction

The aim of this thesis is to, as the title implies, explore several issues in empirical finance that have until now not received enough attention or been totally ignored. This research study also tries to investigate new methodological techniques that are emerging in the field of financial economics. The structure of the thesis is based on the three-paper approach and consists of essentially five chapters. This first chapter provides a brief introduction to the three main empirical analyses that constitute the body of the thesis.

The first empirical study deals with the relationship between payout ratios, earnings, dividends, and returns in an international context. It focuses on the payout ratio which when compared to other valuation ratios has not gathered much attention in the past. Hence this chapter tries to fill this gap in the literature. This chapter is also important in that it questions the conventional issue that higher payout ratios lead to lower subsequent earnings growth. In an important recent paper, Arnott and Asness (2003) established the somewhat surprising result that higher aggregate payout ratios for the US are associated with higher future earnings growth, thus offering support for theories that view dividends as signals for earnings expectations or, indeed, for wasteful managerial use of retained earnings. This paper extends the literature in two main ways. First, it investigates whether similar findings are evident in eleven major international markets. Second, it extends the analysis to consider the relationship between payout ratio and future real dividend growth and returns which are the ultimate focus of portfolio managers and strategists.

Although the payout ratio has long been of importance to corporate finance researchers (Lintner, 1956), it has been relatively neglected in the asset pricing and prediction literature despite market fascination with investment strategies based on dividends and earnings (e.g. the 'Dow 10', etc.). Arnott and Asness (2003) redress this omission in the literature by examining the aggregate payout ratio for US stocks since 1871 and its relation to subsequent 10-year real earnings growth; they find a positive coefficient on payout ratio in a simple linear regression for a variety of sub-periods, and suggest that the low payout ratio of 2001 would lead to low earnings growth in the following decade. They report the analysis for 5-year earnings growth and a rolling 30-year period and find that the results are indeed robust. Given that dividends are 'stickier' (more stable over time) than earnings, Arnott and Asness (2003) also examine whether the phenomenon is really reflecting mean reversion in earnings; a transient drop in earnings would raise the payout ratio and signal a future rebound in earnings, hence implying that dividend policy was not really useful as a predictor. This can be tested empirically by including past real earnings growth in the regression, but the above hypothesis was comprehensively rejected. Other possible predictor market variables (such as yield-curve slope and earnings yield) are also included, but the inference remains the same: a high payout ratio is associated with high subsequent earnings growth.

A primary focus of this study is whether the US findings extend to other countries. Arnott and Asness (2003) suggest that their findings, "conform to a world in which managers possess private information that causes them to pay out a large share of earnings when they are optimistic ... and to pay out a small share when they are pessimistic ... Alternatively, the facts also fit a world in which low payout ratios lead to ... inefficient empire building ...". Given different managerial cultures, financial market histories and corporate and individual tax regimes between countries it would be quite remarkable if the US findings were repeated for other countries. In an overview of our results, we report that indeed the findings generally do carry over for our sample of up to 11 countries. When we include lagged 5-year earnings growth we do find significant evidence of mean reversion, in contrast to Arnott and Asness (2003), though the payout ratio is still important. We extend the analysis to consider the relationship between payout ratio dividends and find that there exists a negative relationship between the two variables and this is totally consistent with conventional theory. Concerning the association between payout ratio and returns, we find that the payout ratio is a poor predictor of returns.

Research, in the past decades, has focused a great deal on characterizing the dynamics returns in equity markets. In fact one aspect of our first empirical study has been devoted to studying whether the payout ratio can predict returns. However, one feature of equity returns that has been attributed less attention over the years is nonetheless of considerable importance. The second empirical study proposes a new approach to studying time series dependence in stock prices by modelling the probability that a bull or bear market terminates as a function of its age. Essentially, we use the identical eleven international markets featured in the first chapter and apply survival analysis to the modelling of duration dependence in those eleven bull and bear markets. The main aim of this chapter is to provide a brief introduction to survival analysis which is a statistical technique not used before in this area of empirical finance and which will be explored in greater depth in the following chapter.

If the age of a bull or a bear market affects future price movements, investors will want to calculate expectations conditional on the path followed by stock prices up to a given point in time. For instance, during the long bull market of the nineties, the concern was often expressed that this bull market was at greater risk of coming to an end because it had lasted too long by historical standards. Translated into statistical terms, this indicates a belief that the bull market hazard rate depends positively on its duration. The opposite view is that bull markets gain momentum: the longer a bull market has lasted, the more robust it is and hence the lower its hazard rate. Hypotheses on the probability that a bull or bear market is terminated as a function of its age are naturally expressed in terms of the shape of this hazard function. If a hazard function is increasing then the cycle phase duration is said to exhibit positive duration dependence or non-persistence in the cycle with the increasing probability of a turning point as duration increases. Conversely, a decreasing hazard function is an indication of negative duration dependence, that is, momentum or persistence in the state as the probability of a turning point decreases.

We use Sperandeo's (1990) definition of bull and bear markets as there does not seem to be a generally accepted formal definition of bull and bear markets. The author defines a bull market as a long-term upward price movement characterized by a series of higher intermediate highs interrupted by a series of higher intermediate lows. Conversely, a bear market is defined as a long-term downtrend characterised by lower intermediate lows interrupted by lower intermediate highs. We then follow the procedure described by Lunde and Timmermann (2004) to formalise bull and bear states in terms of movements between local peaks and troughs. By Lunde and Timmermann's definition, the stock market switches from a bull to a bear state if stock prices have declined by a certain percentage since their previous local peak within that bull state. Likewise, the authors define a switch from a bear to a bull state if stock prices experience a similar percentage increase since their local minimum within that state. We use triggering percentages, also called 'filters' hereafter, of 10%, 15%, 20% and 25% for comparison purposes. We use the lognormal model, the loglogistic model, the Weibull model and the exponential model to undertake parametric tests on daily stock price series and daily real stock price series for the eleven international markets used in the first study.

The findings demonstrate that our models depict predominantly negative duration dependence for both bull and bear markets. Negative duration dependence implies that more mature bull and bear phases are more robust to failure than younger bull or bear markets. Presence of duration dependence appears to provide evidence against Fisher's hypothesis of a "Monte Carlo" business cycle. The finding of duration dependence in bull and bear markets implies that stock market prices do not follow a random walk during these phases but rather possess a predictable component. Temporary 'fads' (Poterba and Summers, 1988; Shiller, 1989; and Delong *et al.*, 1990) and time-varying required returns (Fama and French, 1988a, 1988b) are two explanations that have been offered in the literature for predictable price behaviour. In general, the existence of 'fads' implies some degree of market inefficiency and , thus the possibility of earning excess profits, while the presence of time-varying required returns is consistent with rational pricing in an efficient market.

With survival analysis proving to be such an interesting and not well researched technique, Chapter 4 is devoted to a third empirical study that investigates how well the application of survival analysis will work in a completely different area, more specifically how it can be used to model sovereign debt default. This study provides a much more comprehensive examination of survival analysis and its related applications since the main aim of this chapter is to understand the use of this emerging statistical technique in empirical finance. We use the Cox Proportional Hazards model to assess the relationship between the distribution of the survival time and the independent variables. Empirical work, so far, has focused on investigating the importance of various economic factors in establishing the debt servicing capacity of borrowers. Beginning in the mid-1970s, with the rapid growth in sovereign external debt, debt servicing problems have become a topic of considerable importance. Due to the rise in international lending, banks have devoted a significant amount of work to assessing country credit risk. In the banking area, with the international banking system being a major creditor of less-developed countries (LDCs), country risk analysis has become essential. This paper adds a new dimension to the existing literature in that it focuses on the length, or more specifically, the duration of a default period.

The sample of emerging market sovereign issuers in default comes from the Standard & Poor's database and runs from 1975 to 2004. Default, as defined by Standard & Poor's is "the failure to meet a principal or interest payment on the due date (or within the specified grace period) contained in the original terms of the debt issue." The paper investigates the effect of eleven macroeconomic and seven balance sheet variables on the duration of three types of debt, namely foreign currency bank debt, local currency debt and foreign currency bond debt by utilizing a survival analysis approach. The distribution of survival times can be characterised by the survival function or the hazard function.

Univariate regressions are run with each of the independent variables while multivariate regressions with a combination of independent variables are run to determine the explanatory significance of the covariates. The analysis tests the null hypothesis that the independent variables considered together have no significant impact on the length of default of any one specific type of debt. The findings suggest that both macroeconomic and balance sheet variables contribute to some extent in predicting the length of default of the three types of debt. The fit of the model is improved by combining macroeconomic and balance sheet variables in one model for all types of debt. However, the explanatory power of this improved model as illustrated by the likelihood ratio statistic is best for foreign currency bank debt default.

The remainder of the work is organised as follows. Chapter 2 deals with the first of our empirical analyses, "International Evidence on Payout Ratio, Returns, Earnings and Dividends." Chapter 3 presents the second empirical study "Investigating Duration Dependence in Bull and Bear Markets." Chapter 4 exposes the last empirical study "Using Survival Analysis Approach to Model the Duration of

Sovereign Debt Default." Each chapter recapitulates the scope of each study in detail and its importance. Chapter 5 discusses the implications of the empirical results, identifies possible courses of future research and concludes the thesis.

2. International Evidence on Payout Ratio, Returns, Earnings and Dividends

Conventional view is that higher retained earnings would lead to undertaking more positive net present value projects and this in turn would result in subsequent higher earnings by companies. However, recent US evidence has shown that, contrary to popular belief, the greater the proportion of earnings paid out as dividends, the greater the subsequent real earnings growth. This study extends previously carried out work by examining whether a similar relationship exists in eleven international markets, and also by further defining the role payout ratio plays in explaining future real dividend growth and returns. Higher payout ratios do indeed lead to higher real earnings growth, although not to higher real dividend growth. Unfortunately, these findings do not translate to returns predictability in a persuasive fashion: the results are mixed for different countries and time periods.

2.1 Introduction

This paper aims to study the relationship between payout ratios, earnings, dividends, and returns in an international context. A study done by Arnott and Asness (2003) has shed new light on the conventional view that higher retained earnings would lead to undertaking more positive net present value projects and result in subsequent higher earnings by companies. In their paper, Arnott and Asness investigate whether the payout ratio of the U.S equity market portfolio forecasts future aggregate earnings growth. The historical evidence strongly suggests that expected future earnings growth is fastest when current payout ratios are high and slowest when payout ratios are low.

This paper studies whether a similar effect can be seen to exist in other countries. For the purpose of this study, a sample of eleven countries are used out of the 30-nation Organisation for Economic Cooperation and Development (OECD), namely the United States (US), the United Kingdom (UK), France (FR), Germany (GY), Italy (IT), Greece (GR), Spain (SP), Portugal (PT), Switzerland (SW), Netherlands (NL), and Japan (JP). These countries were chosen to represent the major industrialised markets of the world. The USA is used to support the findings of Arnott and Asness. It would be interesting to see whether the dividend and earnings culture pervasive in the US also exists in other countries. Research has shown that dividend payout ratios in the US have been at an all-time low. In addition, valuation ratios such as price-to-earnings ratios and price-to-dividend ratios have been high by historical standards. Analysts in the US are, therefore, very optimistic about high long-term earnings growth on the basis that payout ratios are low. However, the historical evidence shown by Arnott and Asness has challenged this optimistic view held by market observers.

The second section of this chapter deals with the literature review. There has been a considerable amount of academic discussion on dividends and the dividend policy. In 1961, Modigliani and Miller published the "irrelevance" theorem that stated that in a world without taxes, transaction costs, or other market "imperfections," a company's dividend policy should have no effect on its market value. An assumption crucial to the argument is the independence of a company's investment policy from its dividend policy; that is, the "irrelevance" argument holds only if the company's investment decisions are not influenced by management's insistence on maintaining or raising the company's dividend. However, Lintner (1956) found that corporations follow extremely deliberate dividend payout strategies and this evidence raised the question of how firms chose their dividend policies.

The reasons why companies pay dividends and their effect on company valuation have intrigued academic researchers for a number of years. In 1976, Fischer Black wrote an article entitled "The Dividend Puzzle." In a world where dividends are taxed more heavily (for most investors) than capital gains, and where capital gains are not taxed until realized, a corporation that pays no dividends will be more attractive to taxable individual investors than a similar corporation that pays dividends. This will tend to increase the price of the non-dividend-paying corporations' stock. Many corporations will be tempted to eliminate dividend payments. The higher rate of taxation on dividend income relative to capital gains has been offered as an explanation for the positive relation between stock returns and dividend yields. A number of studies including Litzenberger and Ramaswamy (1979, 1980, 1982), Morgan (1982) and Poterba and Summers (1984) have found a significant relationship between dividend yield and returns. Other studies have generated results that are inconsistent with the existence of tax effects (Black and Scholes,1984; and Miller and Scholes, 1981). Since, it has been found that different tax systems can have a different impact on the relative valuation of dividends and capital gains, this chapter also provides a description of the tax system in operation in each of the eleven countries.

In this chapter we also use, as a guide, a paper by La Porta *et al.* (2000) to understand how dividend policies address agency problems between corporate insiders and outside shareholders. La Porta *et al.* find that the severity of agency problems to which minority shareholders are exposed differs greatly across countries in part because legal protection of these shareholders varies.

The next section is the results section and is divided into two main parts. We test whether higher payout ratios predict higher future earnings growth. Using the constant-growth valuation model of Gordon (1962) which dictates that the expected return equals the dividend yield plus an assumed expected growth term G. In the analysis, this equation applies to a total market index portfolio. The first part of the results section deals with the growth term, G, being real earnings growth. In the second part, the growth term is taken to be real dividend growth.

It has been enlightening to find out that the same results presented in the Arnott and Asness (2003) paper can be observed in almost all of the eleven countries. We carry out our analysis on the original time periods associated with each country's data. However, due to the different data times frames, we also use three matched data periods to put the results on a more even plane for comparison purposes. For the matched data periods, all markets record a positive payout ratio coefficient with Italy standing as the lone exception over the 1-year horizon. Thus, overall, across various earnings growth horizons and using a number of countries, the evidence clearly points to the existence of a positive relationship between PR and REG. Although not following conventional theory, the findings are consistent with those of Arnott and Asness.

In the US, historical dividend growth is understated by the declining payout ratio trend. This is why most analyses use earnings data rather than dividend to forecast growth. However, in other countries a culture of dividends is still omnipresent. Following this train of thought, the paper aims to study the ability of payout ratio at explaining future real dividend growth. In fact, the findings show that most countries have a negative relationship between the payout ratio and dividend growth: the lower the payout ratio, the greater future real dividend growth.

This paper also investigates another important area of study which is the relationship between subsequent real returns and payout ratios, dividend yield, and earnings yield. It has been found that for the 5-year regressions there is no general relationship between the payout ratio and returns, with the coefficients showing a fairly even mix of positive and negative signs. Furthermore, the explanatory power for most of these regressions is negligible. We therefore conclude that there is little evidence within these results to suggest that the payout ratio has any ability to predict subsequent aggregate market returns. The majority of countries show a positive relationship between real returns and earnings yield, and the same applies to dividend yield. Finally, the last section of this chapter concludes the study.

2.2 Literature Review

2.2.1 Dividend Policy

Corporations view the dividend decision as quite important as it determines what funds flow to investors and what funds are retained by the firms for reinvestment. Dividend policy can also provide information to the stockholder concerning the firm's performance. There are different types of dividends. The most common type is in the form of cash. Public companies usually pay regular cash dividends four times a year. Sometimes firms will pay a regular cash dividend and an extra cash dividend. Paying a cash dividend reduces the corporate cash and retained earnings shown in the balance sheet, except in the case of a liquidating dividend (where paid-in capital may be reduced). Another type of dividend is paid out in shares of stock. This dividend is referred to as a stock dividend. It is not a true dividend because no cash leaves the firm. Rather, a stock dividend increases the number of shares outstanding, thereby reducing the value of each share.

The decision whether or not to pay a dividend rests in the hands of the board of directors of the corporation. A dividend is distributed to shareholders on record as of a specific date. The mechanics of a dividend payment can be followed by a certain number of steps.

1. On the declaration date, the board of directors declares a payment of dividends.
2. On the record date, the declared dividends are distributed to shareholders on record as of this date.
3. A share of stock becomes ex-dividend on the date the seller is entitled to keep the dividends; under NYSE rules, shares are traded ex-dividend on or after the second business day before the record date. Obviously, the ex-dividend date is

important because an individual purchasing the security before the ex-dividend date will receive the current dividend whereas another individual purchasing the security on or after this date will not receive the dividend.

4. On the payment date, the dividend checks are mailed to shareholders on record.

It is expected that the stock price will fall on the ex-dividend date. In a world with neither taxes nor transaction costs, the stock price would be expected to fall by the amount of the dividend. The amount of the price drop is a matter for empirical investigation. Elton and Gruber (1970) have argued that, due to personal taxes, the stock price should fall less than the dividend.

A powerful argument can be made that dividend policy does not matter. In the perfect world of Miller and Modigliani in which, among other things, there are no transaction costs broadly construed, no taxes, and costless information, it is now generally acknowledged that dividend policy should have no effect upon the value of equity provided the investment strategy of the firm is known (Miller and Modigliani, 1961). However, when real world considerations such as taxes are introduced, the story is different. Cash dividends received are taxed as ordinary income while capital gains are generally taxed at somewhat lower rates. However, dividends are taxable when distributed whereas taxes on capital gains are deferred until the stock is sold. Thus for individual shareholders, the effective tax rate on dividend income is higher than the tax rate on capital gains.

The relationship between dividend yields and common stock returns has received considerable attention. Financial theory indicates that the expected return on a security should be positively related to its dividend yield due to the disparity that exists between the tax rates for dividend yields and that for capital gains. Although the issue has been researched thoroughly, the empirical results are not generally consistent with each other. On one hand, Brennan (1970) as well as Litzenberger and Ramaswamy (1982) finds a positive relationship between expected pre-tax returns and dividend yields. Brennan (1970) advances one hypothesis which predicts that investors receive higher before-tax, risk-adjusted returns on stocks with higher anticipated dividend yield to compensate for the higher taxation of dividend income versus capital gains income.

On the other hand, both Black and Scholes (1974) and Miller and Scholes (1982) find no relationship between expected pre-tax returns and dividend yields. Black and Scholes (1974) refute the logic of the tax case against dividends. They argue that investors who require current income for consumption purposes may resort to dividend as a means of providing the necessary income. They further go on to say that investors weigh the benefits of receiving dividends against the tax disadvantages, and while some investors may prefer high dividend payouts others will ask for low payouts. Those paying no taxes would be predominantly holders of high-yielding stocks and those paying high taxes would be the predominant holders of low-yielding stocks. If in some sense, the array of different dividend-paying stocks were exactly equal to that demanded by the different clienteles, Black and Scholes made a case that it would not be possible to demonstrate that the expected returns on high yield common stocks differ from that on low yield common stocks either before or after taxes. Therefore, unless there are substantial costs associated with changes in dividend policy, one would expect in an efficiently operating capital market in which firms were optimising their stockholders' interests that there would be no observable relationship between risk-adjusted returns measured before stockholders' taxes and those dividend yields that actually prevail in the market – even if shareholders faced different tax rates.

The dividend puzzle (Black, 1976) has captured the attention of financial economists for a long time. Ever since Black (1976) published "The Dividend Puzzle," the corporate finance literature has struggled to rationalize the massive amounts of cash that firms distribute to stockholders. Feldstein and Green (1983) argue that the nearly universal policy of paying substantial dividends is the primary puzzle in the economics of corporate finance, with the particular focus being "Why do corporations not eliminate (or sharply reduce) their dividends and increase their retained earnings?" The genesis of the dividend puzzle is Miller and Modigliani's (1961) irrelevance proposition, which holds that the payout policy has no impact on stockholder wealth. In a nutshell, if a firm can essentially avoid distributing cash (or at least defer payouts for a very long time) without harming stockholders in frictionless settings, why would it distribute cash when flotation costs, taxes, and/or asymmetric information problems encourage retention? Miller (1977) built his "Debt and Taxes" analysis on the tax advantages of retention, but this classic paper offered no explanation as to why firms distributed so much cash despite these tax benefits. Over the last 25 years, a substantial literature has emerged to rationalize large payouts, positing a variety of signalling, tax, clientele, agency, and behavioural motivations. While these efforts have generated some useful insights, they have yet to provide a widely accepted solution to the dividend puzzle.

In the United States and other countries, the dividend puzzle is even deeper since many shareholders are taxed more heavily on their dividend receipts than on capital gains. One popular explanation for the puzzle is that firms can signal future profitability by paying dividends (Bhattacharya, 1979). Empirically this theory had considerable initial success as firms that initiated or raised dividends experienced share price increases and the converse was true for firms that eliminated or cut dividends. However, recent results are more mixed as current dividend changes do not help predict firms' future earnings growth (DeAngelo, 1996; and Benartzi, 1997).

Another idea which has received only limited attention until recently (Jensen, 1986; and Gomes, 2000) is that dividend policies address agency problems between corporate insiders and outside shareholders. According to these theories, unless profits are paid out to shareholders, they may be diverted by the insiders for personal use or committed to unprofitable projects that provide private benefits for the insiders. As a consequence, outside shareholders have a preference for dividends over retained earnings. La Porta *et al.* (2000) have attempted to identify some of the basic elements of the agency approach to dividends so as to understand its key implications and to evaluate them on a cross section of more than 4,000 firms and 33 countries.

The authors' reason for looking around the world is that the severity of agency problems to which minority shareholders are exposed differs greatly across countries, in part because legal protection of these shareholders varies. Empirically, they have found that dividend policies vary across legal regimes in ways consistent with a particular version of the agency theory of dividends. Specifically, firms in common law countries, where investor protection is typically better, make higher dividend payouts than firms in civil law countries do. Moreover, in common but not civil law countries, high growth firms make lower dividend payouts than low growth firms. These results support the version of the agency theory in which investors in good legal protection countries use their legal powers to extract dividends from firms, especially when reinvestment opportunities are poor.

As Miller and Modigliani (1961) have demonstrated, under the conditions known as "perfect capital markets," there is no good reason for corporate managements to prefer one dividend policy to another. Differences in dividend policy should not affect the value of the firm. Contrary to this prediction, however, corporations follow extremely deliberate dividend payout strategies (Lintner, 1956). This evidence raises the question of how firms choose their dividend policies. Lintner (1956) suggested that managers estimated what portion of the firm's earnings was likely to be permanent and what portion of the earnings was likely to be temporary. He looked at the dividend-payout patterns of firms and concluded that dividends were more likely to be raised following a permanent, rather than temporary, increase in earnings and that firms had a long-run target for their dividend-to-earnings ratio. However, because managers needed time to assess the permanence of any earnings rise, dividend changes appeared to lag earnings changes by a number of periods. It followed from Lintner's analysis that the dividend-to-earnings ratio rose when a company began a period of bad times and the ratio fell when a company reached a period of good times. Lintner also found that:

1. Managers tend to think of dividend payments in terms of a proportion of income and also think that investors are entitled to a "fair" share of corporate income. Corporations think in terms of a long-run target payout ratio.
2. Managers avoid making a change in the level of dividend payments if it will have to be reversed later. Thus, the level of dividends is more stable than the level of earnings. Firms "smooth" out changes in their dividends relative to changes in their earnings.

Taken together, Lintner's observations suggest that two parameters describe dividend policy: the target payout ratio, t, and the speed of adjustment of current dividends to the target, s. Dividend changes will tend to conform to the following type of model:

$$\mathrm{Div}_1 - \mathrm{Div}_0 = s * (t\mathrm{EPS}_1 - \mathrm{Div}_0)$$

where Div_1 and Div_0 are dividends in the next year and dividends in the current year respectively. EPS_1 is the earnings per share in the next year. A conservative company will have a low adjustment rate and a less conservative company a high adjustment rate. As can be seen, if $s = 0$, $Div_1 = Div_0$ and if $s = 1$, the actual change in dividends will be equal to the target change in dividends. The level of dividends will be set by t. A firm will have a low t if it has many NPV projects and a high t if it has few positive NPV projects relative to available cash flow.

2.2.2 Relationship between Dividend Yield and Returns

Over the past decade, a number of researchers have explored the time series behaviour of dividend yields. Several studies provide support for the use of the dividend-price ratio as a measure of expected stock returns. If the stock price represents a claim to the future stream of dividends, the price can be exactly determined assuming constantly growing dividends and a known discount rate. Under the Gordon growth model,

$$P_t = \sum_{t=1}^{\infty} D_t\,(1 + g)^i / (1 + r)^i = D_{t+1}/(r - g)$$

where P is the stock price, D is the dividend, r is the discount rate, and g is the constant growth rate of dividends. In the certainty model, the discount rate is the expected return on the stock. Although the model is not directly applicable to the case in which growth rates and discount rates vary through time, the model suggests that dividend yields should capture variations in expected stock returns.

Fama and French (1988) use a regression framework to show that the dividend yield predicts a significant proportion of multiple year returns to the NYSE index. They further observe that the explanatory power of the dividend yield increases as the time horizon of the returns increases; over four-year horizons, R^2's range from a low of 19% to an astonishingly high value of 64%. Similar results are reported by Campbell and Schiller (1988). The apparent predictability of market returns from past values of dividend yields is regarded by Rozeff (1984) as support for the rejection of the random walk model of stock prices, and by Fama and French (1988) as evidence for the cyclical behaviour of expected returns.

The direct and somewhat disturbing implications of most of these studies is that significant components of long-term stock returns may be predicted using combinations of past returns and macroeconomic variables. However, Goetzmann and Jorion (1993) using a bootstrap methodology have re-examined the ability of dividend yields to predict long-horizon stock returns. In bootstrapped regressions of one to four-year returns of the S&P stock return index on the preceding dividend yield, they fail to reject the null hypothesis that future returns are unrelated to past dividend yields at conventional significance levels. Moreover, when they explicitly model the null hypothesis as a random walk, they find that the observed regressions of return on past dividend yields provide only marginal statistical significance against the random walk.

If long-term market returns are predicted by the dividend yield, the following regression should produce a significant coefficient and a non trivial R^2:

$$R_{t,t+T} = \alpha_T + \beta_T Y_T + \varepsilon_{t,\, t+T}$$

Where $R_{t,t+T}$ is the compound total stock return from month t to month t + T and Y_T is the ratio Dt/Pt, the annual dividend up to time t divided by the stock price as of time t. The null hypothesis is that there is no relation between $R_{t,t+T}$ and Y_T, i.e., that $\beta_T = 0$.

Keim (1985) focuses on the relationship between stock returns and long-run dividend yields and finds that the relation is non-linear. Moreover, the author finds that much of the relation is due to a significant non-linear relationship between dividend yields and returns in the month of January. Regression coefficients on dividend yields which some models predict should be non-zero due to differential taxation of dividends and capital gains exhibit a significant January seasonal effect, even when controlling for size. This finding is significant since there are no provisions in the after-tax asset pricing models that predict the tax differential is more important in January than in other months. Hence these results provide evidence that the average returns on the dividend yield portfolios are non-linearly related with average yields. Keim also investigates the relation between yield and size, using the total market value of equity as a proxy for size and concludes that the peaks and troughs of the non-linear long-run yield function may be due to the location of small and large firms within the dividend yield range. Keim's therefore deduces that the relationship between long-run dividend yield and stock returns cannot be solely due to differences in marginal tax rates for dividends and capital gains.

Previous research examining the relation between dividend yield and equity returns documents a U-shaped pattern arising from the positive CAPM-adjusted average excess returns of zero-dividend firms. Christie (1990) examines the unique role of zero-dividend firms in the empirical relation between excess equity returns and anticipated dividend yields. Using a size-based expected-returns model the author shows that zero-dividend firms earn negative excess returns of -0.41% per month over the 1946-1985 period relative to firms of similar size. Despite the general conformity of the yield-return function during the post-war years to the predictions of after-tax models of equilibrium returns, the negative size-adjusted excess returns cannot be attributed solely to tax effects. The study suggests that a dividend-expectation effect may be driving the observed before-tax return differential.

2.2.3 Predictive Power of Valuation Ratios

Very little work has been done on the dividend payout ratio and its role in asset pricing and forecasting market behaviour. Lamont (1998) finds that the aggregate payout ratio forecasts excess return on both stocks and corporate bonds in post-war U.S. data. High dividends are found to forecast high returns while high earnings are found to forecast low returns. The correlation of earnings with business conditions gives them predictive power for returns as they contain information about future returns that is not captured by other variables. Lamont also observes that dividends and earnings contribute substantial explanatory power at short horizons. However, in forecasts of long-horizon returns, only scaled stock prices matter.

The scaled price variables, the dividend yield (D/P) and Earnings Yield (E/Y) have been used to predict future stock returns. Shiller (1984) and Fama and French

(1988) estimate regressions of returns on either the lagged dividend yield or the lagged earnings yield and find that both have explanatory power, with a dominant contribution from dividend yield. Fama and French (1988) also find earnings to be more variable than dividends and conclude that if this higher variability is unrelated to the variation in expected returns, E/P is a noisier measure of expected returns than D/P. However, Lamont's study (1998) finds that the higher variability of earnings is not noise but is actually related to expected returns.

The dividend payout ratio helps forecast returns because both dividends and earnings have separately identifiable ability. Dividends contain information about future returns because they help measure the value of future dividends. Earnings, on the other hand, contain information because they are correlated with current business conditions. Risk premia on stocks covary negatively with current economic activity: investors require high expected returns in recessions and lower expected returns in booms. Since earnings vary with economic activity, current earnings predict future returns. The information dividends and earnings contain is chiefly about short-run variation in expected returns. Price is the only relevant variable for forecasting long-horizon returns.

Apart from Lamont's paper, research on the relationship between the payout ratio and returns has been negligible. Over the past few years the propensity to pay dividends has declined. This trend which is more pronounced in the U.S. has shown dividend payout ratios to be driven to unprecedented low levels from the late 1999 to mid-2001. The proportion of firms paying cash dividends has fallen from 66.5% in 1978 to 20.8% in 1999 in the U.S. due in part to the changing characteristics of publicly traded firms. Fama and French (2001) find that the population of publicly traded firms tilts increasingly toward small firms with low profitability and strong growth opportunities, and those are characteristics typical of firms that have never paid dividends. They also conclude that regardless of their characteristics, firms have become less likely to pay dividends, and thus this lower propensity to pay is at least as important as changing firm characteristics in the declining incidence of dividend-paying firms.

Among academic researchers, conventional wisdom regarding the predictability of stock prices has shifted dramatically over the past couple of decades. While early empirical evidence favoured the random walk hypothesis for stock returns, accumulating empirical evidence now suggests that stock returns are, in fact, partly predictable. The initial trickle of evidence in favour of predictability, obtained by examining the univariate time series properties of stock prices (Lo and MacKinlay, 1988; and Poterba and Summers, 1988) has been supplemented by convincing evidence that accounting and financial variables appear to have predictive power for stock returns (Fama and French, 1988, 1989; Campbell and Shiller, 1988; and Lakonishok, Shleiffer and Vishny, 1994).

Campbell and Shiller (2001) examine the use of price-earnings ratios and dividend-price ratios as forecasting variables for the stock market using aggregate annual U.S. data from 1871 to 2000 and aggregate quarterly data for twelve countries since 1970. Various simple efficient-markets models of financial markets imply that these ratios should be useful in forecasting future dividend growth, future earnings growth or future productivity growth. Campbell and Shiller conclude that, overall, the ratios do poorly in forecasting any of these. Rather, the ratios appear to be useful primarily in forecasting future stock price changes, contrary to the simple efficient-markets models.

Stock market valuation ratios such as dividend-price and price-earnings ratios have stayed at extremely high levels by historical standards for some years in the U.S. It is reasonable to suspect that prices are not likely to ever drift too far from their normal levels relative to indicators of fundamental value, such as dividends and earnings. Thus, it seems natural to give at least some weight to the simple mean-reversion theory that when stock prices are very high relative to these indicators, as they have been recently, then prices will eventually fall in the future to bring the ratios back to more normal historical levels. Campbell and Shiller (2001) explain that if we accept the premise that valuation ratios will continue to fluctuate within their historical ranges in the future, and neither move permanently outside nor get stuck at one extreme of their historical ranges, then when a valuation ratio is at an extreme level either the numerator or the denominator of the ratio must move in a direction that restores the ratio to a more normal level. Moreover, they argue that either the numerator or the denominator must be forecastable based on the ratio. For example, high prices relative to dividends, that is, a low dividend-price ratio, must forecast some combination of unusual increases in dividends and declines (or at least slow growth) in prices.

The conventional random-walk theory of the stock market is that stock price changes are not predictable, so that neither the dividend-price ratio nor any other valuation ratio has any ability to forecast movements in stock prices. From the Gordon equation: $R = D/P + G$, D/P is a component of the stock return. The random-walk theory says that a lower dividend-price ratio should be associated with slightly more rapid price growth to offset the lower dividend component of return. In other words, the theory says that prices should move in a direction that drives the dividend-price ratio away from its historical average; dividends must do all the necessary adjustment to bring the ratio back to its historical average. Random walk theory is oversimplified as the theory actually says that returns, not prices, should be unforecastable. However, the difference between return and price change is small and in practice forecasts of returns and forecasts of price changes are very similar.

The dividend-price ratio is a widely used valuation ratio but it has the disadvantage that its behaviour can be affected by shifts in corporate financial policy. As a tax-favoured alternative to paying dividends, companies can repurchase their stock. Repurchases transfer cash to those shareholders who sell their stock and benefit ongoing shareholders because future dividend payments will be divided among fewer shares. If a corporation permanently diverts funds from dividends to a repurchase program, it reduces current dividends but begins an ongoing reduction in the number of shares and thus increases the long-run growth rate of dividends per share. This in turn can permanently lower the dividend-price ratio, driving it outside its normal historical range. One way to adjust the dividend-price ratio for shifts in corporate financial policy is to add net repurchases (dollars spent on repurchases less dollars received from new issues) to dividends. This approach assumes that both repurchases and issue of shares take place at market value, so that dollars spent and received correspond directly to shares repurchased and issued. In practice, however, many companies issue shares below market value as part of their employee stock option incentive plans.

Another valuation ratio commonly used is the price-earnings ratio. Campbell and Shiller[1] (2001) use a price-smoothed-earnings ratio to forecast price change. This price-smoothed-earnings ratio responds to long-run variations in the level of stock prices. It has roughly the same range of variation as the conventional price-earnings ratio with a slightly higher mean. The results of the study are that the price-smoothed-earnings ratio has little ability to predict future growth in smoothed earnings. However, Campbell and Shiller find that the ratio is a good forecaster of ten-year growth in stock prices.

Campbell and Shiller have carried their analysis to an international level. They found that countries such as Australia, Canada, and the U.K. behaved very much like the U.S. The dividend-price ratio was positively associated with subsequent price growth, and showed little reaction to subsequent dividend growth. However, several Continental European countries like France, Germany, Italy, Sweden and Switzerland showed a very different pattern. In these countries, a high dividend-price ratio was associated with weak subsequent dividend growth, just as the efficient-markets theory would imply. There was little relation between the dividend price ratio and subsequent price growth. Japan and Spain represent an intermediate case in which the dividend-price ratio appears to have been associated with both subsequent dividend growth and subsequent price growth. Finally the Netherlands show no clear relation between the dividend-price ratio and subsequent growth rates of either dividends or prices. Hence these recent international data provide mixed evidence.

Arnott and Asness (2003) investigate whether dividend policy, as observed in the payout ratio of the U.S equity market portfolio, forecasts future aggregate earnings growth. The historical evidence strongly suggests that expected future earnings growth is fastest when current payout ratios are high and slowest when payout ratios are low. The evidence presented by Arnott and Asness contradicts the views of many who believe that substantial reinvestment of retained earnings will fuel faster future earnings growth. It is consistent with the view of managers signalling their earnings expectations through dividend or engaging, at times, in inefficient empire building.

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[1] Campbell and Shiller use Benjamin Graham's and David Dodd's advise that for purposes of examining valuation ratios, one should use an average of earnings of "not less that five years, preferable seven or ten years." Campbell and Shiller smooth earnings by taking an average of real earnings over the past ten years.

Market-wide dividend payout ratios in the U.S. have been in the lowest historical decile. This combined with high valuation ratios may cause long-run future equity returns to fall below historical norms unless future earnings growth is faster than normal. In their paper, Arnott and Asness use the constant-growth valuation model of Gordon (1962) to illustrate their point.

$$R = D/P + G$$

Expected return, R, equals the dividend yield, D/P, plus an assumed constant expected growth term, G. This equation can be rewritten in the following way:

$$R = (D/E) * (E/P) + G$$

where D/E is the dividend-payout ratio and E/P is the earnings yield. Assuming dividend policy does not affect the expected return on the market portfolio and assuming the payout ratio is constant through time, so earnings and dividend growth are equal, a low payout ratio (D/E) must be offset by a low P/E or by high expected growth. Arnott and Asness make use of Modigliani and Miller's (1961) indifference proposition whereby investors are indifferent to dividend policy in the general algebraic case. As the level of earnings remains fixed there is no change in the earnings yield. The decrease in the payout ratio must therefore be absorbed by an opposite shift in the expected growth term. Moreover, Arnott and Asness claim that in the past 130 years US equity P/Es have not offset variation in payout ratios. It is also well-known that recent P/Es have been very high.

There has always been indecision about what should be taken as the long-run growth term, G. According to Ilmanen (2003), some authors have used earnings data, others dividend data, and yet others gross domestic product data to proxy for cash flows. However, it has been shown that dividend growth is understated by the declining trend in dividend payout rates since the late 1970's, partly related to firms' shift from dividend payments towards share repurchases. The author finds that this trend has increased from 33.5% in 1978 to 79.2% in 1999. The same trend is observed in the U.K but to a lesser extent as a culture of dividends is much more deeply rooted in the U.K than in the U.S. In this chapter, we investigate both real earnings growth and real dividend growth as being the growth term.

The results generated by Arnott and Asness (2003) agree with historical evidence that strongly suggests expected future earnings growth is fastest when current payout ratio is high and slowest when payout ratio is low. This evidence is based on U.S. data, mainly using the S&P 500 Index as main template. The authors have tried to explain their results by saying that corporate managers do not like to cut dividends. A high payout ratio would probably indicate managerial confidence in the stability and growth of future earnings and a low payout ratio would indicate the opposite. Another hypothesis is that companies sometimes retain too much of their earnings as a result of the managers' desires to build empires (Jensen, 1986). The assumption here is that inefficient empire building sets the groundwork for poor earnings growth in the future. On the other hand, financing through share issuance and paying substantial dividends, although perhaps less tax efficient, may subject management to more scrutiny, reduce conflicts of interest and thus curtail empire building. Another explanation advanced by Arnott and Asness is that the positive relationship between the payout ratio and subsequent earnings growth might be driven by sticky dividends (Lintner, 1956) combined with mean reversion in more volatile earnings. Temporary peaks and troughs in earnings, subsequently reversed, could cause the payout ratio to be positively correlated with future earnings growth, that is, temporarily low earnings today cause a high payout ratio; thus forecasting the earnings snapback tomorrow. Finally, such results brought about in the authors' paper might be due to an error in the data or experimental design. For instance, the results might be time-period specific, either as to the years covered by the study or the length of the forecasting period.

2.2.4 Tax Structure

Under the assumption of perfect capital markets when a firm pays dividends, the shareholder is indifferent between capital gains and the payment of dividends. However, when income taxes are introduced, dividend policy appears to be relevant to the firm's valuation as there is a differential tax advantage of capital gains versus dividend income. This is due to the double taxation of dividends (for example in the US) and to the historically higher tax rate on ordinary income than on capital gains income. In order to understand the effect of taxation on the dividend policy, it is necessary to understand the tax system under which each country operates.

In a world without taxes, investors would have no incentive to prefer one particular group of stocks. So they would hold well-diversified portfolios that moved closely with the market. But the fact that investors pay taxes at different rates on investment income provides an incentive for them to hold different portfolios. For example, an investor who is highly taxed on his dividend income has an incentive to slant his portfolio towards the low payout stocks, even though this results in a less well-diversified portfolio. This extra demand by highly-taxed investors for low-yield stocks will cause their prices to rise. As a result, tax-exempt investors such as pension funds will be induced to slant their portfolios towards the high-yielding stocks even though this causes their portfolios also to be less well-diversified. In between these two extremes is the investor with an "average" rate of tax. He has no incentive to slant his portfolio towards one particular group of stocks and will, therefore, invest in a well-diversified portfolio of high and low-yielders.

The investor who pays tax at the average rate will be prepared to hold a well-diversified portfolio of both high and low-yielders only if he receives equal returns after tax. If the returns are to be equal after tax, the high yielders must offer a higher return before tax. Thus, given two stocks which promise equal total returns (dividends plus capital gains) to investors, the stock that provides more of its return in the form of dividends will have a higher pre-tax expected return, and thus a lower stock price, than the one whose return is expected mostly in the form of capital gain.

Morgan and Thomas (1998) find that, generally, a positive relationship exists between stock returns and anticipated dividend yields in the United States. Because dividends are higher taxed than capital gain, investors will demand a higher before-tax return from stocks which provide a large proportion of their return in the form of highly taxed dividends. One implication is that an individual in a zero tax bracket should invest in securities with high dividend yields. There is at least casual evidence that pension funds, which are not subject to taxes, select securities with high dividend yields. The UK system, however, treats dividend income more leniently. The work of Morgan and Thomas (1998) also shows the same situation present in the US as existing in the UK despite a very different tax structure. It is important to know more about the tax system of each country in our sample to have a grasp of how different tax systems can have an impact on the relative valuation of dividends and capital gains.

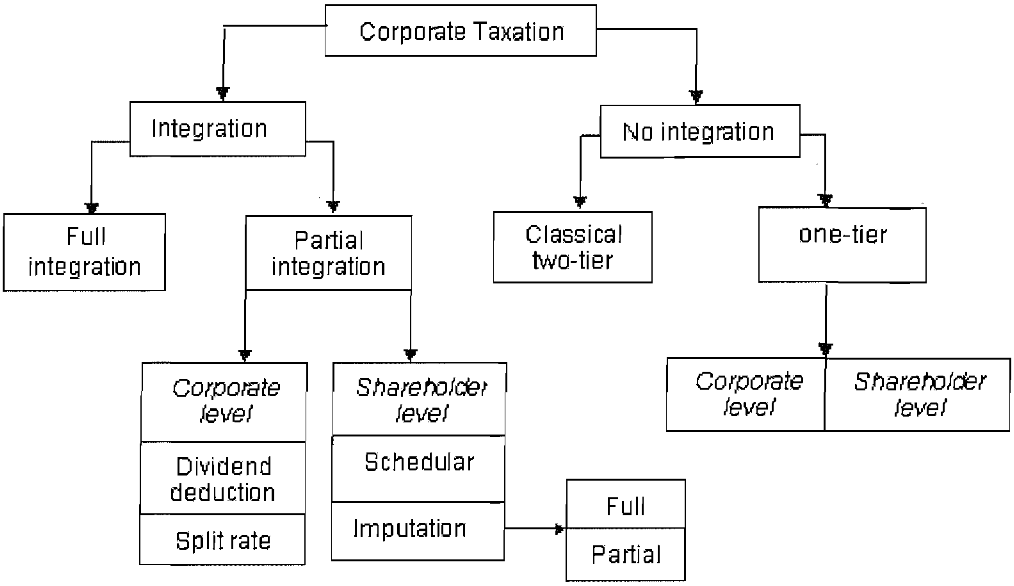
Under the classical system, corporation tax operates separately from personal tax. Consequently dividends are subject to double taxation, first at the corporation level and then in the hands of the shareholders at their personal income tax rate. However, in European countries, the classical system was replaced by the imputation tax system, under which shareholders are entitled to a partial/full tax credit for the corporation tax paid on the underlying profits distributed. No tax credits are provided on capital gains. Thus imputation systems are designed to alleviate the double taxation on dividends and reduce the shareholders' preference for retained earnings. The US and Switzerland are the only countries in our sample following a classical tax system.

Under the imputation system, shareholders receive credit for taxes paid by the company on earnings distributed as dividends. These credits may be used to offset shareholders' tax liability. Part of the corporate tax liability on distributed profits is "imputed" to shareholders and regarded as prepayment of their personal income tax. In the most frequent version of the imputation system, dividends are regarded as having borne personal tax at the "imputation" rate t_{imp} and shareholders are liable only for the difference between their marginal tax rates on personal income and the imputation rate (i.e., they pay taxes on dividend receipts at the rate $t_{div} - t_{imp}$). Accordingly, the value to an investor of one dollar in earnings distributed in the form of dividends is equal to $(1-t_{corp} + t_{imp}) * (1 - t_{div})$. In certain countries, the operation of the system is defined in terms of a tax credit rate t_{cred} and not an imputation rate. In those countries that rely on tax credits, shareholders are liable for the difference between the personal taxes owed on dividends-cum-tax-credit received and the tax credit (i.e., they pay taxes on dividend receipts at the rate $(1 + t_{cred}) * (t_{div} - t_{cred})$. In such case, t_{cred} is re-expressed in terms of its associated t_{imp} and the formula is used for the imputation system.

If the relationship between dividend yields and returns is primarily driven by tax effects, then relationship observed under the imputation system should be the reverse of that observed under the classical system. High yielding stocks should earn low risk-adjusted returns, whilst low yielding stocks should generate higher returns to compensate investors for the increased tax burden associated with capital gains. Stock with a zero yield should be required to produce the highest returns of all, since all their returns will be received by investors in the form of capital gains.

There is a global trend toward lower tax rates on all forms of capital income, including corporate income taxes and individual taxes on dividends and capital gains. Policymakers in many countries are recognizing that high capital income taxes distort savings and investment decisions and reduce economic growth. There are different tax regimes as shown in the figure below and different countries have adopted different models. Economic double taxation (EDT) of corporate income refers to the fact that income is first taxed at the corporate level when it arises and then taxed a second time at the shareholder level when it is distributed. Most of the countries within the European Union integrate the corporate and shareholder taxation and a variety of methods have been employed. Some of them are trivial in the sense that they amount to reducing one of the nominal tax rates involved, i.e. the corporate tax rate or the shareholders' tax rates on dividends or capital gains, or allowing the corporations to accelerate depreciation allowances. Other methods are more complicated, such as the imputation system at the shareholder level, the split rate system and dividend deductions at the corporate level.

Figure 2-1. Main corporate Taxation models



A 'no integration' corporate tax system is one that considers companies and shareholders as different entities. Hence, corporate income and dividends are treated as totally distinct from each other and taxed independently. There are two types of no integration tax systems:

1. Classical two-tier system

   Tax is levied on both corporate income and distributed profits (i.e. dividend). This results in double taxation of the same income. Few countries adopt such a system, like Switzerland and the US.
2. One-tier system

   Tax is levied only once, either at the company's level or at the shareholders' level. Hong Kong and Ireland adopt this system.

Tax systems that adopt the principle of integration are those which recognise that dividends are of similar source as corporate income. As such, tax relief (partial or full) is given to avoid double taxation of income. There are two types of integration tax systems:

1. Full integration

   Tax all profits at the shareholders' level only, regardless of whether the profits are actually distributed.

2. Partial integration

   Relief is accorded either at the corporate or at the shareholder level. Many variations of partial integration exist, the main ones are the dividend deduction, split rate, and imputation (full or partial). Singapore has a full-imputation system.

Under the classical system, no relief is given for double taxation. Under full integration (e.g. France), corporate profits, whether paid out as dividend or retained by the company, is deemed to be a part of shareholder's income. However, a tax credit is allowed from a shareholder's personal income tax for tax paid by the company. This method is hard to administer and difficult for individual shareholders to follow. Other compromises, or partial integration systems, are the split rate system (e.g. Japan) under which dividends are taxed at a lower rate than retained earnings; the imputation or dividend credit (Australia, New Zealand) under which personal income is "grossed up" by the amount of corporation tax paid but a credit is then allowed for corporation tax from gross personal tax due; and partial or full dividend deduction at either the level of the company or shareholder (Sweden). Perhaps the easiest system, administratively, of giving relief to dividends is exemption of dividend income from the personal income tax.

United States

The United States uses the classical taxation system where the corporate and shareholder taxes are not integrated. There are several different methods in which relief could be provided for the double taxation of corporate dividends in the United States. One would provide a shareholder credit for corporate taxes paid. When a corporate shareholder receives a taxable dividend, the shareholder would be entitled to a credit against their taxes for the corporate taxes effectively paid on the dividend income. Most countries that have tax relief for double taxation of dividends use a form of the shareholder credit. However, the Treasury Department advised against this approach in a 1992 report because of the complexity of actually implementing the shareholder credit. In its report, Treasury recommended instead that dividend tax relief could be better implemented if a shareholder was allowed to exclude from gross income the dividends received from a corporation.

United Kingdom

The UK has a partial imputation tax system adopted in 1973 whereby when a company distributes profits it must also pay an Advanced Corporation Tax (ACT) equivalent to the basic income tax rate, on the gross dividend to the Inland Revenue. The essence of the imputation system is that when a shareholder receives dividends, he is deemed to have already paid income tax at the basic tax rate. Before July 1997, tax-exempt investors could receive a full tax credit equal to the ACT. Higher rate taxpayers, on the other hand, would be subject to additional income tax. After July 1997, the dividend tax credit was no longer refundable to corporations and pension funds. The tax credit, however, remained refundable to individuals until the 1999 Finance Act was introduced. Then, tax-exempt investors were no longer able to reclaim the tax paid on their behalf. Also, the ACT rate was reduced, along with the basic rate of tax on dividends, from 20% to 10%. The higher tax rate on dividends was also cut from 40% to 32.5%. The changes did not affect high-rate taxpayers but tax-exempt investors lost their tax credit.

Germany

The German tax system was adopted in 1977 and combines the features of a split rate system with those of a full imputation system. At company level, profits distributed are subject to a lower corporation tax rate than retained profits. As from 1998 headline tax rates of 40% on retained profits and 30% on distributed profits were augmented by a 5.5% solidarity surcharge and additional local taxes on corporate profits ranged from around 13% to 20%. Shareholders are entitled to a tax credit on dividend received equivalent to the full amount of tax paid at the company level, which is credited against their tax liability. Capital gains are taxed as ordinary income. Foreigners are not entitled to tax credit but dividend stripping remains possible as corporate and individual non-residents may sell their shares to German residents who are entitled to the dividend and credits attaching thereto.

France

A full imputation tax system was introduced in France in 1993 following a partial imputation system since 1966. The French system remains different from other European countries as the top marginal income tax rate is amongst the highest in Europe but the average rate of this tax is one of the lowest. Companies are liable to corporation tax on their annual profits at the rate of 36⅔ while net profits available for distribution are grossed up by the Avoir Fiscal (imputation tax credit rate) and then taxed at the corporate income tax rate of 36⅔. Dividends distributed out of profits that have not borne the full corporation tax (e.g. profits not generated in France) are subject to equalisation tax, the "précompte". Shareholders are entitled to the avoir fiscal (the dividend tax credit fraction of corporation tax already paid by the company). The avoir fiscal is added to the shareholders' taxable income and its amount is deducted from the tax chargeable to the shareholders in order to avoid economic double taxation borne by distributed corporate profit. Capital gains from the sale of shares or bonds are taxed at a rate of 16% plus a 3.9% social contribution tax.

Italy

In Italy, a full imputation system was adopted in 1977. Italian companies are subject to IRPEG (Imposta sul Reddito delle Persone Giuridiche), the corporate tax and ILOR (Imposta Local sul Redditi), a so-called income tax which in effect is best thought as an additional levy on corporate profits. To foster company capitalisation, Dual Income Tax (DIT) has been introduced in 1997 that carries a reduction for part of corporate gains and that applies in the event of any increase in net assets in the form of capital conferment by business partners or out of undistributed dividend reserves. Since 1998 companies must form two separate baskets "A" and "B" when preparing their income tax return and calculate the tax credit of the dividend received. "A" consists of the amount of income tax actually paid by the company that distributes dividends. The rationale of this provision is to grant full imputation tax credit to the Italian resident shareholder but only to the extent that corporation tax has been actually paid by the distributing company. "B" is the "figurative tax" corresponding to the receipt of tax-free profits distributed as dividends. Shareholders are taxed on the grossed up dividends received and are entitled to a full dividend tax credit including a credit of 10% withholding tax on the dividend payment. In the Italian market, companies issue two types of equity:

1. Common stocks and preferred stocks are registered stocks and shareholders have to be listed in the company's book also provided to the tax authorities.

2. Convertible and non-convertible savings which are bearer stocks and shareholders can maintain their anonymity. These shares do not provide voting rights but provide a privilege for yearly dividends of no less than 5% of par value or the common stock dividend plus 2% of par value whichever is greater.

Capital gains accrued from substantial holdings are taxed at 27% while capital gains on all other equity holdings are taxed at 12.5%.

Greece

Greece fully exempts domestic dividends from individual taxation. The Greek solution not to tax dividend income at the personal level can be interpreted as applying a flat personal income tax rate of zero.

Portugal

Portugal adopted the imputation tax system in 2000. Such a system provides recipients with a tax credit for corporate taxes paid prior to the distribution of dividends. In order to relieve double taxation, Portugal sets the individual tax rate on dividends lower than the ordinary top rate on wages. It offers a reduced dividend tax rate of 20%. The taxpayer has a choice between including dividends in taxable income and receiving a partial credit against the corporate income tax or paying a withholding tax rate of 25% as a dispensatory tax.

The partial credit rate against the corporate income tax was 50% in the year 2001. The credit is included in taxable income, so the tax relief it generates is given by $TC * t_{irc} * (1- t_{irs})$, where TC is the tax credit rate, t_{irc} is the corporate income tax rate (32% in 2000) and t_{irs} is the personal income tax rate applying to the bracket where the taxpayer's income lies. There are no published statistics on how many taxpayers take advantage of the tax credit, but an inquiry next to the staff of the Directorate General for Taxation revealed that number to be insignificant as almost all households with dividends choose the dispensatory regime. This result is surprising because since the mid 90s the tax minimizing strategy for all taxpayers, even in the highest bracket, is to include dividends in taxable income. One additional tax benefit to be taken into account is that dividends from corporations listed in the Portuguese stock market are only partially taxable under the personal income tax. In the year 2000 only 60% of the dividends were taxable whereas that proportion in 2001 climbed 80%. Finally, one should notice that a 25% final withholding tax rate applies to dividends or any other type of distributed profits going to non-residents.

Netherlands

Under the present Income Tax Act taxation on income from investments is based on the assumption that people will have a taxable return of 4% on their stocks and other shares. Shareholders are not separately liable for income tax on the actual dividend they receive. For non-residents the dividend tax levied on a dividend is in principle a final levy. Netherlands has introduced a flat rate personal income tax schedule for dividend income, which allows the collection of the tax as a withholding tax without a further assessment procedure. This country offers a reduced dividend tax rate of 25%. This flat rate is half or even less than half the top personal income tax rate. Since the personal income tax schedule is progressive, Netherlands provides an assessment option if dividend income earners would pay a personal income tax rate on their total annual income, which is lower than the flat rate.

The corporation paying the dividend withholds dividend tax at a rate of 25% and pays the tax to the Tax Department. Shareholders are liable for income tax on the gross dividend they receive. An amount of this dividend is exempted from income tax.

Spain

Spain offers partial credit. For correcting the effect of double taxation of dividends there is an "imputation correction system". This method consists of computation of 140% of the delivered dividend, allowing for a discount of 40% of paid dividends on tax return. The correction of double taxation is not complete, only lessened.

Switzerland

Switzerland has a classical tax system. It does not relieve double taxation at present although there are reforms in sight to take care of the matter. Its corporate tax rate is 24.5%, which is much lower than the U.S. federal corporate rate of 35%. Capital gains are taxed at the normal ordinary tax rate.

Japan

Japan operates a hybrid classical system (split rate system) that provides some relief from double taxation of dividends by imposing a lower flat rate on dividends instead of an income tax.

2.2.5 Shareholder Protection

As Miller and Modigliani (1961) have demonstrated, under the conditions known as "perfect capital markets," there is no good reason for corporate managements to prefer one dividend policy to another. Differences in dividend policy should not affect the value of the firm. One of the central assumptions of the Miller-Modigliani proposition, and of modern finance as well, is that the interests of management and stock holders are reasonably consonant, if not inseparable. Corporate managements, therefore, are assured to act so as to maximise shareholder wealth. This in turn implies that the market values of companies with more diverse ownership will not differ, other things equal, from companies which are owned and run largely by insiders.

The most forceful challenge to this standard assumption of the modern finance literature has come from the "agency cost" argument originated by Michael Jensen and William Meckling (1976). Jensen and Meckling argue that the separation of ownership and control may explain a lot about corporate behaviour that does not appear rational under the assumptions of perfect markets. More precisely, they argue that "agency costs" result from the potential conflict of interests between "agents" (managers) and "principals" (stockholders/owners). This agency problem between corporate insiders and outside shareholders, it is believed, can be addressed by dividend policies. Unless profits are paid out to shareholders, they may be diverted by the insiders for personal use or committed to unprofitable projects that provide private benefits for the insiders. As a consequence, outside shareholders have a preference for dividends over retained earnings.

By paying dividends, insiders return corporate earnings to investors and hence are no longer capable of using these earnings to benefit themselves. In addition, the payment of dividends exposes companies to the possible need to approach the capital markets in the future to raise external funds, and hence gives outside investors an opportunity to exercise some control over the insiders at that time (Easterbrook, 1984).

La Porta *et al.* (2000) distinguish between two different agency models of dividends. Under the first view, the 'outcome model', dividends are an outcome of an effective system of legal protection of shareholders. Under this system, minority shareholders use their legal powers to force companies to disgorge cash, thus precluding insiders from using too high a fraction of company earnings to benefit themselves. Shareholders may do so by voting for directors who offer better dividend policies, by selling shares to potential hostile raiders who then gain control over non-dividend paying companies, or by suing companies that spend too lavishly on activities that benefit only the insiders. Moreover, good investor protection makes asset diversion legally riskier and more expensive for the insiders, thereby raising the relative attraction of dividends for them. The greater the rights of the minority shareholders, the more cash they can extract from the company, other things equal.

Another implication of that theory is that in a country with good shareholder protection shareholders, who feel protected, would accept low dividend payouts and high reinvestment rates from a company with good opportunities because they know that when this company's investment pays off, they could extract high dividends. In contrast, a mature company with poor investment opportunities would not be allowed to invest unprofitably. As a consequence, with good shareholder protection, high growth companies should have significantly lower dividend payouts than low growth companies. In contrast, if shareholder protection is poor, such a relationship between payouts and growth would not necessarily be expected as the shareholders might try to get what they could immediately.

In an alternative agency model, dividends are a substitute for legal protection. This view relies crucially on the need for firms to come to the external capital markets for funds, at least occasionally. To be able to raise external funds on attractive terms, a firm must establish a reputation for moderation in expropriating shareholders. One way to establish such a reputation is by paying dividends, which reduces what is left for expropriation. For this mechanism to work, the firm must never want to "cash in" its reputation by stopping dividends and expropriating shareholders entirely. The firm would never want to cash in if, for example, there is enough uncertainty about its future cash flows that the option of going back to the capital market is always valuable (Bulon and Rogoff, 1989).

A reputation for good treatment of shareholders is worth the most in countries with weak legal protection of minority shareholders, who have little else to rely on. As a consequence, the need for dividends to establish a reputation is the greatest in such countries. In countries with stronger shareholder protection, in contrast, the need for a reputational mechanism is weaker, and hence so is the need to pay dividends. This view implied that other things equal, dividend payout ratios should be higher in countries with weal legal protection of shareholder than in those with strong protection.

Additionally, in this view, firms with better growth prospects also have a stronger incentive to establish a reputation since they have a greater potential need for external finance, other things equal. As a result, firms with better growth prospects might choose higher dividend payout ratios than firms with poor growth prospects. However, firms with good growth prospects also have a better current use of funds than firms with poor growth prospects. The relationship between growth prospects and dividend payout ratios is therefore ambiguous.

Investor protection turns out to be crucial because, in many countries, expropriation of minority shareholders and creditors by the controlling shareholders is extensive. Expropriation can take a variety of forms. In some instances, the insiders (management) simply steal the profits. In other instances, the insiders sell the output, the assets, or the additional securities in the firm they control to another firm they own at below market prices. Such transfer pricing, asset shipping and investor dilution, though often legal, have largely the same effect as theft. In still other instances, expropriation takes the form of diversion of corporate opportunities from the firm, installing possibly unqualified family members in managerial positions, or overpaying executives. In general, expropriation is related to the agency problem of "perquisites" by managers and other types of empire building.

Extensive expropriation can be limited by protecting investors through the legal system, meaning both laws and their enforcement. Protected shareholder rights include, amongst others, those to receive dividends on pro-rate terms, to vote for directors, to participate in shareholders' meetings, to subscribe to new issues of securities on the same term as insiders, to sue directors or the majority for suspected expropriation, and to call extraordinary shareholders' meetings.

The laws in different countries are typically not written from scratch but rather transplanted from a few legal families or traditions (Watson, 1974). In general, commercial laws have come from two broad traditions: common law, which is English in origin, and civil law, which derives from Roman law. Within the civil tradition, there are only three major families from which modern commercial laws originate: French, German, and Scandinavian. The French and the German civil traditions, as well as the common-law tradition, have spread around the world through a combination of conquest, imperialism, outright borrowing, and more subtle imitation.

In our sample of eleven countries, the United States and the United Kingdom follow the common law system. The remaining nine countries adopt the civil law system. In general, La Porta *et al.* (2000) show that civil law countries have weaker legal protection of minority shareholders than do common law countries. The authors use an antidirector rights index that measures how strongly the legal system favours minority shareholders against managers or dominant shareholders in the corporate-decision making process, including the voting process. This index is made up of six characteristics:

1. The country allows shareholders to mail their proxy vote.
2. Shareholders are not required to deposit their shares prior to the General Shareholders' Meeting.
3. Cumulative voting or proportional representation of minorities on the board of directors is allowed.

4. An oppressed minorities mechanism is in place.
5. The minimum percentage of share capital that entitles a shareholder to call for an Extraordinary Shareholders' Meeting is less than or equal to 10 percent.
6. Shareholders have preemptive rights that can only be waived by a shareholders meeting.

The index is formed by adding one when each of the above characteristics is satisfied. The range for the index is from zero to six. An index of three or less qualifies as low protection. The US and UK are the only two common law countries in our sample and, following the Shareholder Rights table set up by La Porta et al (1998), they have high shareholder protection with an index of 5. Amongst the civil law countries, only Spain and Japan achieve high shareholder protection with an index of 4. Italy and Germany have the lowest shareholder protection hitting 1 on the index. Portugal and France have an index of 3 while Greece, Switzerland, and Netherlands have a score of 2.

La Porta *et al.* (2000) also investigate how the dividend policy, more specifically the dividend payout, works in civil and common law countries. Several measures of the dividend-payout ratio are used as the accounting data comes from countries with different accounting standards. The numerator in the payout ratio is the total cash dividend paid to common and preferred shareholders. The denominators are cash flow, earnings and sales. To determine whether a company is a high growth or low growth company, the authors use a sales growth rate variable as a measure of investment opportunities. The paper's findings reveal that common law countries have higher payouts than civil law countries. The fact that common law countries which have higher investor protection also have higher dividend payouts supports the outcome agency models of dividend, according to which better shareholder protection leads to higher dividend payouts. In contrast, the result is inconsistent with the basic predictions of the substitute agency model of dividends. More generally, the fact that dividend payouts are so different in environments with different shareholder protection suggests that agency considerations are likely to be central to the explanation of why firms pay dividends. Additional results address the relationship between dividend payout rates and sales growth rates across legal regimes. Again these results are consistent with the predictions of the outcome agency model according to which well-protected minority shareholders are willing to delay dividends in firms with good growth prospects.

In the civil law family, in contrast, rapidly growing firms appear to have high dividend payouts. The positive association between dividend payouts and growth sales in civil law countries is consistent with the dividends as substitutes theory applying to these countries. Further results of La Porta's *et al.* paper can be summarised as follows:

1. On all measures of dividend payout ratios, countries with better shareholder protection have higher dividend payout ratios than do countries with worse protection.
2. On all measures of dividend payouts, within countries with good shareholder protection, high growth firms have lower dividend payouts than low growth firms.
3. On all measures of dividend payouts, within countries with low shareholder protection, high growth firms have higher dividend payouts than low growth firms. These differences are not statistically significant however.

To summarise, La Porta *et al.* (2000) investigate two agency models of dividends. According to the 'outcome model', dividends are paid because minority shareholders pressure corporate insiders to pour out cash. On the other hand, according to the 'substitute model' insiders interested in issuing equity in the future pay dividends to establish a reputation for decent treatment of minority shareholders. The first model predicts that stronger minority shareholder rights should be associated with higher dividend payouts. The stronger the rights of the minority shareholders, the more cash they can extract from the company, other things equal. Moreover, high-growth companies are expected to have a low dividend payout in countries with good shareholder protection. However, the second model predicts that in countries where shareholder protection is low firms with good growth prospects pay out more to establish good reputations. This model also says that in countries with good shareholder protection, dividend payouts are low as the need to establish a good reputation is weaker. The quality of shareholder protection is viewed as a proxy for lower agency costs. La Porta *et al.* (2000) find that the severity of agency problems to which minority shareholders are exposed differs greatly across countries in part because legal protection of these shareholders varies. Empirically, dividend policies vary across legal regimes in ways consistent with a particular version of the agency theory of dividends.

La Porta's *et al.* (2000) paper finds conclusive evidence to support the outcome agency model of dividends. They use three measures of the dividend payout ratio, namely dividend-to-cash-flow ratio, dividend-to-earnings ratio and dividend-to-sales ratio. The tests reveal that common law countries have higher payouts than civil law countries and for two out of the three payout measures, the difference between civil and common law medians is statistically significant at the 5 percent level. The fact that common law countries have higher dividend payout supports the outcome agency model of dividends, according to which better shareholder protection leads to higher dividend payouts. Additional results show that on all measures of dividend payouts, within countries with good shareholder protection, high growth firms have lower dividend payouts than low growth firms. Finally, on all measures of dividend payouts, within countries with low shareholder protection, high growth firms have higher dividend payouts than low growth firms.

2.3 Data and Methodology

For the purpose of this research, eleven countries are studied out of the 30-nation Organisation for Economic Cooperation and Development (OECD), namely the United States (US), the United Kingdom (UK), France (FR), Germany (GY), Italy (IT), Greece (GR), Spain (SP), Portugal (PT), Switzerland (SW), Netherlands (NL), and Japan (JP). The data which consists of monthly dividend yield, earnings yield, Retail Price Index (RPI) or Consumer Price Index (CPI), and the monthly index level is drawn from DataStream, an online database covering all listed companies on major exchanges of the world. For each country an index is chosen to represent the country's aggregate market. In order to obtain comparable results to the Arnott and Asness paper, the S&P 500 is used as an index for the US. For all countries, except

Germany and Spain, the index used is a total market index. For Germany, the DAX 30 Index is used as the total market index had missing earning yield values. The same problem is encountered for Spain and to correct this, the MADRIDZ Index is used. The USA and UK have observations ranging from January 1965 to December 2002. France, Germany, Switzerland, Netherlands, and Japan start from January 1973. Italy's first month of data is in January 1986 while Spain's is in January 1987. Greece and Portugal both start in 1990. All observations end on December 2004.

Following the procedure used in the Arnott and Asness (2003) paper, the Earnings Yield series is used to estimate a history of 12-month trailing earnings in index points for each country. This is done by multiplying the earnings yield series by the price series. In order to obtain a Real Earnings series, the Earnings series is divided through by the RPI or CPI depending on the country. The same process is applied to the Dividend Yield in order to create a Real Dividend series. The payout ratio is defined as the one year trailing dividends to one year trailing earnings. An important point with these types of indices is that their composition will vary over time. Arnott and Asness (2003) point out that the aggregate Earnings Per Share series is not the same as the earnings growth on a static portfolio. The authors explain that higher performing stocks will replace lower performing stocks in the index and each time rebalancing occurs to account for new listings, the divisor of the index will increase. This process will cause the total earnings of the index as well as the earnings per share to decrease and so the end result is that they will not be able to keep pace with the growth experienced by the economy as a whole (GDP growth).

A return series is also constructed for each index and this is done in such a way as to be consistent with the method used by Fama and French (1998). One assumption is that dividends are reinvested at the end of twelve-month periods for return periods in excess of one year. The formula used for calculating return on the index is the following:

$$R_n = [P_2 * (1 + d_2)/P_1] - 1$$

R_n is the nominal twelve month return, P_1 and P_2 are the respective price levels at the beginning and end of the twelve month period and d_2 is the dividend yield at the end of the period expressed as a decimal. The real return series is then calculated by subtracting the change in inflation over the period from the nominal return. Return horizons used in this paper are 10, 5, 3, and 1-year horizons.

Because of the use of overlapping observations in the regressions, the standard errors of the regressions are biased due to serial correlation. The Newey-West (1987) correction method calculates new coefficient standard errors that are heteroscedasticity and autocorrelation consistent (HAC).

Regressions are first run on a 10-year, 5-year, 3-year and 1-year rolling basis for all countries over their original data periods. Due to the different data time frames, the study then focuses on three matched periods of data. The USA and the UK, which have the most observations available, have three time periods: 1965-2004 (Period 1), 1973-2004 (Period 2), and 1990-2004 (Period 3). France, Germany, Netherlands, Switzerland, and Japan have two time periods: 1973-2004 and 1990-2004. The remaining countries, Greece, Spain, Italy and Portugal only have one time period: 1990-2004. For the longest time period, all regressions are estimated for a rolling ten and five years. Thus, for example, those regressions on the UK Total Market Index are of the 10-year and 5-year Real Earnings Growth (REG) or Real Dividend Growth (RDG) on the payout ratio (PR) over the period 1965 to 2004. The second time period, 1973-2004, uses 5-year REG, or RDG, or Real Returns. Taking France as an example, we regress 5-year Real Returns on the payout ratio to investigate the relationship between those two variables over the 1973-2004 period. Both the 10-year and 5-year periods are consistent with the approach of AA (2003). The last time period of 1990-2004 uses 1-year Real Returns or REG, or RDG as dependent variables.

We investigate the explanatory power of the following variables: the payout ratio, dividend yield, earnings yield, lagged dividend and earnings growth on the dependent variables. For the lagged variables, the first time period uses real earnings or dividend growth lagged by 10-years and 5-years while the second time period utilises 5-year lags. Regression models are run for all countries, in order to understand whether similar conclusions can be reached for different equity markets. For additional tests we also create 'World' indices, both equally-weighted (EW) and value-weighted (VW), for the periods 1973-2004 and 1990-2004 which include all of the countries in our sample for that particular period. The value-weighted series were created by assigning a set of weights based on each country's market value expressed in US dollars.[2] All returns for these indices are calculated from the perspective of a US dollar investor.

2.4 Results

2.4.1 Summary Statistics

Statistics such as maximum, minimum, mean, and median are computed for the payout ratio for all countries over the three time periods: 1965-2004, 1973-2004, 1990-2004. The panels in Table 2-1 report the findings for each time period. Panel A shows that the UK has higher statistics than the US for the maximum, minimum, mean and median of the payout ratio. Although the difference is not very significant, this finding means that a culture of dividend is much more present in the UK than in the US. Moreover, over the period, the compounded annual real growth for earnings and dividends in the US and the UK are very similar at around 2.25% and 1.15% respectively.

Panel B shows the same statistics and growth rates for the 1973-2004 period. The payout ratio mean ranges from 0.27 for Switzerland to 0.53 for the UK. Over that period, the highest maximum payout ratio goes once again to the UK at 0.83 and the lowest minimum value for the ratio can be attributed to Switzerland at 0.20. The median of the payout ratio ranges between 0.27 and 0.54, with Switzerland noticeably lower than the others. Japan has the lowest compounded annual real growth for dividends and earnings whilst the European countries show higher growth rates. France has the highest with a 5.75% annual real earnings growth rate and a 4.85%

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[2] For the UK, Switzerland, and Japan, a US$/Pound Sterling, US$/Swiss Franc, or US$/Yen exchange rate was used accordingly. For the remaining countries, a US$/Euro exchange rate was used. Datastream applied a synthetic Euro exchange rate to the series prior to the introduction of the Euro in 1999. As the US$/Euro exchange rate only came into existence in January 1999, it was necessary to build a historical US$/Euro exchange rate. From January 1978 to December 1998, the ECU was the precursor of the Euro and when the Euro was established in 1999, it replaced the ECU at a 1:1 ratio. Therefore, for the 1978-98 period a US$/ECU exchange rate was used. For 1973-77, a US$/Euro exchange rate was used based on the Deutsche Mark due to its dominant presence within the ECU.

annual real dividend growth rate. The remaining European countries plus the US have an annual earnings growth rate that ranges between 2.25% and 4.40% while the annual dividend growth rate varies between 0.90% and 3.18%. The equally-weighted World index has higher growth rates compared to the value-weighted index reflecting the outperformance of the smaller markets.

Panel C details the findings over the 1990-2004 period. The results are similar to Panel B, except that four new countries are added. Portugal has the lowest minimum payout ratio of 0.02 over the time period. As before, the UK has the highest mean (0.61) and maximum (0.83) for the payout ratio. The payout ratio means vary between 0.28 and 0.61 and the medians have about the same range, 0.27-0.60. All countries except Japan have positive earnings growth over the 1990-2004 period. The growth rates of the remaining countries range from 1.00% (Portugal) to 8.95% (Greece). Dividend growth is also positive except for the UK at -0.02%. Growth rates for the remaining markets vary from 0.21% (Japan) to 12.78% (Greece). Consistent with the findings in Panel B, the equally-weighted World index has higher growth rates than the value-weighted index.

Although the average payout ratios are not ranked precisely according to the agency rankings of La Porta *et al.* (2000), there is a general consistency that cannot be ignored. The UK and US have high payouts while Greece, Switzerland and Germany have both low payouts and low shareholder protection. There are less clear patterns for the remaining countries.

2.4.2 Growth Term: Earnings Growth

Subsequent Real Earnings Growth and Payout Ratio

We first present regressions run over the 10-year, 5-year, 3-year and 1-year horizons for all countries over their original data periods. In Table 2-2, Panel A, the regressions of 10-year real earnings growth (REG) against the payout ratio (PR) as the independent variable are presented. All eleven countries except for Germany and Greece exhibit a positive relationship between real earnings growth and payout ratio.

Payout ratio is defined as the ratio of one-year trailing dividends to one-year trailing earnings. France, Netherlands, Switzerland, and Portugal show a positive but not significant relationship[3] between 10-yr REG and PR. The UK has positive and significant t-statistics for three out of four horizons with the relationship between the 1-year real earnings growth and payout ratio being positive but not significant. Similar to the UK, France shows a positive relationship between the dependent and independent variable, although only two out of four horizons (5-year and 3-year) are significant. Germany exhibits a positive and significant relation only for the 3-year real earnings growth horizon. Greece shows that the 5-year and 3-year REG reveal positive t-statistics with 95% significance. In addition, the Adjusted R^2 is 54.21% for the 5-year real earnings growth regression compared to 18.06% for the 10-year REG regression which shows a negative relation between REG and PR. Italy shows a predominantly positive PR over the four horizons, with the PR in the 10-year REG regression showing the most significant positive statistics with an Adjusted R^2 of 80.58%. For the remaining countries, that is, Portugal, Spain, Netherlands, and Switzerland there is nothing inconsistent that stands out over the 10, 5, 3, and 1-year regressions. All those countries show a positive payout ratio coefficient. The evidence in Table 2-2, therefore suggests that there does exist a positive relationship between the payout ratio and subsequent real earnings growth for the eleven international markets investigated. Hence this is consistent with the results portrayed by Arnott and Asness (2003). The evidence demonstrates that a higher the payout ratio leads to a greater future real earnings growth, which is not consistent with traditional theory.

The above set of results was based on regressions that encompassed the whole data set available, that is the whole downloadable market index series available from Datastream. The second set of results performs regressions on matched periods of data. Table 2-3 shows the results of a regression of subsequent real earnings growth as a function of payout ratio over three different time periods. The US and UK depict regressions carried out over the following time periods: 1965-2004, 1973-2004, and 1990-2004. France, Germany, Netherlands, Switzerland, and Japan have two regression periods: 1973-2004 and 1990-2004. Italy, Spain, Greece, and Portugal

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[3] All coefficients are tested at the 5% confidence levels. (t-statistics are presented in parentheses for Tables 2-2 to 2-21.)

only have one regression period: 1990-2004. Another point to note is that each specific period has a particular subsequent real earnings growth horizon. This is done to minimise the loss of observations. Hence, the first time period (1965-2004) will use 10-year real earnings growth as the dependent variable, while the second time period (1973-2004) will utilise 5-year real earnings growth and finally the last time period (1990-2004) will be associated with 1-year real earnings growth.

Panels A1 and A2 present the regression results for 10-year and 5-year REG respectively for the US and UK. Both countries exhibit positive coefficients on the PR variable with some statistical significance. This is consistent with Arnott and Asness (2003) but inconsistent with the 'traditional' view that higher retentions of earnings leads to higher subsequent growth. The explanatory power of the US regressions is reasonable, with adjusted-R^2 values of 28.3% and 40.4%, but the UK R^2 values are markedly lower.

Panel B reports 5-year REG regression results for seven countries plus the two World indices. As with Panel A, all PR coefficients are positive, and all but Germany are significant. However, there are considerable differences in the explanatory power of the regressions. The US, France, Japan and the value-weighted World index have reasonably high adjusted-R^2 values but this is not true of the remaining countries, particularly Germany, the Netherlands and Switzerland.

Panel C presents the results of one-year REG regressions for 1990-2004 using all eleven countries. Consistent with the previous results, all of the markets recorded positive PR coefficients, with Italy standing as the lone exception. The explanatory power once again varied from country to country with Germany, Italy, Spain and Greece having particularly low values. Overall, across various earnings growth horizons and using a number of countries, the evidence clearly points to the existence of a positive relationship between PR and REG.

2.4.2.1 Robustness and Methodological Tests

Our findings show that for nine out of eleven international markets, the payout ratio shows a significant positive relationship with 10-year real earnings growth. Since this result defies the conventional theory that higher retained earnings lead to higher future earnings growth, extensive robustness checks need to be carried out.

Sensitivity to 10-year forecasting horizon

The study started with a 10-year forecasting horizon as this was considered to be of economic significance with regards to the long-term and was also short enough to have a reasonable number of independent periods and to have some relevance to an investor's career horizon. For the robustness check, we repeated the tests on 5-yr, 3-yr and 1-yr real earnings growth. This indubitably sacrificed some economic relevance as strong statements about 10-year earnings growth are more important to fair value than statements about 5-yr growth. However, decreasing the horizon increased the number of non-overlapping periods. As seen in Table 2-2, the positive sign on the payout ratio holds for most of the countries over the 5, 3 and 1-yr horizons. However, some t-statistics do lose their significance from one horizon to the other. Germany and Greece are the two countries that started out with a negative payout ratio over the 10-year horizon, only to have the sign change over the other horizons. Italy is the only country exhibiting a negative sign on the PR over the 3-yr horizon. However, the t-statistic is not significant.

Proxy for mean reversion

Mean reversion in earnings might be caused by true mean reversion or by transient errors in reported earnings that would induce apparent mean reversion in the continuously measured changes. A temporary drop in earnings could raise the expected future compound earnings growth from this lower base. The temporary earnings drop would simultaneously raise the current payout ratio because sticky dividends do not fall as much as earnings. Finding this kind of mean reversion might still be interesting, but would have no special standing as a predictor. We tested for this case by adding direct measures of mean reversion in earnings to the regressions and comparing their significance with the remaining significance of the payout ratio.

We introduced prior-10-year real earnings growth to the regression as lagged earnings growth (LEG_{10}). If the mean-reversion hypothesis is true, then adding prior earnings growth as an additional right-hand-side variable could explicitly show the mean reversion we are testing for through a negative coefficient as poor prior 10-year real growth forecasts superior subsequent growth and vice versa. In addition, this might cause the payout ratio to lose much of its importance in bivariate tests. For the lagged variables, the first time period will only make use of real earnings or dividend growth lagged by ten years while the second time period will utilise 5-year lags. Table 2-4 shows the results of the following regressions:

Period 1: 1975-2004

$REG_{10} = a + b1(PR) + b2(LEG_{10})$

Period 2: 1978-2004

$REG_5 = a + b1(PR) + b2(LEG_5)$

Panel A1 reports 10-year REG explained by PR and ten-year lagged earnings growth (LEG_{10}) and Panel A2 displays 5-year REG explained by PR and 5-year lagged earnings growth (LEG_5). Both coefficients of LEG_{10} and LEG_5 are negative, which is consistent with the hypothesis of depressed earnings reverting to a mean, although only the UK LEG_5 coefficient is significant. The introduction of the lagged growth variables has improved the explanatory power to a degree compared to Table 2-3 but the PR coefficients remain positive and significant. Panel B shows the 5-year REG regression results using LEG_5 as an independent variable. All of the coefficients are statistically significant, apart from the US and Switzerland, and all are negative apart from Japan. Despite this the PR coefficients retain positive signs in all but two markets, with many still significant. It is clear that LEG appears to be a very important variable in explaining subsequent REG. LEG seems to have some role to play in explaining subsequent REG, particularly for the 5-year horizon. However, the 10-year results seem more consistent with the findings of Arnott and Asness (2003), who note that whilst LEG has the anticipated negative sign in their results, the predictive ability of the variable is poor and it fails to materially diminish the role of PR, particularly during 1946-2001.

The payout Ratio against stock market valuation levels

If future real earnings growth is going to be faster than normal, investors should perhaps pay a higher P/E multiple than normal and, hence, accept a lower earnings yield on their investments. Thus in an efficient market with constant expected equity returns, a low earnings yield may be a good predictor of higher future real earnings growth.

In addition, there is good reason to believe that the ability to explain future earnings growth may be improved by considering the overall valuation of the aggregate stock market as well. At the individual stock level, Barth *et al.* (1999) find that companies with track records of consistent earnings growth achieve higher price-earnings multiples than firms with patchy earnings records. The presumption is that the market anticipates that those consistent performers will continue to deliver stellar earnings growth and thus are more valuable. Given that the aggregate market discounts future prospects, it would be expected that earnings yields (i.e. higher P/E ratios) would be negatively related to subsequent REG.

Subsequent Real Earnings Growth and Earnings Yield

As stock prices reflect the discounted values of expected cash flows, it follows that low earnings yields (high P/E ratios) reflect high expected earnings growth rates. Table 2-5 shows the results of using earnings yield (EY) as an explanatory variable for future real earnings growth over the complete data sets. Almost all countries show earnings yield variables with negative coefficients and significant at 95% level, that is the lower the earnings yield, the greater the future real earnings growth. The marked inconsistencies are discussed below. Netherlands has a t-statistic that is positive and significant at the 95% level associated with the earning yield for the 10-year real earnings growth horizon. The 5-year, 3-year, and 1-year horizons exhibit negative and significant coefficients at the 95% level t-statistics. The explanatory power is highest for the 3-year real earnings growth horizon at 13.51%. Japan also shows the same trend as Netherlands for the 10-year and 5-year real earnings growth regressions. The 3-year and 1-year horizons, however, exhibit negative earnings yield coefficients. The Adjusted R^2 for the 10-year horizon is 40.59% compared to 7.72% for the 1-year horizon. Hence, the findings support the view that the market correctly anticipates faster future earnings growth and pays up for it.

Subsequent Real Earnings Growth and Payout Ratio & Earnings Yield

Table 2-6 summarises the results of the matched data sets when using both the payout ratio and the earnings yield as explanatory variables. Panels A1 and A2 display the 10-year and 5-year regression results for the US and UK. The inclusion of EY generally produces a modest improvement in the explanatory power of the regressions and the predominance of negative coefficients for EY is consistent with the earlier hypothesis. Despite the inclusion of EY, PR retains its positive coefficient albeit with reduced statistical significance.

Panel B reports the 5-year regression results for 1973-2004. As in Panel A, the use of EY results in higher adjusted R^2 values. The coefficients are negative in five of the markets, and are significant for France, Germany and Switzerland. Again, PR retains a positive relationship with REG in all cases and with generally high levels of significance.

Panel C displays the 1-year regression results for all eleven markets. The impact of EY is most noticeable in these equations. A significant improvement in the explanatory power is noted, along with strongly negative coefficients for most countries. PR has a positive coefficient for all markets except Italy and Greece and is statistically significant in the UK, US, France, Netherlands, Japan and Spain plus both World indices, although generally the results appear less conclusive than the five-year regressions.

The implication of Table 2-6 is that the inclusion of EY does not detract in any meaningful way from the positive relationship previously observed between PR and REG. Regressions containing EY have improved explanatory ability over PR alone, although this is most noticeable in the shorter 1-year regressions.

For the sake of completeness, we run the regression of subsequent real earnings growth against the payout ratio and earnings yield variables over the 10-year, 5-year, 3-year and 1-year horizons using the complete data sets. The results are shown in Table 2-7 and, over all four horizons, the general evidence is that the payout ratio is still positive although with reduced statistical significance. The earnings yield variable continues to present a negative coefficient and the Adjusted R^2 can be seen to be higher for almost all regressions compared to the ones in Table 2-2. Thus, overall, adding the earnings yield variable increases the explanatory power of the model over all regression horizons for the majority of countries.

2.4.3 Growth Term: Dividend Growth

Subsequent Real Dividend Growth and Payout Ratio

In the previous section, the relationship between PR and subsequent REG was considered. The positive relationship failed to conform to conventional wisdom but was consistent with the US evidence presented by Arnott and Asness (2003). We extend the previous work by asking whether a similar unexpected relationship exists between PR and subsequent real dividend growth (RDG). It is a commonly accepted analogy of Miller and Modigliani (1961) that a high PR would lead to low subsequent RDG, unless made up for by issuance, and vice versa. For example, a 100% PR would almost certainly result in under investment in ongoing business and lead to zero RDG in the long run whilst a low PR may enable many more positive NPV projects to be undertaken and higher subsequent RDG.

Table 2-8 presents the findings of the regression of subsequent real dividend growth against the payout ratio for all eleven international markets using the complete data sets. The majority of countries show a negative relationship between payout ratio and real dividend growth (RDG). The USA, however, exhibits a positive and significant relationship for the 3 and 5-year real dividend growth horizons. Only the 10-year real dividend growth shows evidence of a negative relationship. The explanatory power is highest for this particular regression with an Adjusted R^2 of 4.50%. Two other countries, Italy and Japan, show a positive relationship between payout ratio and 10-year real dividend growth. The t-statistics for the explanatory variable are significant at 95%. All other countries have negative and significant coefficients associated with the payout ratio. Those findings confirm conventional theory that as the payout ratio decreases, the real dividend growth increases. Although, robustness checks are not as necessary as in the case of real earnings growth where the findings defy conventional theory, for the sake of consistency and to supplement the new findings, the checks are once again performed.

2.4.3.1 Robustness and Methodological Tests

Regressions for the three matched periods of data are run and the findings are presented in Table 2-9 where we find that the results coincide with the findings discussed above. Panel A1 reveals that a negative relationship exists between PR and 10-year subsequent RDG, with both the US and UK coefficients being statistically significant. The adjusted R^2 value is particularly high for the UK but this is not true of the US. Panels A2 and B display the 5-year regression results, with similar findings. All of the countries have negative PR coefficients, with the US a lone exception, although the World indices also have positive coefficients. There is some explanatory power for the US and Germany but this is not present for the remaining markets. Panel C reports the 1-year RDG regression results. As with the longer growth horizons, a high proportion of these markets show a negative relationship between PR and RDG. The explanatory power varies considerably from country to country. Overall, the evidence presented in Table 2-9 points to PR and subsequent RDG being negatively related. This is different to the relationship observed between PR and REG in that it concurs with conventional wisdom.

Sensitivity to 10-year Forecasting Horizon

Again, a comparison of the results obtained for the 10-yr real dividend growth regression is carried out with findings reported for the 5-yr, 3-yr and 1-yr regressions. This will determine whether the link identified between the 10-year real dividend growth and payout ratio still holds over the other horizons. As depicted in both Table 2-8 and Table 2-9, almost all countries have negative signs attached to the payout ratio from one horizon to the other. The US is the only country to start out with a negative and significant sign attached to the payout ratio over the 10-yr horizon, with the sign finally changing to positive for the next three horizons. Italy and Japan do start out with a positive and significant payout ratio over the 10-yr horizon, but the sign soon changes to a negative and significant one for the remaining horizons.

Proxy for Mean Reversion

If there is mean reversion present in dividends, this might eliminate the effect of dividend policy as a predictor. Hence, in order to test for this case, a prior-10-yr real dividend growth is added to the regression as lagged dividend growth (LDG_{10}). Over the 5-yr horizon regressions, a 5-yr lag is used. The significance of the model is then analysed to determine whether adding the new lagged variable removes the efficacy of the payout ratio.

Table 2-10 shows the results of the regression of the subsequent real dividend growth on the payout ratio and lagged dividend growth. A negative sign associated with the lagged variable will show the mean-reversion hypothesis to be true as poor prior 10-year real growth forecasts superior subsequent growth. Panel A1 displays the 10-year regression results where the PR coefficients for both the UK, and the US have negative signs. LDG_{10} also has a negative coefficient in both cases, consistent with the evidence for LEG_{10} in Table 2-4, suggesting some tendency for mean reversion. Panels A2 and B show similar findings in the 5-year regression results. The PR variable is negative in all cases apart from the US and the World indices, whilst LDG_5 is negative in all cases apart from the UK and Switzerland. As with the regression results in Table 2-4, the inclusion of the lagged variable adds considerably to the explanatory power compared to the respective earlier regressions reported in Table 2-9.

A further potential explanation for the findings reported in this study may be that mean reversion exists within the payout ratio itself. When PR is high, it then predicts that there will be higher future REG, but also that dividends won't be increased at an equally high rate. Given that managers clearly seek to avoid dividend cuts wherever possible, a period of high earnings growth gives managers the opportunity to raise dividends but to do so at a slower pace than earnings thus bringing PR down to a lower level. This would mean that should earnings stall or decline in future periods there might be less pressure to cut dividends since earnings still adequately cover the distribution. When PR is very high there is presumably less slack for earnings to decrease before a dividend reduction may have to occur.

To investigate whether mean reversion in PR is causing the difference in sign between the relationships of PR and REG and of PR and RDG, we consider a regression where RDG is explained by both PR and the change in PR *over the same period* as the dividend growth (PRC). Clearly if this was designed to predict future RDG it would be useless since it is impossible to observe PRC before the event however for this purpose it may serve as a useful explanatory variable. When PR is high it has been shown that REG is also high, with the logical extension being that this is correlated with rising dividends. The negative relationship between PR and RDG is thus surprising. By controlling for mean reversion in PR through PRC this should allow for a more direct observation of the effect of PR on RDG.

Panels A1 and A2 of Table 2-11 display the results of the 10-year and 5-year regressions for 1965-2004. The addition of PRC leads to positive coefficients for both PR variables in the UK, and the US coefficients to become more positive in comparison to the results in Table 2-9. This appears to support the notion that RDG is actually positively related to PR when mean reversion in PR is accounted for. However, in Panel B many of the markets retain their negative coefficients and statistical significance. Only the UK and Netherlands flip to a positive coefficient from a negative coefficient in Table 2-9. The introduction of PRC has little impact on the 1-year results reported in Panel C. Mean reversion in PR may explain some of the negative relationship observed between RDG and PR but it fails to give a full explanation to this conundrum.

The Payout ratio against Stock market Valuation

Subsequent Real Dividend Growth and Dividend Yield

The efficient-markets theory predicts that dividend yield should forecast dividend growth with a negative sign, meaning that the higher dividend growth is, the lower dividend yield has to be. This makes sense as investors expecting future dividend growth to be faster than normal should drive up the price and hence cause dividend yield to go down. Therefore, a low dividend yield would be a good predictor of future real dividend growth.

Table 2-12 uncovers that almost all countries reveal a negative relationship between RDG and DY. The USA and UK are two countries that show a positive relation between RDG and DY over the 10, 5, and 3-year horizons. Only over the 1-year horizon does the DY variable show a negative sign. However, even then the t-statistics are not significant. The explanatory power is highest for the 10-year regression for the US while the same can be said for the 5-year regression in the UK. Italy and Japan show a positive relation between the dependent and independent variables over the 10-year horizon. This relation changes to a negative one over the next three horizons.

Subsequent Real Dividend Growth and Payout ratio & Dividend Yield

Table 2-13 presents the findings of the regression between subsequent real dividend growth and the payout ratio and dividend yield as independent variables using the three matched data periods. Panels A1 and A2 offer mixed evidence with PR retaining negative coefficients for the UK market but positive coefficients for the US market. The US also exhibits this positive coefficient in the 5-year regression results shown in Panel B. However, five of the other markets retain the negative relationship between RDG and PR, although both World indices have positive coefficients. The DY coefficients are generally negative throughout. The addition of DY has improved the explanatory power of the regressions compared to those where PR was the only independent variable (Table 2-9). Panel C confirms the positive relationship between PR and RDG for the US, whilst the remaining countries, with the exception of France have negative coefficients. DY is strongly negative for all markets apart from the UK and Japan, again confirming the original hypothesis that higher market valuations are consistent with lower future growth of both earnings and dividends.

To complete the analysis, we study the results of the regression between subsequent real dividend growth and the payout ratio and dividend yield when the original data periods are used for the eleven international markets. From Table 2-14, we find that seven out of eleven countries still have a payout ratio with a negative coefficient over the 10-year horizon. The US shows a negative relationship between

RDG and PR only for the 10-year horizon. All other horizons show a positive relation between those two variables. Again over the 10-year horizon, Switzerland and Greece exhibit a positive coefficient for the independent variable. Italy and Japan still keep the positive sign on the PR as exhibited in a model where PR acts as the only independent variable. Over the 5-year and 3-year horizons, Switzerland again shows a positive coefficient for the PR. The same tendency is shown in Spain over the 5-year horizon and in Germany over the 3-year horizon. However, the t-statistics are not significant.

When the dividend yield is introduced in the equation, the negative relationship between RDG and DY is maintained except for some countries. The US, Italy and Japan still exhibit a positive and significant relation between RDG and DY over the 10-year horizon. Moreover, the US and UK also show the same positive relationship over the 5-year and 3-year horizons. Similar to the EY and PR model, the explanatory power is enhanced when dividend yield is added as an independent variable.

2.4.4 Returns

2.4.4.1 Value and Growth Strategies

Investment strategies for outperforming the market are common in this day and age. One particular investment strategy, a dividend yield strategy, has been in existence for several years. This strategy consists of investing an equal amount of money in each of the ten stocks of a market index with the highest dividend yields. In the United States, this strategy has worked particularly well when an equal dollar amount was invested in each of the ten stocks of the Dow Jones Industrial Average with the highest dividend yield. With yearly rebalancing, the portfolio return over time has exceeded that of the Dow.

Dividend yield strategies are part of an investment strategy known as 'value investing.' The premise is that securities classified as value stocks have low prices relative to current income and dividend levels, as well as slower than average growth. Firms that have high ratios of book-to-market equity (B/M), earnings to price (E/P), or cash flow to price (C/P) are classified as value stocks. Studies carried out by Fama and French (1992, 1996) and Lakonishok, Shleifer, and Vishny (1994) that there is a strong value premium in average returns for U.S stocks. Value stocks tend to have higher average returns than growth stocks. Fama and French (1995) and Lakonishok *et al.* (1994) show that the value premium is associated with relative distress. High B/M, E/P, and C/P firms tend to have persistently low earnings while low B/M, E/P, and C/P stocks tend to be strong (growth) firms with persistently high earnings.

One argument advanced by Lakonishok *et al.* (1994) and Haugen (1995) for the value premium in average returns is that the premium appears because the market undervalues distressed stocks and overvalues growth stocks. When these pricing errors are corrected, distressed (value) stocks have high returns and growth stocks have low returns. Furthermore Fama and French (1993, 1995, 1996) argue that the value premium is compensation for risk missed by the capital asset pricing model (CAPM) proposed by Sharpe (1964) and Lintner (1965). This conclusion is based on evidence that there is common variation in the earnings of distressed firms that is not explained by market earnings and that in addition there is common variation in the returns on distressed stocks which is not explained by the market return. Fama and French (1998) have shown that including a risk factor for relative distress in a multifactor version of Merton's (1973) intertemporal capital asset pricing model (ICAPM) or Ross's (1976) arbitrage pricing theory (APT) does capture the value premiums in U.S returns generated by sorting stocks on B/M, E/P, C/P, or D/P (dividend yield).

Still another argument proposed by Black (1993) and Mackinlay (1995) is that the value premium is sample specific. Its appearance in past returns is a chance result unlikely to recur in future returns. However, Davis (1994) has shown that there is a value premium in U.S. returns before 1963, the start date for the studies of Fama and French and others. In answer to the question "Is there a value premium in markets outside the U.S?" Fama and French (1998) have shown that the value premium is indeed omnipresent. Their study is based on returns on market, value, and growth portfolios for the United States and twelve major EAFE (Europe, Australia, and the Far East) countries. The higher average returns on value stocks in the United States are a local manifestation of a global phenomenon.

Earnings Yield and Dividend Yield Strategies.

In this study, the relationship between returns and dividend/earnings yield are consistent with the fact that low earnings yield and dividend yield are characteristics of growth stocks and by the same token, have lower returns than high earnings and dividend yield stocks. The first set of results looks at the effect of dividend yield and earnings yield on nominal and real returns. Table 2-15 shows the average nominal and real return for a range of earnings yield. The earnings yield for most countries ranges between 5% and 10%, except for Japan which is between 2-4%. From the table it can be seen that as earnings yield decreases, so do the average nominal and real returns for most countries. The decrease in returns might present itself as a gradual decline or could increase before finally decreasing. The initial increase might not be significant so that the general trend would be a downward one. The effects of earnings yield and dividend yield on return are explored in more detail in a later section. Table 2-15 shows that high yield strategies produce higher average returns. For the USA the earnings yield ranges from 5 to 8 percent. An investor would expect to get a 10-year average nominal return of 15.35% or a 4.54% average real return if the earning yield was above 8%. Similarly, if the earnings yield was in the range of 5 to 8 percent, one would expect a 12.01% 5-year average nominal return or a 3.59% 5-year average real return. An earnings yield below 5 percent would give a lower 5-year average nominal return of 11.82% or a 2.05% 5-year average real return. Hence, a positive relationship can be seen to exist between the return and earning yield. Table 2-16 presents the same findings but this time using a dividend yield strategy. Dividend yield for most countries ranges between 2% and 5%. Japan is once again an exception with a range of 0.8%-1.6%. Again the dominant observation is that as dividend yield decreases, so do average real returns.

Those results are further compounded by the findings in Table 2-17 and Table 2-18. Table 2-17 exposes the relation between subsequent real returns and earnings yield. For most countries, there is a positive relationship between real returns and earnings yield. France and Switzerland are the only countries which show a negative relationship over the 10-year real return horizon. Netherlands, on the other hand, shows no significant relationship although it does exhibit both positive and negative relations between returns and earnings yield.

Table 2-18 presents the findings on the relation between subsequent real returns and dividend yield. Once again, it can be seen that significantly positive relations exist between those two variables for most countries. Switzerland exhibits a negative relation between RR and DY over the first three return horizons. However, it is only the 10-year model which shows significant t-statistics combined with the highest explanatory power of 8.82%. Italy shows a strong positive relation between the two variables only over the 10-year horizon, which features the highest Adjusted R^2 of 78.71%. Greece reveals positive and significant coefficients associated with DY over the last three return horizons. The same observation can be made for Portugal, except that the t-statistics are not significant. Japan also shows the same trend with the 5-year horizon exhibiting the highest Adjusted R^2 of 20%.

Another point to note is that the earnings yield variable has higher explanatory power for long-run returns, usually 10-year returns while the dividend yield variable explains the short-term returns better. This may be because earnings are more variable than dividends.

Payout Ratio and Returns

Earlier in the study, the ability of the payout ratio to explain growth in both earnings and dividends has been considered. Whilst interesting in itself, the obvious question for practitioners to ask would be the possibility of using this evidence to generate returns. The first assumption that is typically made is that higher earnings/dividend growth leads to higher returns. Table 2-19 assesses the validity of this statement by ranking 5-year periods of REG and RDG on an annual basis and forming Quartiles for the markets where data is available for 1973-2004. Quartile 1 contains the lowest six 5-year periods of REG (RDG), Quartile 2 the next lowest seven periods, Quartile 3 the next seven and finally Quartile 4 contains the six highest periods of REG (RDG). The concurrent average annually compounded real return is then reported in Table 10 for each Quartile.

Panel A demonstrates that periods of high REG (Quartile 4) have clearly accompanied higher returns than periods of low REG (Quartile 1), but there is no evidence of a linear increase in returns across Quartiles. Quartile 2 returns are on average higher than Quartile 3 for two markets; however, Quartile 4 returns are always the highest. Panel B reveals that periods of high RDG are also accompanied by higher returns than are low RDG periods. As with REG however, there is no linear relationship with Quartile 2 returns greater than Quartile 3 returns in several markets, and greater than Quartile 4 returns in the Netherlands and France. The conclusion of this very simple analysis is that both high REG and RDG have tended to exist in parallel with higher returns. A significant implication of this for practitioners using PR to predict growth is that high PR may lead to high REG but also low RDG. Thus, PR emits a somewhat contradictory signal in terms of returns.

This can be further illustrated in Table 2-20 which presents the relationship between payout ratio and subsequent real returns when matched periods are utilized. Panel A1 presents the results of 10-year subsequent real return regressions. Both coefficients of PR are negative but only the UK coefficient is significant. The adjusted R^2 value is very low for the US but fairly substantial for the UK. However, in Panel A2, the US coefficient is positive whilst the UK remains negative. Panel B shows no general relationship between PR and returns with a fairly even mix of positive and negative coefficients. The explanatory power of most of these regressions is negligible. Panel C reports results of the 1-year regressions, where 9 of 11 countries have positive PR coefficients as do both World indices. The adjusted-R^2 values are generally low, albeit typically higher than those in the 5-year regressions in Panel B. There is little evidence within these results to suggest that PR has any ability to predict subsequent aggregate market returns.

However, it remains possible that PR is in some way correlated to the overall valuation of the aggregate market. If this is indeed the case then the specification in Table 2-20 may fail to remove this effect. To test for this, we include EY as an additional explanatory variable to proxy for the overall market valuation (in the same manner as Table 2-6). Panels A1 and A2 of Table 2-21 show the results for the period 1965-2004. The inclusion of EY means that both US coefficients are now positive and significant, the 5-year UK coefficient is also positive, but the 10-year UK coefficient remains significantly negative. Panel B reports the results for the 1973-2004 period. Six of the seven individual markets have positive PR coefficients (compared to five in Table 2-20) although only the UK and US are significant. Both of the World indices have negative coefficients but this may be due to the effect of calculating returns based in US dollars. The inclusion of EY appears to have little effect on the 1-year results reported in Panel C compared to the earlier findings. Overall, the introduction of a variable to control for market valuation tends to suggest that a positive relationship exists between PR and subsequent returns although the evidence is weak with only the US offering a significant relationship. It thus remains difficult to predict future returns from the payout ratio.

2.5 Conclusion

As Miller and Modigliani (1961) have demonstrated, under the conditions known as "perfect capital markets," there is no good reason for corporate managements to prefer one dividend policy to another. Differences in dividend policy should not affect the value of the firm. Contrary to this prediction, however, corporations follow extremely deliberate dividend payout strategies. This evidence raises the question of how firms choose their dividend policies. It has been shown that managers estimate what portion of the firm's earnings is likely to be permanent and what portion of the earnings is likely to be temporary (Lintner, 1956). Lintner looked at the dividend-payout patterns of firms and concluded that dividends were more likely to be raised following a permanent, rather than temporary, increase in earnings and that firms had a long-run target for their dividend-to-earnings ratio. However, because managers need time to assess the permanence of any earnings rise, dividend changes appear to lag earnings changes by a number of periods. It follows from Lintner's analysis that the dividend-to-earnings ratio rises when a company begins a period of bad times and the ratio falls when a company reaches a period of good times.

This paper has studied the effect of the payout ratio, dividend yield, and earnings yield in predicting future real earnings growth, real dividend growth and real returns in eleven countries. The evidence shows that a positive relationship is dominant between the payout ratio and the subsequent real earnings growth. This contradicts the conventional theory that higher retained earnings lead to higher earnings growth. However, the findings in this paper are consistent with the work done by Arnott and Asness (2003) in the US market. The relationship between real dividend growth and payout ratio is a negative one for almost all countries. Furthermore, the paper has found a positive relationship existing between returns and dividend yield and earnings yield. For some countries, it is found that earnings yield has higher explanatory power than dividend yield for long-run returns, usually 10-year returns. The opposite is true of dividend yield. The results on the payout ratio having the potential to predict subsequent real returns are inconclusive.

It is very significant that the results presented by Arnott and Asness are also present in ten other countries has significant meaning. The empirical finding that high retention rates predict low earnings growth may reflect management's exuberance. Alternatively, management may be concerned with dividend smoothing, and will pay higher dividends only when it can afford to do so, given its expectation of strong future profit growth. An alternative explanation can be that in an environment of excellent investment opportunities managers in aggregate will retain more of their earnings to fund those investments and thus the payout ratio will fall. Given that many firms are chasing these perceived opportunities within the marketplace, allied to an initial over-optimism amongst corporate decision makers, future returns fail to match those estimated when earnings were initially retained. This would be consistent with a low PR leading to lower REG. The reverse situation will occur when managers see only limited possibilities and underestimate the profitability of potential projects. They are thus prepared to return large portions of earnings to shareholders and make few investments. These investments do not suffer from the competition that exists during periods of high optimism and as such earn higher rates of return than were initially estimated. In this scenario, a high PR is consistent with higher REG.

The higher rate of taxation on dividend relative to capital gains has been offered as an explanation for the positive relation between stock returns and dividend yield. If that was true, then the relationship observed under the imputation tax system would be the reverse of that under the classical system. However, most countries, except for Switzerland, exhibit a positive relation between returns and dividend yield. Switzerland follows a classical tax system like the U.S and therefore it can be assumed that the tax-based explanation for the relation between dividend yields and returns is not valid. Moreover, countries like France, Germany, Italy, Portugal and

Spain that follow an imputation tax system should have shown a negative relation between returns and dividend yield. However, that is not the case.

It is pertinent to point out that some irregularities exist in the robustness checks when testing the relation between payout ratio and subsequent earnings growth. In some of the countries, the positive relation between the payout ratio and subsequent real earnings growth may be due to mean reversion. Mean reversion in earnings may be caused by true mean reversion or by transient errors in reported earnings that can induce apparent mean reversion in the contiguously measured changes. A temporary drop in earnings can raise the expected future compound earnings growth from this lower base. The temporary earnings drop will simultaneously raise the current payout ratio because sticky dividends do not fall as much as earnings. If the mean-reversion hypothesis is true, then adding prior earnings growth as an additional right-hand-side variable could explicitly show the mean reversion we are testing for through a negative coefficient as poor prior 10-year real growth forecasts superior subsequent growth and vice versa. Japan is the only country with a positive lagged earnings growth variable suggesting that, for all other countries, scaling earnings by dividends produces an effective and consistent measure of mean reversion in earnings. Moreover, the US, UK, France, Germany, Netherlands and Japan all show a very marked increase in predictive power compared to when a model with only payout ratio is used as independent variable over a 5-yr horizon. This would mean that adding the lagged variable does increase the predictive power of the model, and so the efficacy of the payout ratio might be compromised. However, the 10-year results seem more consistent with the findings of Arnott and Asness (2003), who note that whilst LEG has the anticipated negative sign in their results, the predictive ability of the variable is poor and it fails to materially diminish the role of the payout ratio.

For the all countries, when the EY variable is added in the model, the explanatory power increases considerably indicating that the model for predicting 5-yr earnings growth is improved by including EY. The same observation can be made for regressions over the 1-yr horizon. However, the payout ratio retains its positive coefficient, indicating that the inclusion of the earnings yield variable does not detract in any meaningful way from the positive relationship observed between the payout ratio and subsequent real earnings growth. The limitations of the study, more specifically mean reversion that cannot be totally ruled out, put a damper on the positive relationship that may exist between payout ratios and subsequent earnings growth. For those countries that do exhibit such a positive relationship, the future is bleak as today's low payouts are a signal for negative future growth. However, in those countries, where the positive relation between payout ratios and future earnings growth is not completely definite, the future is optimistic.

Table 2-1. Summary Statistics

	Payout Ratio				Compound Annual Real Growth	
Country	Max	Min	Mean	Median	Earnings	Dividend
A. Summary Statistics 1965-2004.						
US	0.77	0.29	0.50	0.49	2.22%	1.14%
UK	0.83	0.33	0.56	0.58	2.26%	1.17%
B. Summary Statistics 1973-2004.						
US	0.77	0.29	0.49	0.46	2.69%	1.53%
UK	0.83	0.33	0.53	0.54	2.25%	1.46%
France	0.69	0.29	0.45	0.45	5.75%	4.85%
Germany	0.69	0.21	0.38	0.37	4.40%	0.90%
Netherlands	0.61	0.29	0.48	0.48	4.01%	2.94%
Switzerland	0.44	0.20	0.27	0.27	2.80%	3.18%
Japan	0.52	0.26	0.38	0.38	0.43%	-0.68%
EW7	0.52	0.35	0.43	0.42	3.94%	2.28%
VW7	0.60	0.34	0.45	0.44	2.72%	1.30%
C. Summary Statistics 1990-2004.						
US	0.77	0.29	0.49	0.44	4.00%	1.92%
UK	0.83	0.45	0.61	0.60	1.02%	-0.02%
France	0.57	0.32	0.44	0.44	3.66%	7.03%
Germany	0.48	0.21	0.32	0.31	2.87%	1.29%
Netherlands	0.61	0.40	0.50	0.50	4.48%	3.99%
Switzerland	0.44	0.21	0.28	0.27	5.45%	6.83%
Japan	0.52	0.26	0.39	0.38	-0.35%	0.21%
Italy	0.69	0.25	0.46	0.49	1.87%	4.11%
Spain	0.55	0.31	0.42	0.42	2.23%	2.91%
Greece	0.61	0.12	0.39	0.43	8.95%	12.78%
Portugal	0.68	0.02	0.45	0.47	1.00%	3.72%
EW11	0.50	0.35	0.43	0.43	5.28%	4.45%
VW11	0.59	0.34	0.46	0.44	2.87%	2.06%

Table 2-2. Subsequent Real Earnings Growth as a Function of Payout Ratio (Original Data Periods)

A. Subsequent 10-yr Real Earnings Growth as a Function of Payout Ratio (PR)				*B. Subsequent 5-yr Real Earnings Growth as a Function of Payout Ratio (PR)*			
Country	Constant		Adjusted R^2	Country	Constant		Adjusted R^2
US	-0.08	0.19 PR	28.30%	US	-0.21	0.45 PR	40.40%
	(-3.61)	(4.07)			(-5.70)	(6.22)	
UK	0.00	0.03 PR	7.80%	UK	-0.05	0.13 PR	17.40%
	(-0.33)	(2.31)			(-2.59)	(3.70)	
France	0.03	0.03 PR	2.80%	France	-0.13	0.42 PR	7.62%
	(2.07)	(0.94)			(-3.97)	(5.92)	
Germany	0.06	-0.06 PR	4.78%	Germany	0.02	0.06 PR	0.26%
	(3.51)	(-1.31)			(0.64)	(0.80)	
Netherlands	-0.02	0.12 PR	15.44%	Netherlands	-0.03	0.15 PR	4.41%
	(-0.76)	(1.73)			(-1.72)	(3.91)	
Switzerland	0.02	0.06 PR	-0.02%	Switzerland	-0.14	0.65 PR	10.70%
	(0.70)	(0.50)			(-3.55)	(4.51)	
Japan	-0.16	0.42 PR	48.19%	Japan	-0.20	0.52 PR	31.70%
	(-15.58)	(15.25)			(-4.80)	(5.18)	
Italy	-0.16	0.39 PR	80.58%	Italy	-0.01	0.04 PR	-0.52%
	(-18.13)	(19.67)			(-0.15)	(0.46)	
Spain	-0.06	0.19 PR	67.14%	Spain	-0.22	0.54 PR	28.26%
	(-7.07)	(9.89)			(-3.86)	(4.42)	
Greece	0.08	-0.18 PR	18.06%	Greece	-0.11	0.43 PR	54.21%
	(6.07)	(-3.24)			(-7.04)	(11.09)	
Portugal	-0.10	0.30 PR	36.69%	Portugal	-0.26	0.63 PR	42.87%
	(-1.46)	(1.92)			(-3.23)	(3.77)	

C. Subsequent 3-yr Real Earnings Growth as a Function of Payout Ratio (PR)				*D. Subsequent 1-yr Real Earnings Growth as a Function of Payout Ratio (PR)*			
US	-0.34	0.72 PR	45.21%	US	-0.36	0.77 PR	17.15%
	(-6.84)	(7.59)			(-3.19)	(3.42)	
UK	-0.11	0.23 PR	17.39%	UK	-0.12	0.26 PR	4.72%
	(-3.71)	(4.64)			(-1.31)	(1.72)	
France	-0.10	0.36 PR	9.51%	France	-0.04	0.24 PR	1.10%
	(-1.68)	(2.93)			(-0.42)	(1.09)	
Germany	-0.05	0.24 PR	4.25%	Germany	-0.07	0.32 PR	2.20%
	(-1.11)	(2.23)			(-1.04)	(1.91)	
Netherlands	-0.15	0.40 PR	13.02%	Netherlands	-0.65	1.48 PR	21.98%
	(-2.60)	(3.37)			(-3.69)	(4.00)	
Switzerland	-0.18	0.79 PR	8.61%	Switzerland	-0.03	0.22 PR	0.09%
	(-3.08)	(3.55)			(-0.27)	(0.48)	
Japan	-0.21	0.53 PR	17.85%	Japan	-0.16	0.41 PR	3.95%
	(-8.61)	(8.57)			(-3.99)	(3.96)	
Italy	0.07	-0.13 PR	0.42%	Italy	-0.02	0.15 PR	-0.17%
	(1.62)	(-1.32)			(-0.28)	(0.81)	
Spain	-0.14	0.38 PR	6.02%	Spain	-0.28	0.74 PR	8.14%
	(-2.63)	(3.38)			(-2.16)	(2.24)	
Greece	-0.10	0.39 PR	13.96%	Greece	0.05	0.08 PR	-0.5%
	(-2.92)	(4.65)			(0.33)	(0.23)	
Portugal	-0.29	0.68 PR	25.22%	Portugal	-0.63	1.46 PR	25.1%
	(-2.56)	(2.86)			(-4.75)	(4.63)	

(t-statistics are presented in parentheses)

Table 2-3. Subsequent Real Earnings Growth as a Function of Payout Ratio

A1. 10-year subsequent real earnings growth as a function of payout ratio (PR) 1965-2004.

Country	Constant		Adjusted R^2
US	-0.08	0.19 PR	28.3%
	(-3.61)	(4.07)	
UK	0.00	0.03 PR	7.8%
	(0.33)	(2.31)	

A2. 5-year subsequent real earnings growth as a function of payout ratio (PR) 1965-2004.

US	-0.21	0.45 PR	40.4%
	(-5.70)	(6.22)	
UK	-0.05	0.13 PR	17.4%
	(-2.59)	(3.70)	

B. 5-year subsequent real earnings growth as a function of payout ratio (PR) 1973-2004.

US	-0.23	0.51 PR	49.3%
	(-7.30)	(8.25)	
UK	-0.06	0.15 PR	17.8%
	(-2.68)	(3.49)	
France	-0.13	0.42 PR	25.9%
	(-4.02)	(5.95)	
Germany	0.02	0.06 PR	0.3%
	(0.68)	(0.88)	
Netherlands	-0.03	0.16 PR	5.4%
	(-0.93)	(2.01)	
Switzerland	-0.12	0.57 PR	8.6%
	(-2.95)	(3.80)	
Japan	-0.20	0.52 PR	31.7%
	(-4.80)	(5.18)	
EW7	-0.18	0.49 PR	18.6%
	(-3.17)	(3.76)	
VW7	-0.29	0.67 PR	55.9%
	(-9.66)	(10.28)	

C. 1-year subsequent real earnings growth as a function of payout ratio (PR) 1990-2004.

US	-0.36	0.88 PR	13.3%
	(-2.40)	(2.84)	
UK	-0.26	0.45 PR	8.2%
	(-2.44)	(2.59)	
France	-0.89	2.15 PR	42.0%
	(-7.61)	(7.96)	
Germany	-0.07	0.36 PR	0.6%
	(-0.33)	(0.57)	
Netherlands	-0.63	1.34 PR	15.6%
	(-2.71)	(2.81)	
Switzerland	-0.36	1.49PR	9.4%
	(-1.46)	(1.65)	
Japan	-0.40	1.01 PR	14.6%
	(-3.85)	(4.02)	
Italy	0.08	-0.09 PR	-0.3%
	(0.80)	(-0.38)	
Spain	-0.18	0.48 PR	4.6%
	(-1.29)	(1.36)	
Greece	0.05	0.08 PR	-0.5%
	(0.33)	(0.23)	
Portugal	-0.63	1.46 PR	25.1%
	(-4.75)	(4.63)	
EW11	-0.35	0.90 PR	6.7%
	(-1.76)	(1.96)	
VW11	-0.55	1.28 PR	17.3%
	(-2.72)	(2.77)	

(t-statistics are presented in parentheses)

Table 2-4. Subsequent Real Earnings Growth as a Function of Payout Ratio and Lagged Earnings Growth

A1. 10-year subsequent real earnings growth as a function of payout ratio (PR) and previous 10-year real earnings growth (LEG_{10}) 1975-2004.

Country	Constant			Adjusted R^2
US	-0.07	0.17 PR	-0.18 LEG_{10}	29.1%
	(-2.03)	(2.51)	(-0.59)	
UK	0.01	0.03 PR	-0.09 LEG_{10}	11.0%
	(1.00)	(3.01)	(-0.72)	

A2. 5-year subsequent real earnings growth as a function of payout ratio (PR) and previous 5-year real earnings growth (LEG_5) 1970-2004.

Country	Constant			Adjusted R^2
US	-0.18	0.41 PR	-0.18 LEG_5	48.4%
	(-4.58)	(5.19)	(-1.36)	
UK	-0.02	0.09 PR	-0.64 LEG_5	56.8%
	(-0.89)	(3.03)	(-8.67)	

B. 5-year subsequent real earnings growth as a function of payout ratio (PR) and previous 5-year real earnings growth (LEG_5) 1978-2004.

Country	Constant			Adjusted R^2
US	-0.22	0.48 PR	-0.15 LEG_5	53.2%
	(-5.96)	(6.93)	(-1.25)	
UK	-0.02	0.10 PR	-0.64 LEG_5	57.1%
	(-0.98)	(2.89)	(-9.11)	
France	0.16	-0.15 PR	-0.98 LEG_5	76.0%
	(4.37)	(-1.89)	(-12.38)	
Germany	0.16	-0.22 PR	-0.87 LEG_5	63.2%
	(4.01)	(-1.95)	(-10.35)	
Netherlands	-0.02	0.17 PR	-0.37 LEG_5	27.1%
	(-0.55)	(2.54)	(-3.93)	
Switzerland	0.01	0.18 PR	-0.25 LEG_5	10.1%
	(0.21)	(0.76)	(-1.41)	
Japan	-0.47	1.28 PR	0.86 LEG_5	50.5%
	(-6.32)	(6.42)	(4.82)	
EW7	-0.09	0.33 PR	-0.58 LEG_5	55.5%
	(-1.71)	(2.94)	(-5.17)	
VW7	-0.18	0.44 PR	-0.44 LEG_5	65.6%
	(-5.51)	(6.26)	(-3.49)	

(t-statistics are presented in parentheses)

Table 2-5. Subsequent Real Earnings Growth as a Function of Earnings Yield (EY) (Original Data Periods)

A. Subsequent 10-yr Real Earnings Growth as a Function of Earnings Yield (EY)				*B. Subsequent 5-yr Real Earnings Growth as a Function of Earnings Yield (EY)*			
Country	Constant		Adjusted R^2	Country	Constant		Adjusted R^2
US	0.06	-0.56 EY	35.15%	US	0.08	-0.84 EY	16.07%
	(6.50)	(-6.11)			(2.86)	(-2.96)	
UK	0.03	-0.09 EY	6.81%	UK	0.05	-0.28 EY	8.48%
	(7.18)	(-2.25)			(4.07)	(-2.66)	
France	0.07	-0.00 EY	16.72%	France	0.16	-1.13 EY	17.53%
	(11.84)	(-5.33)			(7.07)	(-4.35)	
Germany	0.04	0.04 EY	-0.33%	Germany	0.13	-1.23 EY	7.82%
	(1.92)	(0.17)			(3.37)	(-2.32)	
Netherlands	0.01	0.00 EY	11.79%	Netherlands	0.08	-0.36 EY	10.05%
	(1.15)	(2.66)			(5.04)	(-2.71)	
Switzerland	0.14	-1.03 EY	30.09%	Switzerland	0.17	-1.50 EY	29.72%
	(7.76)	(-6.34)			(4.96)	(-4.22)	
Japan	-0.07	1.60 EY	40.59%	Japan	-0.03	0.85 EY	4.58%
	(-13.26)	(13.08)			(-4.10)	(3.98)	
Italy	0.05	-0.57 EY	3.86%	Italy	0.19	-3.02 EY	20.36%
	(2.74)	(-2.17)			(6.53)	(-6.33)	
Spain	0.02	-0.07 EY	0.01%	Spain	0.10	-0.94 EY	16.57%
	(2.73)	(-0.69)			(4.94)	(-4.40)	
Greece	0.12	-0.87 EY	68.79%	Greece	0.12	-0.90 EY	6.82%
	(14.07)	(-9.79)			(4.75)	(-2.92)	
Portugal	0.05	-0.23 EY	92.80%	Portugal	0.07	-0.45 EY	57.71%
	(24.56)	(-31.46)			(6.06)	(-14.23)	
C. Subsequent 3-yr Real Earnings Growth as a Function of Earnings Yield (EY)				*D. Subsequent 1-yr Real Earnings Growth as a Function of Earnings Yield (EY)*			
US	0.08	-0.90 EY	8.03%	US	0.12	-1.34 EY	5.56%
	(1.98)	(-2.10)			(2.01)	(-2.24)	
UK	0.07	-0.49 EY	9.30%	UK	0.13	-1.26 EY	14.28%
	(4.13)	(-3.50)			(3.88)	(-3.16)	
France	0.17	-1.21 EY	11.59%	France	0.24	-2.07 EY	11.36%
	(4.00)	(-2.39)			(4.64)	(-3.19)	
Germany	0.23	-2.55 EY	16.75%	Germany	0.29	-3.30 EY	9.06%
	(4.11)	(-3.57)			(3.29)	(-2.94)	
Netherlands	0.10	-0.65 EY	13.51%	Netherlands	0.21	-1.58 EY	10.12%
	(4.58)	(-2.85)			(3.50)	(-2.56)	
Switzerland	0.16	-1.51 EY	18.23%	Switzerland	0.15	-1.56 EY	9.33%
	(3.72)	(-3.39)			(2.55)	(-2.43)*	
Japan	0.02	-0.62 EY	1.00%	Japan	0.07	-2.43 EY	7.72%
	(1.48)	(-2.09)			(4.76)	(-5.55)	
Italy	0.26	-4.48 EY	32.78%	Italy	0.59	-9.95 EY	33.22%
	(9.52)	(-9.35)			(10.45)	(-10.05)	
Spain	0.13	-1.44 EY	22.67%	Spain	0.24	-2.80 EY	23.20%
	(3.87)	(-3.25)			(4.60)	(-4.69)	
Greece	0.18	-1.75 EY	14.48%	Greece	0.56	-6.70 EY	39.05%
	(6.08)	(-4.74)			(10.68)	(-9.89)	
Portugal	0.07	-0.61 EY	46.96%	Portugal	0.10	-0.76 EY	12.94%
	(3.63)	(-10.42)			(2.99)	(-4.60)	

(t-statistics are presented in parentheses)

Table 2-6. Subsequent Real Earnings Growth as a Function of Payout Ratio and Earnings Yield

A1. 10-year subsequent real earnings growth as a function of payout ratio (PR) and earnings yield (EY) 1965-04.

Country	Constant			Adjusted R^2
US	-0.01	0.10 PR	-0.30 EY	41.2%
	(-0.30)	(1.42)	(-1.76)	
UK	0.01	0.02 PR	-0.05 EY	8.3%
	(0.77)	(0.98)	(-0.66)	

A2. 5-year subsequent real earnings growth as a function of payout ratio (PR) and earnings yield (EY) 1965-2004.

US	-0.18	0.42 PR	-0.21 EY	31.7%
	(-2.97)	(4.49)	(-1.76)	
UK	-0.08	0.16 PR	0.09 EY	17.7%
	(-1.57)	(2.75)	(0.43)	

B. 5-year subsequent real earnings growth as a function of payout ratio (PR) and earnings yield (EY) 1973-2004.

US	-0.19	0.46 PR	-0.32 EY	51.4%
	(-3.33)	(5.69)	(-1.45)	
UK	-0.12	0.22 PR	0.23 EY	20.3%
	(-1.97)	(3.01)	(0.86)	
France	-0.04	0.38 PR	-0.82 EY	36.0%
	(-1.21)	(4.64)	(-3.47)	
Germany	0.09	0.10 PR	-1.21 EY	8.5%
	(2.31)	(1.48)	(-2.50)	
Netherlands	0.06	0.02 PR	-0.33 EY	10.4%
	(0.95)	(0.21)	(-1.80)	
Switzerland	0.01	0.48 PR	-1.15 EY	27.4%
	(0.11)	(3.11)	(-3.35)	
Japan	-0.21	0.52 PR	0.27 EY	31.9%
	(-5.02)	(5.23)	(0.62)	
EW7	-0.15	0.46 PR	-0.23 EY	19.8%
	(-2.31)	(3.31)	(-1.31)	
VW7	-0.30	0.67 PR	0.37 EY	56.6%
	(-9.48)	(11.26)	(1.14)	

C. 1-year subsequent real earnings growth as a function of payout ratio (PR) and earnings yield (EY) 1990-2004.

US	-0.04	0.89 PR	-7.49 EY	22.3%
	(-0.20)	(2.79)	(-2.27)	
UK	-0.13	0.49 PR	-2.59 EY	16.2%
	(-0.96)	(2.90)	(-2.21)	
France	-0.42	1.54 PR	-2.96 EY	50.1%
	(-1.93)	(4.11)	(-2.53)	
Germany	0.04	0.29 PR	-1.39 EY	1.2%
	(0.16)	(0.47)	(-0.60)	
Netherlands	-0.40	1.33 PR	-3.47 EY	29.0%
	(-1.99)	(3.55)	(-3.32)	
Switzerland	0.25	0.46 PR	-5.54 EY	22.8%
	(0.89)	(0.51)	(-4.58)	
Japan	-0.35	0.95 PR	-1.35 EY	14.2%
	(-1.35)	(2.99)	(-0.17)	
Italy	0.40	-0.10 PR	-5.77 EY	14.6%
	(2.43)	(-0.40)	(-3.09)	
Spain	-0.05	0.66 PR	-2.88 EY	36.5%
	(-0.36)	(2.15)	(-5.64)	
Greece	0.58	-0.03 PR	-6.74 EY	38.8%
	(3.54)	(-0.14)	(-6.46)	
Portugal	-0.51	1.25 PR	-0.29 EY	26.0%
	(-2.79)	(3.11)	(-1.13)	
EW11	-0.12	0.91 PR	-4.65 EY	21.5%
	(-0.56)	(2.25)	(-3.60)	
VW11	-0.49	1.78 PR	-14.52 EY	22.3%
	(-2.41)	(3.82)	(-2.55)	

(t-statistics presented in parentheses)

Table 2-7. Subsequent Real Earnings Growth as a Function of Payout Ratio (PR) and Earnings Yield (EY) (Original Data Periods)

A. Subsequent 10-yr Real Earnings Growth as a Function of Payout Ratio (PR)Earnings Yield (EY)

Country	Constant			Adjusted R^2
US	0.01	0.07 PR	-0.40 EY	36.39%
	(0.25)	(0.97)	(-2.20)	
UK	0.01	0.02 PR	-0.05 EY	7.86%
	(0.76)	(0.97)	(-0.62)	
France	0.04	0.07 PR	0.00 EY	28.34%
	(5.65)	(3.17)	(-5.48)	
Germany	0.06	-0.06 PR	0.00 EY	4.40%
	(2.39)	(-1.31)	(0.01)	
Netherlands	-0.01	0.09 PR	0.00 EY	16.09%
	(-1.04)	(2.09)	(0.81)	
Switzerland	0.12	0.08 PR	-1.03 EY	30.54%
	(3.12)	(0.8)	(-6.60)	
Japan	-0.15	0.30 PR	0.92 EY	57.35%
	(-15.88)	(9.92)	(7.36)	
Italy	-0.19	0.41 PR	0.31 EY	81.69%
	(-13.53)	(19.80)	(2.56)	
Spain	-0.05	0.20 PR	-0.14 EY	72.78%
	(-5.08)	(10.25)	(-3.37)	
Greece	0.12	-0.02 PR	-0.84 EY	68.33%
	(12.53)	(-0.61)	(-8.22)	
Portugal	0.08	-0.06 PR	-0.25 EY	93.35%
	(4.04)	(-1.29)	(-12.77)	

B. Subsequent 5-yr Real Earnings Growth as a Function of Payout Ratio (PR)Earnings Yield (EY)

Country	Constant			Adjusted R^2
US	-0.22	0.49 PR	-0.11 EY	52.79%
	(-3.50)	(5.40)	(-0.44)	
UK	-0.07	0.15 PR	0.06 EY	18.06%
	(-1.43)	(2.65)	(0.32)	
France	-0.03	0.38 PR	-0.96 EY	38.49%
	(-0.75)	(4.37)	(-3.80)	
Germany	0.10	0.09 PR	-1.31 EY	8.98%
	(2.27)	(1.28)	(-2.48)	
Netherlands	0.07	0.01 PR	-0.35 EY	9.77%
	(1.06)	(0.11)	(-1.84)	
Switzerland	0.01	0.57 PR	-1.44 EY	38.10%
	(0.20)	(4.46)	(-4.15)	
Japan	-0.19	0.45 PR	0.54 EY	28.09%
	(-11.13)	(10.08)	(2.87)	
Italy	0.23	-0.08 PR	-3.15 EY	20.45%
	(4.78)	(-1.08)	(-6.41)	
Spain	-0.13	0.48 PR	-0.76 EY	38.64%
	(-2.28)	(4.12)	(-3.47)	
Greece	-0.04	0.43 PR	-0.86 EY	61.05%
	(-1.77)	(11.96)	(-4.35)	
Portugal	-0.08	0.30 PR	-0.34 EY	63.36%
	(-1.88)	(3.71)	(-6.32)	

C. Subsequent 3-yr Real Earnings Growth as a Function of Payout Ratio (PR)Earnings Yield (EY)

US	-0.31	0.69 PR	-0.27 EY	45.73%
	(-3.84)	(5.99)	(-0.82)	
UK	-0.11	0.24 PR	0.01 EY	17.19%
	(-1.91)	(3.32)	(0.03)	
France	0.01	0.32 PR	-1.10 EY	19.04%
	(0.15)	(2.71)	(-2.24)	
Germany	0.11	0.38 PR	-3.04 EY	26.86%
	(1.79)	(3.13)	(-4.79)	
Netherlands	-0.04	0.24 PR	-0.41 EY	16.04%
	(-0.41)	(1.75)	(-1.47)	
Switzerland	-0.03	0.68 PR	-1.42 EY	24.48%
	(-0.41)	(3.03)	(-3.17)	
Japan	-0.19	0.54 PR	-0.76 EY	19.62%
	(-7.54)	(8.83)	(-2.88)	
Italy	0.50	-0.44 PR	-5.42 EY	42.91%
	(10.25)	(-5.68)	(-11.49)	
Spain	-0.04	0.39 PR	-1.46 EY	29.36%
	(-0.25)	(3.26)	(-3.69)	
Greece	0.03	0.36 PR	-1.64 EY	26.59%
	(0.77)	(4.67)	(-4.76)	
Portugal	-0.05	0.23 PR	-0.52 EY	48.61%
	(-0.69)	(1.96)	(-6.11)	

D. Subsequent 1-yr Real Earnings Growth as a Function of Payout Ratio (PR)Earnings Yield (EY)

US	-0.27	0.71 PR	-0.78 EY	18.79%
	(-1.60)	(2.64)	(-1.22)	
UK	0.23	-0.13 PR	-1.54 EY	14.71%
	(1.81)	(-0.86)	(-2.97)	
France	0.16	0.18 PR	-2.03 EY	11.88%
	(1.25)	(0.86)	(-3.00)	
Germany	0.14	0.49 PR	-3.89 EY	14.23%
	(1.46)	(2.70)	(-3.54)	
Netherlands	-0.57	1.37 PR	-0.26 EY	21.94%
	(-2.17)	(2.93)	(-0.37)	
Switzerland	0.15	0.02 PR	-1.55 EY	9.07%
	(1.09)	(0.05)	(-2.48)	
Japan	-0.10	0.46 PR	-2.57 EY	12.63%
	(-2.43)	(4.58)	(-6.03)	
Italy	0.77	-0.33 PR	-10.61EY	34.40%
	(7.73)	(-2.15)	(-10.32)	
Spain	-0.12	0.89 PR	-3.04 EY	35.44%
	(-1.03)	(3.43)	(-5.72)	
Greece	0.59	-0.08 PR	-6.73 EY	38.74%
	(7.42)	(-0.51)	(-9.87)	
Portugal	-0.55	1.32 PR	-0.27 EY	48.74%
	(-2.72)	(3.04)	(-1.02)	

(t-statistics presented in parentheses)

Table 2-8. Subsequent Real Dividend Growth as a Function of Payout Ratio (Original Data Periods

A. Subsequent 10-yr Real Dividend Growth as a Function of Payout Ratio (PR)				*B. Subsequent 5-yr Real Dividend Growth as a Function of Payout Ratio (PR)*			
Country	Constant		Adjusted R^2	Country	Constant		Adjusted R^2
US	0.03	-0.04 PR	4.50%	US	-0.01	0.03 PR	0.80%
	(3.38)	(-2.50)			(-0.72)	(1.05)	
UK	0.14	-0.21 PR	58.40%	UK	0.10	-0.15 PR	0.10%
	(8.23)	(-7.33)			(3.93)	(-3.38)	
France	0.11	-0.14 PR	32.65%	France	0.12	-0.15 PR	7.60%
	(8.78)	(-5.15)			(4.25)	(-2.76)	
Germany	0.10	-0.18 PR	38.52%	Germany	0.10	-0.22 PR	11.30%
	(6.30)	(-5.18)			(3.57)	(-3.28)	
Netherlands	0.10	-0.12 PR	7.63%	Netherlands	0.13	-0.18 PR	5.70%
	(4.22)	(-2.32)			(2.55)	(-1.84)	
Switzerland	0.16	-0.46 PR	14.77%	Switzerland	0.10	-0.22 PR	1.30%
	(4.39)	(-3.60)			(2.74)	(-1.56)	
Japan	-0.02	0.05 PR	3.19%	Japan	0.02	-0.06 PR	2.50%
	(-3.74)	(3.03)			(0.98)	(-1.49)	
Italy	-0.11	0.29 PR	32.96%	Italy	0.36	-0.80 PR	27.63%
	(-5.95)	(6.84)			(8.42)	(-7.71)	
Spain	0.10	-0.20 PR	35.98%	Spain	0.02	-0.02 PR	-0.66%
	(4.94)	(-4.40)			(0.40)	(-0.17)	
Greece	0.21	-0.46 PR	56.64%	Greece	0.23	-0.36 PR	40.20%
	(14.23)	(-7.56)			(13.45)	(-8.38)	
Portugal	0.13	-0.24 PR	48.24%	Portugal	0.14	-0.21 PR	10.95%
	(6.70)	(-4.84)			(7.06)	(-4.23)	
C. Subsequent 3-yr Real Dividend Growth as a Function of Payout Ratio (PR)				*D. Subsequent 1-yr Real Dividend Growth as a Function of Payout Ratio (PR)*			
US	-0.03	0.07 PR	3.50%	US	-0.02	0.05 PR	0.50%
	(-1.56)	(1.82)			(-0.66)	(0.85)	
UK	0.07	-0.10 PR	4.85%	UK	0.06	-0.07 PR	1.43%
	(2.22)	(-1.89)			(1.10)	(-0.88)	
France	0.18	-0.29 PR	13.83%	France	0.29	-0.56 PR	19.99%
	(4.90)	(-4.09)			(4.56)	(-4.25)	
Germany	0.13	-0.27 PR	9.55%	Germany	0.19	-0.45 PR	12.46%
	(3.27)	(-3.14)			(3.26)	(-3.25)	
Netherlands	0.13	-0.19 PR	4.17%	Netherlands	0.10	-0.14 PR	0.73%
	(1.75)	(-1.32)			(0.84)	(-0.59)	
Switzerland	0.07	-0.09 PR	-0.11%	Switzerland	0.34	-1.11 PR	11.56%
	(1.25)	(-0.46)			(3.45)	(-3.09)	
Japan	0.03	-0.12 PR	6.74%	Japan	0.09	-0.26 PR	11.21%
	(3.70)	(-5.01)			(5.76)	(-6.79)	
Italy	0.54	-1.18 PR	42.30%	Italy	0.49	-1.02 PR	19.96%
	(12.24)	(-11.43)			(7.90)	(-7.15)	
Spain	0.18	-0.38 PR	7.53%	Spain	0.22	-0.46 PR	5.16%
	(2.55)	(-2.55)			(2.01)	(-1.95)	
Greece	0.47	-0.92 PR	57.87%	Greece	0.70	-1.42 PR	50.40%
	(16.92)	(-13.24)			(8.78)	(-7.52)	
Portugal	0.19	-0.34 PR	9.32%	Portugal	0.54	-1.08 PR	21.20%
	(3.32)	(-2.97)			(6.35)	(-6.24)	

(t-statistics presented in parentheses)

Table 2-9. Subsequent Real Dividend Growth as a Function of Payout Ratio

Country	Constant		Adjusted R^2
A1. 10-year subsequent real dividend growth as a function of payout ratio (PR) 1965-2004.			
US	0.03	-0.04 PR	4.5%
	(3.38)	(-2.50)	
UK	0.14	-0.21 PR	58.4%
	(8.23)	(-7.33)	
A2. 5-year subsequent real dividend growth as a function of payout ratio (PR) 1965-2004.			
US	-0.01	0.03 PR	0.8%
	(-0.72)	(1.05)	
UK	0.10	-0.15 PR	0.1%
	(3.93)	(-3.38)	
B. 5-year subsequent real dividend growth as a function of payout ratio (PR) 1973-2004.			
US	-0.03	0.09 PR	14.2%
	(-2.52)	(3.56)	
UK	0.07	-0.07 PR	4.1%
	(2.97)	(-1.85)	
France	0.12	-0.15 PR	7.6%
	(4.25)	(-2.76)	
Germany	0.10	-0.22 PR	11.3%
	(3.57)	(-3.28)	
Netherlands	0.13	-0.18 PR	5.7%
	(2.55)	(-1.84)	
Switzerland	0.10	-0.22 PR	1.3%
	(2.74)	(-1.56)	
Japan	0.02	-0.06 PR	2.5%
	(0.98)	(-1.49)	
EW7	0.01	0.03 PR	-0.2%
	(0.32)	(0.28)	
VW7	-0.03	0.10 PR	7.2%
	(-2.20)	(2.90)	
C. 1-year subsequent real dividend growth as a function of payout ratio (PR) 1990-2004.			
US	-0.04	0.11 PR	2.3%
	(-1.01)	(1.37)	
UK	0.11	-0.18 PR	5.3%
	(2.51)	(-2.63)	
France	-0.21	0.64 PR	6.9%
	(-1.32)	(1.66)	
Germany	0.48	-1.41 PR	34.5%
	(4.13)	(-4.09)	
Netherlands	0.35	-0.61 PR	12.9%
	(3.60)	(-3.19)	
Switzerland	0.52	-1.59 PR	13.9%
	(2.56)	(-2.17)	
Japan	0.04	-0.10 PR	0.7%
	(1.10)	(-1.49)	
Italy	0.51	-0.98 PR	16.6%
	(3.43)	(-3.15)	
Spain	0.35	-0.78 PR	10.4%
	(2.13)	(-2.16)	
Greece	0.70	-1.42 PR	50.4%
	(8.78)	(-7.52)	
Portugal	0.54	-1.08 PR	21.2%
	(6.35)	(-6.24)	
EW11	0.26	-0.48 PR	4.9%
	(2.22)	(-1.88)	
VW11	-0.02	0.08 PR	0.2%
	(-0.32)	(0.57)	

(t-statistics presented in parentheses)

Table 2-10. Subsequent Real Dividend Growth as a Function of Payout Ratio and Lagged Dividend Growth

A1. 10-year subsequent real dividend growth as a function of payout ratio (PR) and previous 10-year real dividend growth (LDG_{10}) 1975-2004.

Country	Constant			Adjusted R^2
US	0.03	-0.03 PR	-0.01 LDG_{10}	4.9%
	(2.71)	(-1.26)	(-0.09)	
UK	0.09	-0.08 PR	-0.26 LDG_{10}	70.6%
	(8.60)	(-4.23)	(-4.17)	

A2. 5-year subsequent real dividend growth as a function of payout ratio (PR) and previous 5-year real dividend growth (LDG_5) 1970-2004.

US	-0.02	0.05 PR	-0.24 LDG_5	9.3%
	(-1.32)	(1.91)	(-2.65)	
UK	0.11	-0.15 PR	-0.16 LDG_5	16.6%
	(4.31)	(-2.98)	(1.95)	

B. 5-year subsequent real dividend growth as a function of payout ratio (PR) and previous 5-year real dividend growth (LDG_5) 1978-2004.

US	-0.03	0.10 PR	-0.56LDG_5	40.0%
	(-2.54)	(4.49)	(-6.29)	
UK	0.12	-0.16 PR	0.13 LDG_5	18.7%
	(4.81)	(-3.32)	(1.24)	
France	0.15	-0.17PR	-0.50 LDG_5	25.1%
	(5.23)	(-2.79)	(-4.91)	
Germany	0.18	-0.40 PR	-0.86 LDG_5	46.4%
	(4.50)	(-3.42)	(-6.99)	
Netherlands	0.12	-0.13 PR	-0.19 LDG_5	12.3%
	(2.40)	(-1.17)	(-1.41)	
Switzerland	0.14	-0.36 PR	0.26 LDG_5	9.7%
	(3.32)	(-2.40)	(1.35)	
Japan	0.01	-0.04 PR	-0.16 LDG_5	2.4%
	(0.76)	(-0.86)	(-1.29)	
EW7	-0.04	0.18 PR	-0.21 LDG_5	11.3%
	(-1.10)	(2.43)	(-1.45)	
VW7	-0.02	0.08 PR	-0.28 LDG_5	16.8%
	(-1.18)	(2.43)	(-2.28)	

(t-statistics presented in parentheses)

Table 2-11. Subsequent Real Dividend Growth as a Function of Payout Ratio and Subsequent Payout Ratio Change

A1. 10-year sub. real dividend growth as a function of payout ratio (PR) and sub. PR change (PRC) 1965-2004.				
Country	Constant			Adjusted R^2
US	0.01	-0.01 PR	0.03 PRC	7.5%
	(1.17)	(-0.41)	(1.81)	
UK	0.00	0.03 PR	0.19 PRC	83.5%
	(0.21)	(0.92)	(8.54)	
A2. 5-year sub. real dividend growth as a function of payout ratio (PR) and sub. PR change (PRC) 1965-2004.				
US	-0.01	0.03 PR	0.01 PRC	0.6%
	(-0.63)	(0.85)	(0.21)	
UK	0.00	0.03 PR	0.23 PRC	43.8%
	(0.14)	(0.64)	(6.55)	
B. 5-year sub. real dividend growth as a function of payout ratio (PR) and sub. PR change (PRC) 1973-2004.				
US	-0.03	0.09 PR	-0.00 PRC	13.8%
	(-2.07)	(2.89)	(-0.00)	
UK	0.01	0.03 PR	0.17 PRC	18.7%
	(0.30)	(0.60)	(3.68)	
France	0.16	-0.26 PR	-0.09 PRC	9.2%
	(3.95)	(-2.97)	(-1.65)	
Germany	0.13	-0.29 PR	-0.12 PRC	12.3%
	(3.42)	(-2.95)	(-0.96)	
Netherlands	0.00	0.07 PR	0.07 PRC	24.3%
	(0.11)	(0.81)	(5.39)	
Switzerland	0.08	-0.15 PR	0.06 PRC	1.1%
	(1.43)	(-0.69)	(0.36)	
Japan	0.11	-0.32 PR	-0.23 PRC	35.4%
	(5.16)	(-5.28)	(-6.00)	
EW7	0.05	-0.07 PR	-0.09 PRC	0.7%
	(0.75)	(-0.40)	(-0.89)	
VW7	0.03	-0.04 PR	-0.09 PRC	15.6%
	(0.77)	(-0.49)	(-1.99)	
C. 1-year sub. real dividend growth as a function of payout ratio (PR) and sub. PR change (PRC) 1970-2004.				
US	0.02	0.00 PR	-0.27 PRC	13.6%
	(0.34)	(0.02)	(-2.11)	
UK	0.06	-0.09 PR	0.22 PRC	12.9%
	(1.11)	(-1.14)	(2.55)	
France	-0.39	1.04 PR	0.65 PRC	12.2%
	(-1.85)	(2.12)	(1.57)	
Germany	0.44	-1.28 PR	0.23 PRC	35.1%
	(3.87)	(-3.83)	(0.92)	
Netherlands	0.57	-1.05 PR	-0.48 PRC	20.6%
	(5.72)	(-5.38)	(-3.16)	
Switzerland	0.37	-1.06 PR	0.60 PRC	15.0%
	(1.50)	(-1.18)	(0.76)	
Japan	0.14	-0.35 PR	-0.59 PRC	26.2%
	(2.75)	(-3.14)	(-3.46)	
Italy	0.29	-0.53 PR	1.36 PRC	37.0%
	(2.48)	(-1.93)	(3.66)	
Spain	0.12	-0.23 PR	1.17 PRC	27.8%
	(0.85)	(-0.70)	(2.96)	
Greece	0.65	-1.31 PR	0.25 PRC	51.0%
	(7.42)	(-6.20)	(1.11)	
Portugal	-0.14	0.40 PR	1.60 PRC	55.8%
	(-1.18)	(1.44)	(4.97)	
EW11	0.37	-0.73 PR	-0.39 PRC	6.7%
	(2.97)	(-2.66)	(-1.39)	
VW11	0.11	-0.20 PR	-0.44 PRC	20.2%
	(1.62)	(-1.39)	(-2.61)	

(t-statistics presented in parentheses)

Table 2-12. Subsequent Real Dividend Growth as a Function of Dividend Yield (DY) (Original Data Periods)

A. Subsequent 10-yr Real Dividend Growth as a Function of Dividend Yield (DY)				*B. Subsequent 5-yr Real Dividend Growth as a Function of Dividend Yield (DY)*			
Country	Constant		Adjusted R^2	Country	Constant		Adjusted R^2
US	-0.01	0.50 DY	18.16%	US	0.00	0.14 DY	0.28%
	(-2.06)	(4.29)			(0.24)	(0.61)	
UK	-0.02	0.84 DY	6.97%	UK	-0.04	1.18 DY	9.53%
	(-1.05)	(1.92)			(-1.47)	(2.13)	
France	0.07	-0.63 DY	14.15%	France	0.12	-1.85 DY	30.97%
	(6.25)	(-2.72)			(8.85)	(-6.55)	
Germany	0.06	-1.23 DY	16.16%	Germany	0.11	-2.88 DY	21.39%
	(4.07)	(-2.71)			(4.69)	(-4.30)	
Netherlands	0.06	-0.38 DY	1.85%	Netherlands	0.11	-1.41 DY	14.06%
	(3.33)	(-0.96)			(5.00)	(-2.96)	
Switzerland	0.17	-5.08 DY	48.60%	Switzerland	0.17	-5.66 DY	45.07%
	(8.54)	(-7.44)			(6.69)	(-5.89)	
Japan	-0.01	0.52 DY	5.53%	Japan	0.00	-0.62 DY	2.77%
	(-5.51)	(3.95)			(-0.23)	(-3.13)	
Italy	-0.11	4.49 DY	47.03%	Italy	0.38	-14.60 DY	53.95%
	(-7.82)	(9.14)			(14.34)	(-13.43)	
Spain	0.06	-1.40 DY	73.57%	Spain	0.04	-0.78 DY	4.02%
	(9.61)	(-8.03)			(1.57)	(-1.23)	
Greece	0.18	-3.52 DY	81.33%	Greece	0.23	-4.43 DY	56.28%
	(28.04)	(-13.72)			(18.05)	(-11.56)	
Portugal	0.11	-2.15 DY	85.62%	Portugal	0.12	-2.79 DY	36.65%
	(12.60)	(-9.15)			(6.28)	(-5.05)	

C. Subsequent 3-yr Real Dividend Growth as a Function of Dividend Yield (DY)				*D. Subsequent 1-yr Real Dividend Growth as a Function of Dividend Yield (DY)*			
US	0.00	0.21 DY	0.51%	US	0.01	-0.21 DY	0.07%
	(-0.21)	(0.73)			(0.76)	(-0.53)	
UK	-0.01	0.53 DY	1.41%	UK	0.04	-0.62 DY	1.23%
	(-0.32)	(0.91)			(1.25)	(-0.80)	
France	0.12	-1.99 DY	19.29%	France	0.15	-2.69 DY	14.35%
	(5.57)	(-3.70)			(4.32)	(-3.62)	
Germany	0.12	-3.59 DY	20.85%	Germany	0.15	-4.76 DY	17.03%
	(3.88)	(-3.91)			(3.39)	(-3.71)	
Netherlands	0.13	-1.91 DY	21.68%	Netherlands	0.15	-2.53 DY	18.03%
	(6.12)	(-4.72)			(5.14)	(-4.70)	
Switzerland	0.16	-5.44 DY	28.71%	Switzerland	0.20	-7.34 DY	19.92%
	(4.80)	(-4.34)			(3.68)	(-3.73)	
Japan	0.01	-1.48 DY	10.39%	Japan	0.02	-2.70 DY	12.38%
	(2.14)	(-6.29)			(3.71)	(-7.17)	
Italy	0.47	-18.59DY	56.47%	Italy	0.50	-19.05DY	36.66%
	(16.20)	(-15.19)			(11.73)	(-10.83)	
Spain	0.05	-0.99 DY	2.26%	Spain	0.09	-2.14 DY	4.80%
	(1.32)	(-1.10)			(2.02)	(-1.97)	
Greece	0.33	-7.60 DY	43.22%	Greece	0.47	-11.65DY	33.27%
	(14.04)	(-9.88)			(11.77)	(-8.73)	
Portugal	0.16	-4.32 DY	26.16%	Portugal	0.41	-12.46DY	38.69%
	(4.57)	(-5.29)			(4.83)	(-5.23)	

(t-statistics presented in parentheses)

Table 2-13. Subsequent Real Dividend Growth as a Function of Payout Ratio and Dividend Yield

Country	Constant			Adjusted R^2
A1. 10-year subsequent real dividend growth as a function of payout ratio (PR) and dividend yield (DY) 1965-04.				
US	-0.03	0.01 PR	0.01 DY	16.8%
	(-1.65)	(0.70)	(3.69)	
UK	0.14	-0.21 PR	-0.00 DY	58.4%
	(5.52)	(-7.66)	(-0.29)	
A2. 5-year subsequent real dividend growth as a function of payout ratio (PR) and dividend yield (DY) 1965-2004.				
US	-0.01	0.03 PR	0.00 DY	0.7%
	(-0.77)	(1.07)	(0.42)	
UK	0.04	-0.11 PR	0.01 DY	19.8%
	(1.09)	(-2.73)	(1.65)	
B. 5-year subsequent real dividend growth as a function of payout ratio (PR) and dividend yield (DY) 1973-2004.				
US	-0.03	0.09 PR	-0.00 DY	14.0%
	(-1.83)	(3.44)	(-0.13)	
UK	-0.01	-0.02 PR	0.01 DY	10.0%
	(-0.16)	(-0.44)	(1.50)	
France	0.14	-0.04 PR	-0.02 DY	32.0%
	(4.87)	(-0.50)	(-4.78)	
Germany	0.10	-0.05 PR	-0.02 DY	15.9%
	(3.45)	(-0.67)	(-2.37)	
Netherlands	0.25	-0.20 PR	-0.02DY	24.0%
	(5.15)	(-3.67)	(-3.34)	
Switzerland	0.13	0.11 PR	-0.05 DY	34.9%
	(3.67)	(0.62)	(-4.40)	
Japan	0.02	-0.04 PR	-0.01 DY	5.0%
	(0.96)	(-0.86)	(-1.20)	
EW7	0.06	0.00 PR	-0.98 DY	11.0%
	(1.26)	(0.05)	(-2.90)	
VW7	-0.04	0.10 PR	0.04 DY	7.0%
	(-2.12)	(2.92)	(0.26)	
C. 1-year subsequent real dividend growth as a function of payout ratio (PR) and dividend yield (DY) 1990-2004.				
US	-0.03	0.02 PR	-0.03 DY	8.0%
	(-0.82)	(1.76)	(-1.58)	
UK	0.12	-0.34 PR	0.02 DY	15.9%
	(2.57)	(-3.43)	(2.82)	
France	-0.14	0.63 PR	-0.02 DY	7.7%
	(-0.69)	(1.53)	(-0.88)	
Germany	0.55	-0.96 PR	-0.11 DY	47.6%
	(5.44)	(-3.16)	(-4.03)	
Netherlands	0.36	-0.45 PR	-0.03 DY	21.2%
	(4.72)	(-3.03)	(-3.91)	
Switzerland	0.92	-1.37 PR	-0.29 DY	44.7%
	(3.98)	(-2.08)	(-4.68)	
Japan	-0.04	-0.11 PR	0.10 DY	6.0%
	(-0.89)	(-1.56)	(1.28)	
Italy	0.50	-0.48 PR	-0.09 DY	20.2%
	(3.44)	(-1.23)	(-1.33)	
Spain	0.34	-0.62 PR	-0.02 DY	11.6%
	(2.04)	(-1.69)	(-1.40)	
Greece	0.70	-1.23 PR	-0.03 DY	51.3%
	(8.73)	(-4.70)	(-1.08)	
Portugal	0.68	-0.72 PR	-0.11 DY	46.8%
	(7.10)	(-5.52)	(-5.15)	
EW11	0.25	-0.34 PR	-2.15 DY	6.8%
	(2.24)	(-1.55)	(-1.34)	
VW11	-0.14	0.11 PR	3.01 DY	5.1%
	(-1.09)	(0.68)	(1.55)	

(t-statistics presented in parentheses)

Table 2-14. Subsequent Real Dividend Growth as a Function of Payout Ratio (PR) and Dividend Yield (DY) (Original Data Periods)

A. Subsequent 10-yr Real Dividend Growth as a Function of Payout Ratio (PR) and Dividend Yield (DY)

Country	Constant			Adjusted R^2
US	-0.01	-0.00 PR	0.47 DY	17.94%
	(-0.56)	(-0.30)	(3.30)	
UK	0.14	-0.22 PR	-0.11 DY	58.22%
	(5.49)	(-7.61)	(-0.28)	
France	0.11	-0.12 PR	-0.27 DY	34.64%
	(7.80)	(-4.07)	(-1.20)	
Germany	0.10	-0.18 PR	-0.03 DY	38.28%
	(14.20)	(-9.50)	(-0.16)	
Netherlands	0.14	-0.14 PR	-0.60 DY	12.48%
	(5.67)	(-3.29)	(-1.52)	
Switzerland	0.16	0.06 PR	-5.29 DY	48.55%
	(4.80)	(0.48)	(-7.66)	
Japan	-0.01	0.00 PR	0.51 DY	5.15%
	(-1.88)	(0.1)	(2.48)	
Italy	-0.15	0.17 PR	3.50 DY	55.77%
	(-9.33)	(4.38)	(6.96)	
Spain	0.08	-0.06 PR	-1.23 DY	75.91%
	(9.34)	(-2.46)	(-6.61)	
Greece	0.18	0.07 PR	-3.89 DY	81.17%
	(15.87)	(0.82)	(-7.47)	
Portugal	0.13	-0.09 PR	-1.81 DY	89.71%
	(36.23)	(-5.26)	(-14.94)	

B. Subsequent 5-yr Real Dividend Growth as a Function of Payout Ratio (PR) and Dividend Yield (DY)

Country	Constant			Adjusted R^2
US	-0.04	0.07 PR	0.24 DY	6.92%
	(-2.56)	(2.71)	(1.23)	
UK	0.05	-0.11 PR	0.71 DY	17.48%
	(1.29)	(-2.80)	(1.29)	
France	0.14	-0.04 PR	-1.76 DY	31.15%
	(4.86)	(-0.46)	(-4.43)	
Germany	0.11	-0.04 PR	-2.59 DY	21.29%
	(3.82)	(-0.50)	(-3.16)	
Netherlands	0.26	-0.28 PR	-1.76 DY	26.03%
	(5.23)	(-3.55)	(-3.44)	
Switzerland	0.11	0.29 PR	-6.18 DY	47.39%
	(3.59)	(1.86)	(-5.40)	
Japan	0.03	-0.08 PR	-0.27 DY	6.91%
	(3.47)	(-3.83)	(-1.26)	
Italy	0.44	-0.27 PR	-12.64 DY	55.96%
	(12.84)	(-2.82)	(-9.94)	
Spain	0.03	0.02 PR	-0.80 DY	3.39%
	(0.72)	(0.15)	(-1.12)	
Greece	0.24	-0.06 PR	-3.90 DY	56.33%
	(16.30)	(-1.06)	(-6.22)	
Portugal	0.16	-0.24 PR	-0.03 DY	37.81%
	(4.14)	(-2.93)	(-0.67)	

C. Subsequent 3-yr Real Dividend Growth as a Function of Payout Ratio (PR) and Dividend Yield (DY)

US	-0.04	0.07 PR	0.21 DY	3.98%
	(-1.76)	(1.84)	(0.8)	
UK	0.06	-0.09 PR	0.21 DY	4.85%
	(1.5)	(-1.96)	(0.36)	
France	0.19	-0.19 PR	-1.57 DY	23.95%
	(5.61)	(-2.30)	(-2.61)	
Germany	0.11	0.08 PR	-4.12 DY	20.95%
	(3.10)	(0.74)	(-3.30)	
Netherlands	0.31	-0.35 PR	-2.37 DY	34.94%
	(4.44)	(-2.98)	(-4.96)	
Switzerland	0.09	0.29 PR	-5.87 DY	30.19%
	(2.04)	(1.49)	(-4.27)	
Japan	0.04	-0.08 PR	-1.22 DY	12.92%
	(3.83)	(-3.26)	(-4.95)	
Italy	0.67	-0.72 PR	-14.28DY	69.40%
	(19.96)	(-8.69)	(-12.53)	
Spain	0.18	-0.35 PR	-0.48 DY	7.56%
	(2.50)	(-2.38)	(-0.52)	
Greece	0.47	-0.70 PR	-3.28 DY	62.28%
	(18.05)	(-8.04)	(-3.97)	
Portugal	0.23	-0.17 PR	-3.87 DY	27.96%
	(3.40)	(-1.41)	(-4.74)	

D. Subsequent 1-yr Real Dividend Growth as a Function of Payout Ratio (PR)and Dividend Yield (DY)

US	-0.01	0.05 PR	-0.23 DY	0.63%
	(-0.36)	(0.87)	(-0.62)	
UK	0.12	-0.11 PR	-0.98 DY	4.41%
	(2.56)	(-1.76)	(-1.32)	
France	0.31	-0.44 PR	-1.71 DY	24.78%
	(4.85)	(-3.60)	(-2.41)	
Germany	0.17	-0.13 PR	-3.90 DY	17.23%
	(3.30)	(-0.75)	(-2.24)	
Netherlands	0.32	-0.32 PR	-2.92 DY	23.06%
	(3.39)	(-1.78)	(-5.46)	
Switzerland	0.40	-0.81 PR	-6.36 DY	25.67%
	(3.66)	(-1.76)	(-2.92)	
Japan	0.08	-0.19 PR	-2.07 DY	17.60%
	(5.90)	(-4.85)	(-5.35)	
Italy	0.61	-0.40 PR	-16.08DY	38.68%
	(10.74)	(-2.75)	(-7.88)	
Spain	0.20	-0.33 PR	-1.45 DY	6.61%
	(1.94)	(-1.41)	(-1.31)	
Greece	0.75	-1.40 PR	-2.89 DY	58.51%
	(17.45)	(-9.60)	(-2.07)	
Portugal	0.71	-0.77 PR	-10.40DY	46.91%
	(6.50)'	(-5.17)	(-5.29)	

(t-statistics presented in parentheses)

Table 2-15. Average Nominal and Real Returns ranked by Earnings Yield.

Country	Earnings Yield	1-yr Nominal Return	3-yr Nominal Return	5-yr Nominal Return	10-yr Nominal Return	1-yr Real Return	3-yr Real Return	5-yr Real Return	10-yr Real Return
	>8%	19.13%	14.09%	15.10%	15.35%	5.17%	5.03%	4.95%	4.54%
	5-8%	15.85%	14.12%	12.89%	14.38%	10.28%	7.64%	5.58%	5.43%
USA	<5%	0.19%	3.42%	7.01%	9.43%	-2.91%	-0.75%	1.48%	-0.33%
	>10%	34.60%	25.90%	23.95%	21.62%	23.16%	15.97%	14.78%	14.09%
	6-10%	15.85%	14.12%	12.89%	14.38%	10.28%	7.64%	5.58%	5.43%
UK	<6%	0.19%	3.42%	7.01%	9.43%	-2.91%	-0.75%	1.48%	-0.33%
	>9%	23.44%	18.29%	18.50%	19.29%	15.54%	10.59%	11.29%	13.75%
	6-9%	19.62%	21.20%	19.13%	14.24%	16.03%	17.90%	15.82%	10.43%
France	<6%	2.20%	3.905	8.77%	11.39%	-1.16%	3.00%	5.59%	1.03%
	>8%	15.11%	12.01%	12.17%	13.39%	11.13%	8.18%	8.65%	10.56%
	6-8%	17.56%	11.63%	13.19%	10.64%	14.74%	8.93%	10.48%	7.73%
Germany	<6%	1.29%	7.13%	5.81%	7.99%	-0.36%	8.90%	6.07%	6.59%
	>10%	14.23%	9.84%	10.20%	11.85%	11.01%	6.68%	6.88%	8.46%
	7-10%	9.98%	13.61%	14.60%	15.21%	6.28%	10.17%	11.45%	12.69%
Switzerland	<7%	10.66%	11.15%	12.40%	8.76%	9.79%	13.39%	14.40%	-
	>10%	18.06%	16.82%	16.63%	16.72%	10.97%	10.92%	11.45%	12.88%
	7-10%	17.13%	16.16%	17.57%	17.77%	17.51%	14.88%	15.74%	15.66%
Netherlands	<7%	9.71%	10.89%	12.13%	9.31%	7.11%	12.66%	13.17%	-
	>4%	11.63%	13.87%	16.21%	15.97%	4.72%	8.26%	11.51%	12.40%
	2-4%	10.95%	15.58%	8.00%	2.44%	9.87%	14.70%	6.87%	1.29%
Japan	<2%	0.73%	-6.32%	-3.47%	-3.13%	-0.01%	-7.17%	-5.11%	-5.19%
	>7%	11.48%	13.97%	11.25%	12.45%	6.71%	9.47%	6.86%	8.01%
	6-7%	8.16%	8.59%	9.19%	11.39%	3.78%	3.92%	4.84%	7.46%
Italy	<6%	5.66%	4.99%	8.84%	5.81%	2.27%	4.30%	7.07%	-3.93%
	>9%	21.76%	21.83%	19.78%	15.69%	16.99%	17.54%	15.70%	11.95%
	7-9%	17.19%	14.32%	14.78%	15.26%	12.21%	9.57%	10.33%	11.75%
Spain	<7%	3.47%	-0.88%	0.46%	-	0.47%	-3.52%	-1.27%	-
	>9%	11.91%	22.98%	26.77%	16.04%	0.78%	13.63%	18.67%	9.95%
	6-9%	17.31%	26.76%	21.86%	19.01%	10.49%	28.47%	15.07%	9.10%
Greece	<6%	31.85%	-13.76%	-2.34%	-	28.49%	-17.40%	-	-
	>7%	13.55%	14.23%	15.87%	13.07%	5.69%	7.85%	10.70%	8.83%
	6-7%	4.68%	25.73%	22.73%	8.72%	1.01%	22.45%	19.62%	-
Portugal	<6%	15.67%	2.63%	1.80%	-	12.65%	2.06%	1.60%	-

Table 2-16. Average Nominal and Real Returns ranked by Dividend Yield.

Country	Earnings Yield	1-yr Nominal Return	3-yr Nominal Return	5-yr Nominal Return	10-yr Nominal Return	1-yr Real Return	3-yr Real Return	5-yr Real Return	10-yr Real Return
USA	>4%	16.34%	14.38%	15.09%	14.97%	5.19%	5.08%	5.01%	4.62%
	3-4%	12.73%	10.35%	11.59%	14.42%	3.75%	3.70%	3.72%	3.51%
	<3%	9.09%	10.99%	12.42%	9.07%	2.10%	2.15%	2.18%	2.95%
UK	>5%	31.44%	25.34%	22.22%	19.42%	21.79%	16.99%	14.28%	11.67%
	4-5%	17.37%	14.70%	16.16%	15.50%	11.02%	7.72%	8.87%	8.32%
	<4%	2.88%	4.23%	4.66%	10.79%	-1.02%	-1.31%	-3.40%	-3.32%
France	>4%	24.05%	22.23%	22.27%	20.37%	14.25%	12.75%	13.25%	13.26%
	3-4%	20.16%	15.18%	16.71%	14.21%	16.25%	11.65%	13.39%	10.52%
	<3%	7.09%	9.56	9.87%	12.40%	5.14%	10.04%	8.83%	11.12%
Germany	>3%	13.38%	12.10%	11.80%	12.64%	9.07%	8.00%	7.97%	9.38%
	2-3%	14.91%	12.19%	12.54%	11.45%	12.62%	10.04%	10.32%	9.21%
	<2%	5.26%	6.32%	7.62%	6.17%	3.70%	7.86%	8.21%	3.79%
Switzerland	>3%	16.67%	12.13%	10.73%	11.72%	13.53%	9.26%	7.64%	8.31%
	2-3%	9.61%	11.26%	12.15%	13.81%	6.03%	7.84%	8.85%	10.84%
	<2%	10.92%	11.52%	13.66%	14.18%	9.19%	11.67%	13.44%	13.31%
Netherlands	>5%	16.72%	17.97%	17.70%	17.64%	7.94%	9.04%	9.89%	12.51%
	4-5%	18.57%	14.91%	16.12%	15.75%	19.18%	16.05%	16.57%	14.66%
	<4%	10.70%	12.35%	14.00%	14.07%	8.12%	13.24%	14.16%	16.39%
Japan	>1.6%	11.63%	13.87%	16.21%	15.97%	4.72%	8.26%	11.51%	12.40%
	0.8-1.6%	18.29%	15.53%	8.46%	3.41%	17.70%	15.21%	9.06%	3.30%
	<0.8%	-3.68%	-4.30%	-2.55%	-2.08%	-4.80%	-5.34%	-3.91%	-3.29%
Italy	>3%	6.85%	8.50%	9.85%	13.53%	1.91%	3.76%	5.38%	10.04%
	2-3%	10.17%	6.19%	8.05%	10.04%	5.66%	1.24%	3.51%	5.24%
	<2%	5.93%	9.05%	10.81%	1.33%	2.72%	9.40%	9.85%	-3.93%
Spain	>4%	17.94%	15.60%	18.55%	15.69%	12.67%	10.64%	14.08%	11.95%
	3%	13.39%	15.37%	16.21%	15.26%	8.21%	10.60%	11.75%	11.75%
	<3%	12.22%	6.14%	5.27%	-	9.39%	5.37%	5.40%	-
Greece	>4%	19.15%	29.05%	36.86%	15.19%	9.66%	21.15%	30.00%	9.88%
	2-4%	17.12%	26.92%	13.84%	17.75%	11.27%	32.55%	7.59%	10.01%
	<2%	17.66%	-8.56%	1.61%	19.01	9.35%	-16.21%	-7.80%	9.10%
Portugal	>3%	10.39%	21.63%	21.66%	10.93%	5.46%	17.47%	17.95%	8.08%
	<3%	12.56%	4.15%	3.23%	15.15%	8.59%	2.36%	1.46%	10.35%

Table 2-17. Subsequent Real Returns as a Function of Earnings Yield (EY) (Original Data Periods)

A. Subsequent 10-yr Real Returns as a Function of Earnings Yield (EY)

Country	Constant		Adjusted R^2
US	0.03	0.63 EY	10.56%
	(1.53)	(2.99)	
UK	-0.02	1.09 EY	42.75%
	(-0.92)	(4.00)	
France	0.24	-0.01 EY	76.11%
	(29.21)	(-20.38)	
Germany	-0.01	1.25 EY	33.35%
	(-0.50)	(6.05)	
Netherlands	0.17	-0.00 EY	5.99%
	(9.61)	(-1.81)	
Switzerland	0.17	-0.77 EY	8.11%
	(7.03)	(-3.32)	
Japan	-0.10	4.12 EY	59.91%
	(-11.51)	(19.32)	
Italy	-0.08	2.10 EY	37.39%
	(-4.38)	(7.52)	
Spain	0.05	0.64 EY	29.83%
	(2.73)	(3.18)	
Greece	0.12	-0.26 EY	2.00%
	(6.50)	(-1.37)	
Portugal	0.07	0.03 EY	18.70%
	(21.19)	(8.18)	

B. Subsequent 5-yr Real Returns as a Function of Earnings Yield (EY)

Country	Constant		Adjusted R^2
US	0.06	0.31 EY	0.81%
	(1.52)	(0.79)	
UK	-0.02	1.13 EY	19.41%
	(-0.64)	(3.32)	
France	0.02	1.05 EY	8.08%
	(0.39)	(2.00)	
Germany	-0.02	1.42 EY	5.43%
	(-0.32)	(1.77)	
Netherlands	0.08	0.37 EY	2.09%
	(2.11)	(1.16)	
Switzerland	0.14	-0.58 EY	2.21%
	(2.77)	(-1.09)	
Japan	-0.08	3.89 EY	26.97%
	(-6.08)	(10.73)	
Italy	0.03	0.44 EY	-0.36%
	(0.63)	(0.67)	
Spain	-0.11	2.51 EY	20.58%
	(-1.85)	(3.56)	
Greece	-0.13	3.30 EY	23.20%
	(-2.57)	(5.67)	
Portugal	0.10	-0.01 EY	-0.96%
	(3.81)	(-0.14)	

C. Subsequent 3-yr Real Returns as a Function of Earnings Yield (EY)

US	0.03	0.58 EY	2.10%
	(0.68)	(1.3)	
UK	-0.04	1.38 EY	16.98%
	(-1.08)	(4.58)	
France	-0.02	1.37 EY	6.37%
	(-0.22)	(1.90)	
Germany	0.00	1.05 EY	1.43%
	(0.06)	(1.02)	
Netherlands	0.06	0.52 EY	2.64%
	(1.27)	(1.34)	
Switzerland	0.11	-0.34 EY	0.23%
	(2.05)	(-0.59)	
Japan	-0.06	3.15 EY	12.02%
	(-3.52)	(6.82)	
Italy	-0.10	2.46 EY	4.63%
	(-2.11)	(3.10)	
Spain	-0.13	2.72 EY	14.20%
	(-2.07)	(3.34)	
Greece	-0.18	3.95 EY	15.57%
	(-2.91)	(4.94)	
Portugal	0.07	0.03 EY	-0.74%
	(1.92)	(0.54)	

D. Subsequent 1-yr Real Returns as a Function of Earnings Yield (EY)

US	0.01	1.00 EY	2.69%
	(0.11)	(1.51)	
UK	-0.09	2.19 EY	13.36%
	(-1.57)	(3.60)	
France	-0.05	1.77 EY	3.04%
	(-0.39)	(1.33)	
Germany	-0.06	2.01 EY	1.78%
	(-0.52)	(1.27)	
Netherlands	0.06	0.45 EY	0.49%
	(0.74)	(0.64)	
Switzerland	0.06	0.28 EY	-0.17%
	(0.62)	(0.29)	
Japan	0.00	1.21 EY	0.37%
	(0.09)	(1.52)	
Italy	-0.19	4.12 EY	3.93%
	(-2.42)	(3.04)	
Spain	-0.11	2.63 EY	5.01%
	(-1.03)	(1.85)	
Greece	0.08	0.31 EY	-0.63%
	(0.75)	(0.23)	
Portugal	0.06	-0.12 EY	-0.37%
	(1.1)	(-1.68)	

(t-statistics presented in parentheses)

Table 2-18. Subsequent Real Returns as a Function of Dividend Yield (DY) (Original Data Periods)

A. Subsequent 10-yr Real Returns as a Function of Dividend Yield (DY)				*B. Subsequent 5-yr Real Returns as a Function of Dividend Yield (DY)*			
Country	Constant		Adjusted R^2	Country	Constant		Adjusted R^2
US	0.00	2.19 DY	3.26%	US	0.03	1.44 DY	7.19%
	(-0.08)	(3.55)			(0.61)	(1.48)	
UK	-0.07	3.11 DY	25.33%	UK	-0.16	5.16 DY	33.11%
	(-2.05)	(4.36)			(-2.82)	(4.34)	
France	0.04	1.85 DY	31.00%	France	0.00	2.77 DY	16.25%
	(1.75)	(5.00)			(0.05)	(3.62)	
Germany	0.06	0.74 DY	3.16%	Germany	0.06	0.98 DY	0.67%
	(3.22)	(1.25)			(1.21)	(0.67)	
Netherlands	0.11	0.42 DY	1.14%	Netherlands	0.08	0.92 DY	1.39%
	(4.39)	(0.97)			(1.46)	(0.86)	
Switzerland	0.16	-2.50 DY	8.82%	Switzerland	0.13	-1.34 DY	0.78%
	(5.65)	(-2.65)			(2.57)	(-0.71)	
Japan	0.16	-2.50 DY	8.81%	Japan	-0.05	7.87 DY	20.82%
	(12.67)	(-5.02)			(-4.20)	(9.07)	
Italy	-0.13	6.68 DY	78.71%	Italy	0.07	-0.80 DY	-0.43%
	(-12.69)	(18.57)			(2.10)	(-0.59)	
Spain	0.08	0.67 DY	7.76%	Spain	-0.16	7.40 DY	38.05%
	(4.64)	(1.48)			(-3.75)	(5.51)	
Greece	0.11	-0.58 DY	1.23%	Greece	-0.22	11.91 DY	84.15%
	(8.91)	(-1.24)			(-12.97)	(23.41)	
Portugal	0.09	-0.32 DY	12.02%	Portugal	-0.05	4.91 DY	27.96%
	(11.43)	(-1.73)			(-0.56)	(1.51)	
C. Subsequent 3-yr Real Returns as a Function of Dividend Yield (DY)				*D. Subsequent 1-yr Real Returns as a Function of Dividend Yield (DY)*			
US	0.01	1.80 DY	3.81%	US	-0.02	2.75 DY	3.89%
	(0.13)	(1.49)			(-0.27)	(1.63)	
UK	-0.21	6.45 DY	34.38%	UK	-0.34	9.75 DY	25.87%
	(-4.02)	(6.30)			(-4.47)	(6.05)	
France	-0.03	3.35 DY	10.52%	France	-0.03	3.40 DY	3.02%
	(-0.55)	(3.10)			(-0.26)	(1.45)	
Germany	0.05	1.16 DY	0.44%	Germany	0.04	1.37 DY	0.04%
	(0.78)	(0.65)			(0.46)	(0.50)	
Netherlands	0.06	1.07 DY	1.27%	Netherlands	0.04	1.29 DY	0.56%
	(0.98)	(0.84)			(0.47)	(0.70)	
Switzerland	0.10	-0.61 DY	-0.16%	Switzerland	0.07	0.53 DY	-0.25%
	(1.94)	(-0.32)			(0.79)	(0.16)	
Japan	-0.04	6.34 DY	8.80%	Japan	0.00	3.02 DY	0.46%
	(-2.33)	(5.75)			(0.13)	(1.62)	
Italy	0.12	-3.43 DY	1.42%	Italy	0.07	-1.28 DY	-0.40%
	(2.76)	(-1.89)			(1.02)	(-0.45)	
Spain	-0.14	6.53 DY	17.82%	Spain	-0.11	6.12 DY	6.41%
	(-2.35)	(3.80)			(-1.13)	(2.08)	
Greece	-0.29	14.61 DY	47.34%	Greece	-0.09	6.94 DY	3.27%
	(-7.05)	(10.73)			(-1.02)	(2.47)	
Portugal	-0.05	4.09 DY	7.56%	Portugal	-0.03	2.76 DY	0.49%
	(-0.49)	(1.26)			(-0.20)	(0.67)	

(t-statistics presented in parentheses)

Table 2-19. Average Real Returns Ranked by Concurrent Real Earnings Growth and Real Dividend Growth

A. Average 5-year real returns of quartiles ranked by concurrent 5-year real earnings growth (REG) 1973-2004.

	1 (Low REG)	2	3	4 (High REG)
US	7.66%	6.11%	3.30%	16.80%
UK	5.76%	11.38%	8.64%	12.97%
France	6.17%	8.70%	9.66%	20.11%
Germany	3.45%	-0.60%	9.34%	17.07%
Netherlands	3.76%	9.03%	15.25%	21.31%
Switzerland	0.66%	2.17%	14.47%	17.01%
Japan	-6.48%	3.14%	7.43%	12.27%
EW7	5.21%	4.46%	13.87%	15.96%
VW7	6.57%	6.15%	10.04%	13.06%

B. Average 5-year real returns of quartiles ranked by concurrent 5-year real dividend growth (RDG) 1973-2004.

	1 (Low RDG)	2	3	4 (High RDG)
US	6.63%	4.97%	10.87%	11.40%
UK	-1.36%	13.63%	11.90%	14.57%
France	2.88%	18.12%	8.86%	14.79%
Germany	-0.83%	6.67%	6.09%	18.19%
Netherlands	2.53%	19.23%	14.44%	8.90%
Switzerland	-0.67%	8.24%	7.39%	19.35%
Japan	-2.33%	-2.61%	9.21%	12.09%
EW7	5.36%	9.37%	6.75%	18.03%
VW7	6.87%	2.23%	9.46%	17.27%

Table 2-20. Subsequent Real Returns as a Function of Payout Ratio

Country	Constant		Adjusted R^2
A1. 10-year subsequent real returns as a function of payout ratio (PR) 1965-2004.			
US	0.14	-0.14 PR	2.5%
	(3.37)	(-1.67)	
UK	0.30	-0.39 PR	51.5%
	(10.79)	(-7.28)	
A2. 5-year subsequent real returns as a function of payout ratio (PR) 1965-2004.			
US	-0.03	0.19 PR	2.9%
	(-0.54)	(1.63)	
UK	0.19	-0.21 PR	5.3%
	(3.70)	(-2.09)	
B. 5-year subsequent real returns as a function of payout ratio (PR) 1973-2004.			
US	-0.11	0.40 PR	18.1%
	(-2.48)	(4.93)	
UK	0.14	-0.08 PR	0.7%
	(3.21)	(-0.92)	
France	0.07	0.09 PR	0.3%
	(0.82)	(0.45)	
Germany	0.07	0.02 PR	-0.0%
	(1.25)	(0.18)	
Netherlands	0.22	-0.22 PR	1.8%
	(2.83)	(-1.26)	
Switzerland	0.05	0.14 PR	-0.0%
	(0.72)	(0.56)	
Japan	0.00	0.11 PR	0.1%
	(0.05)	(0.63)	
EW7	0.20	-0.24 PR	8.5%
	(5.13)	(-2.69)	
VW7	0.24	-0.50 PR	25.2%
	(6.81)	(-4.05)	
C. 1-year subsequent real returns as a function of payout ratio (PR) 1990-2004.			
US	0.04	0.13 PR	0.3%
	(0.33)	(0.60)	
UK	-0.38	0.75 PR	10.7%
	(-2.41)	(3.14)	
France	-0.77	1.81 PR	11.5%
	(-3.11)	(3.51)	
Germany	0.37	-0.88PR	3.2%
	(1.58)	(-1.24)	
Netherlands	-0.31	0.84 PR	2.6%
	(-1.02)	(1.46)	
Switzerland	0.08	0.15 PR	-0.5%
	(0.26)	(0.14)	
Japan	-0.43	1.06PR	9.5%
	(-2.44)	(2.34)	
Italy	0.43	-0.77 PR	6.6%
	(1.86)	(-1.59)	
Spain	-0.01	0.29 PR	-0.2%
	(-0.01)	(0.41)	
Greece	-0.26	1.01 PR	7.7%
	(-1.61)	(2.61)	
Portugal	-0.09	0.38 PR	0.9%
	(-0.57)	(1.08)	
EW11	-0.25	0.69 PR	13.3%
	(-1.91)	(2.73)	
VW11	-0.11	7.65 PR	1.5%
	(-0.64)	(0.88)	

(t-statistics presented in parentheses)

Table 2-21. Subsequent Real Returns as a Function of Payout Ratio and Earnings Yield

A1. 10-year subsequent real returns as a function of payout ratio (PR) and earnings yield (EY) 1965-2004.

Country	Constant			Adjusted R^2
US	-0.28	0.39 PR	1.83 EY	25.4%
	(-2.83)	(2.98)	(5.09)	
UK	0.20	-0.28 PR	0.42 EY	54.0%
	(3.03)	(-3.43)	(1.67)	

A2. 5-year subsequent real returns as a function of payout ratio (PR) and earnings yield (EY) 1965-2004.

US	-0.19	0.36 PR	1.10 EY	13.2%
	(-2.47)	(2.79)	(3.42)	
UK	-0.22	0.25 PR	1.74 EY	25.0%
	(-1.79)	(1.82)	(2.88)	

B. 5-year subsequent real returns as a function of payout ratio (PR) and earnings yield (EY) 1973-2004.

US	-0.22	0.51 PR	0.78 EY	25.5%
	(-3.38)	(5.41)	(2.62)	
UK	-0.27	0.41 PR	1.58 EY	28.5%
	(-2.31)	(3.22)	(2.93)	
France	-0.07	0.14 PR	1.27 EY	12.6%
	(-0.94)	(0.92)	(2.72)	
Germany	-0.04	-0.05 PR	1.91 EY	9.5%
	(-0.57)	(-0.41)	(2.59)	
Netherlands	0.02	0.06 PR	0.66 EY	5.7%
	(0.14)	(0.23)	(1.53)	
Switzerland	0.07	0.13 PR	-0.21 EY	0.0%
	(0.78)	(0.48)	(-0.41)	
Japan	-0.10	0.04 PR	3.88 EY	28.0%
	(-1.73)	(0.34)	(4.62)	
EW7	0.02	-0.06 PR	1.08 EY	22.5%
	(0.32)	(-0.51)	(3.08)	
VW7	0.25	-0.51 PR	-0.05 EY	25.0%
	(4.18)	(-3.97)	(-0.16)	

C. 1-year subsequent real returns as a function of payout ratio (PR) and earnings yield (EY) 1990-2004.

US	-0.19	0.12 PR	5.46 EY	13.4%
	(-1.26)	(0.60)	(2.65)	
UK	-0.67	0.67 PR	5.63 EY	28.7%
	(-4.09)	(3.02)	(3.93)	
France	-1.48	2.86 PR	5.08 EY	20.8%
	(-4.71)	(5.63)	(2.73)	
Germany	0.02	-0.67 PR	4.42 EY	8.5%
	(0.07)	(-0.87)	(1.84)	
Netherlands	-0.47	0.85 PR	2.47 EY	5.6%
	(-1.49)	(1.57)	(1.81)	
Switzerland	-0.02	0.31 PR	0.86 EY	-0.9%
	(-0.04)	(0.25)	(0.39)	
Japan	-2.17	3.10 PR	44.91 EY	60.0%
	(-6.61)	(5.46)	(7.68)	
Italy	0.07	-0.75 PR	6.37 EY	13.0%
	(0.31)	(-1.65)	(2.22)	
Spain	-0.12	0.13 PR	2.49 EY	4.0%
	(-0.41)	(0.21)	(1.72)	
Greece	-0.35	1.03 PR	1.14 EY	7.6%
	(-1.30)	(2.61)	(0.54)	
Portugal	-0.12	0.42 PR	0.06 EY	0.3%
	(-0.53)	(0.93)	(0.38)	
EW11	-0.27	0.67 PR	0.53 EY	12.8%
	(-1.52)	(2.53)	(0.18)	
VW11	-0.13	7.75 PR	0.24 EY	5.4%
	(-0.76)	(0.92)	(1.34)	

(t-statistics presented in parentheses)

3. Investigating Duration Dependence in Bull and Bear Markets

This empirical study proposes a new approach to studying time series dependence in stock prices by modelling the probability that a bull or bear market terminates as a function of its age. One distinctive aspect of this paper is using survival analysis as the methodological technique on the identical eleven international markets used in the first paper. Survival analysis has not been used extensively in financial economics. The main aim of this paper is therefore to study a technique not used heretofore in this area of empirical finance and understand how well survival analysis would work as a modelling tool and whether there are advantages to its use here. Bull and bear markets are a common way of describing cycles in equity prices and in this paper, we provide an initial foray into the application of survival analysis to studying duration dependence in bull and bear markets of those eleven countries. Several parametric models, namely, Lognormal, Loglogistic, Weibull and Exponential models are used to study duration dependence in daily stock prices. If a hazard function is increasing then the cycle phase duration is said to exhibit positive duration dependence or non-persistence in the cycle with the increasing probability of a turning point as duration increases. Conversely, a decreasing hazard function is an indication of negative duration dependence, that is, momentum or persistence in the state as the probability of a turning point decreases. The findings demonstrate that our models depict predominantly negative duration dependence for both bull and bear markets of the eleven countries. Negative duration dependence implies that more mature bull and bear markets are more robust to failure than younger bear and bull markets.

3.1 Introduction

Research, in the past decades, has focused a great deal on characterizing the dynamics of returns in equity markets. In fact one aspect of the previous chapter has been devoted to studying whether the payout ratio can predict returns. However, less attention has been attributed to one feature of equity returns over the years and it is one of considerable importance. Over the past century, aggregate stock prices have gone through extensive periods of rise and fall. Those periods, more commonly known as bull and bear markets respectively, have been the subject of much speculation amongst practitioners where the most important concern has been to figure out when the current bull or bear market would end. Commentators in the popular press have fuelled the debate by conjecturing that a current bull market is more likely to end as it has been ongoing for a long period of time. For instance, during the long bull market of the nineties, the concern was often expressed that this bull market was at greater risk of coming to an end because it had lasted too long by historical standards. This question of whether the probability of leaving the state of interest depends upon how long one has spent in it is known as duration dependence.

The aim of this study is to provide a framework for analysing duration dependence in bull and bear markets. We introduce, in this chapter, survival analysis which is a statistical technique not used extensively in financial economics. The issue to be explored is whether the probability that a cycle will end increases as the phase lengthens. This type of modelling has been considerably less studied in the past and this study seeks to address this lack in the research. The existence of duration dependence has an important significance in stock price behaviour. If stock prices constitute a random walk, long-run cycles of bull and bear markets are similar to the outcome of consecutive tosses of a fair coin, market phases do not tend to a fixed length and duration dependence does not exist. On the other hand, if stock prices have a cyclical component and positive duration exists, the probability of a market phase ending increases with its length. If this is the case, it is evident that actual prices are moving toward their permanent or trend level in a non-random manner as the cyclical component dissipates over time.

The movement from a bull market to a bear market phase involves a turning point and the idea behind this study is motivated by similar research that has been carried out by Lunde and Timmermann (2004) on US equity prices. We use the authors' approach to developing an algorithm that seems to be quite successful in locating periods in time that have been thought of as bull and bear markets. We then apply this algorithm to equity prices in eleven international markets. Once the turning points are established, characteristics of the bull and bear phases can be identified and duration dependence is examined with parametric hazard models, namely the exponential model, the Weibull model, the lognormal and loglogistic models. The duration data needs to be characterised in terms of the conditional probability that the bull or bear state ends in a short time interval following some period t, given that the state lasted up to t, which in other words is the definition of the hazard function. Hypotheses on the probability that a bull or bear market is terminated as a function of its age are naturally expressed in terms of the shape of this hazard function.

The findings demonstrate that our models depict predominantly negative duration dependence for both bull and bear markets. Negative duration dependence implies that older bull and bear phases are more robust to failure than younger bull markets. Presence of duration dependence appears to provide evidence against Fisher's hypothesis of a "Monte Carlo" business cycle. The finding of duration dependence in bull and bear markets implies that stock market prices do not follow a random walk during these phases but rather possess a predictable component. Two explanations for predictable price behaviour have been offered in the literature, namely temporary 'fads', (Poterba and Summers, 1988; Shiller, 1989; and Delong *et al.*, 1990) and time-varying required returns (Fama and French, 1988a, 1988b). In general, the existence of 'fads' implies some degree of market inefficiency and, thus the possibility of earning excess profits, while the presence of time-varying required returns is consistent with rational pricing in an efficient market.

3.2 Literature Review

3.2.1 Brief Introduction on Survival Analysis

In this chapter, we introduce survival analysis which is a statistical technique that is just now emerging in the financial economics field and that we use to model duration dependence. Survival analysis is just another name for time to event analysis. The term survival analysis is used predominantly in biomedical sciences where the interest is observing time to death either of patients or of laboratory animals. Time to event analysis has also been used widely in the social sciences where interest is on analysing time to events such as job changes, marriage, birth of children, and so forth. The engineering sciences have also contributed to the development of survival analysis which is here called "failure time analysis" since the main focus is in modelling the time it takes for machines or electronic components to break down. The developments from these diverse fields have for the most part been consolidated into the field of "survival analysis".

There are certain aspects of survival analysis data such as censoring and non-normality that generate great difficulty when trying to analyse the data using traditional statistical models such as multiple linear regression. The non-normality aspect of the data violates the normality assumption of most commonly used statistical models such as regression or ANOVA, etc. First of all, survival data are typically not symmetric. A histogram of survival times will indicate that they tend to be positively skewed. As a result it is not reasonable to assume data of this type to be normally distributed. A censored observation is defined as an observation with incomplete information. There are four different types of censoring possibilities: right truncation, left truncation, right censoring and left censoring. We will focus exclusively on right censoring for a number of reasons. Most data used in analyses have only right censoring. Furthermore, right censoring is the most easily understood of all the four types of censoring and if a researcher can understand the concept of right censoring thoroughly it becomes much easier to understand the other three types. When an observation is right censored, it means that the information is incomplete because the subject did not have an event during the time that the subject was part of the study. The point of survival analysis is to follow subjects over time and observe at which point in time they experience the event of interest. It often happens that the study does not span enough time in order to observe the event for all subjects in the study. This could be due to a number of reasons. Perhaps, the subject drops out of the study for reasons unrelated to the study (i.e. patients moving to another area and leaving no forwarding address). The main feature in this example is that if the subject had been unable to stay in the study then it would have been possible to observe the time of the event eventually.

There are both parametric and nonparametric techniques available to model survival data. The parametric methods of estimation assume that the probability density of the time to a particular event follows a specific distribution, such as the exponential distribution, while the nonparametric methods do not.

One important concept in survival analysis is the hazard rate. From looking at data with discrete time (time measured in large intervals such as months, years, or even decades) we can get an intuitive idea of the hazard rate. For discrete time the hazard rate is the probability that an individual will experience an event at time t while that individual is at risk of having an event. Thus the hazard rate is really just the observed rate at which events occur. If the hazard rate is constant over time and it is equal to 1.8, for example, this would mean that one would expect 1.8 events to occur in a time interval that is one unit long. Furthermore, if a person has a hazard rate of 1.5 at time t and a second person has a hazard rate of 3.0 at time t then it would mean that the second person's risk of an event would be two times greater at time t. It is important to realise that the hazard rate is an unobserved variable and it controls both the occurrence and the timing of the events. It is the fundamental dependent variable in survival analysis. Another important aspect of the hazard function is to understand how the shape of the hazard function will influence the other variables of interest such as the survival function.

3.2.2 Literature Review on Duration Dependence

Several studies have examined the cycles of expansion and contraction that aggregate stock prices go through. The important issue is whether stock prices have maintained fixed cycle lengths which would be an indicator of stock price behaviour. As a cycle length increases, the probability that it will end should logically increase. Thus the existence of fixed cycle lengths indicates that the length of a cycle may be useful in forecasting future turning points in the stock market. The notion of fixed cycle lengths, however, contradicts the description of stock prices as random walks. Statistically, the question of whether prices follow fixed cycle lengths can be structured as one of duration dependence. The primary issue to be investigated is whether the probability that a cycle phase will end increases as the phase lengthens. If this is the case, there is an implication of predictability in stock prices.

Cochran and Defina (1995) study duration dependence in US stock market cycles over the period 1885 to 1992 using parametric hazard functions. Analyses are performed on stock market expansion and contraction cycles for the complete sample and on pre-World War II and post-World War II sub-samples. The hazard function is considered to be perfectly appropriate in examining duration dependence as it specifies the probability that a particular phase will end conditional on the time which has been spent in the phase. If a hazard function is increasing (decreasing) then the cycle phase durations are said to exhibit positive (negative) duration dependence. Estimates of the hazard function are used to test the null hypothesis of no duration dependence. The authors find that duration dependence exists in pre-World War II expansions and in post-World War II contractions. Pre-war contractions and post-war expansions, however, do not show any evidence of duration dependence. The results also suggest that duration dependence in market expansions has diminished over time while duration dependence in contractions has increased. Cochran and Defina present some additional tests excluding observations and dividing the data sets at different event times such as the creation of the Federal Reserve in 1914 (testing pre-1914 and post-1914 samples) and the Great Depression (testing pre-crash and post-crash samples). One case excludes both the Great Depression and wartime observations. Although differing in magnitude and size, similar results are produced from these samples.

Sichel (1991) investigates duration dependence in US business cycles using parametric hazard models. According to Sichel, parametric models provide a natural framework since the statistical object of interest is the probability of exiting from a state conditional on the length of time in that state. The author brings forth several advantages that parametric methods have over nonparametric methods. First, parametric methods provide estimates of the magnitude of duration dependence present, rather than just evidence of the existence or non-existence of duration dependence. Second, it is much easier to control correctly for truncation and censoring and to test additional hypotheses by extending the basic model. Lastly, parametric techniques may have higher power for detecting duration dependence than nonparametric approaches. Sichel (1991) uses the NBER monthly reference of business cycle chronology from 1854 to 1990. In addition to the full sample, pre- and post-WW II sub-samples are also investigated. The study provides statistically significant evidence of positive duration dependence for expansions before World War II and contractions after World War II. Positive duration dependence would indicate that expansions or contractions are more likely to end as they become "older". While extending the basic model, Sichel finds that the mean duration of expansions is significantly longer after World War II and the contractions are shorter. One suggestion proposed by the author for that observation is that some cyclical characteristics of the economy changed after the war. Much of the current debate about shifts in cyclical characteristics has focused on whether volatility around trend decreased after World War II (Romer, 1989; and Blake and Gordon, 1989).

Several authors have used nonparametric methods to investigate duration dependence in the American business cycle. The business cycle is modelled as the outcome of a Markov process that switches between two discrete states, with one of the states representing expansions and the other contractions. There have been different ways of specifying the transition probability matrix governing the movement of the economy between these two states. Nefti (1982) assumed that the transition probabilities were duration dependent, that is, the longer the economy stayed in one state, the more likely it was to change to the other. Hamilton (1989) on the other hand assumed that the state transition probabilities were duration independent meaning that after a long time spent in the expansion state, the economy was no more likely to switch to the recession state than after a short expansion. Diebold and Rudebusch (1990) use nonparametric methods to investigate duration dependence. The authors' main reason for not testing a particular hazard function is that the drawback of incorrect parametric forms can distort the available departures from the null hypothesis. As Heckman and Singer (1984) have shown, incorrect parameterizations of the hazard function can lead to severely misleading inferences. Diebold and Rudebusch (1990) obtain the lengths of expansions, contractions, and whole cycles used in the study from business cycle turning dates since 1854, as designed by the National Bureau of Economic Research (NBER). The authors test observed durations for conformity to the exponential distribution. The reason behind this is that a constant hazard implies an exponential distribution of durations. An exponential distribution of historical lengths of expansions and contractions is precisely the null hypothesis tested by Fischer (1925) and Hamilton (1989). The results show some evidence of duration dependence in whole cycles and in pre-war expansions but little evidence elsewhere.

Empirical work on duration dependence in the business cycle has been researched to some extent, largely motivated by the question of whether it is possible to predict the termination of an expansion or a contraction. Fisher (1925) was one of the first researchers to consider this question, raising the issue of whether the probability of exiting any phase of the cycle was just a constant, as might be expected to happen when the series underlying the business cycle was not serially correlated. Fisher argued that business cycles instead of maintaining a fixed cyclical length actually represented Monte Carlo cycles. Monte Carlo cycles may be represented to a casual observer by a repeated coin toss where runs of consecutive heads or tails may appear more likely to end as they grow longer, but the termination probability of a run actually remains constant.

Economic cycles are usually described by binary ransom variables taking the values of unity and zero, with unity indicating a state of expansion and zero a state of contraction. Ohn, Taylor and Pagan (2004) discuss tests for duration dependence that might be applied to the analysis of such binary data. The authors refer to the states distinguished by the binary outcomes for St as phases and the sample of data available might be S_t, where $t = 1,\ldots, T$. The T observations are divided into n phases and the duration of time spent in the i^{th} phase will be designated as X_i. Duration dependence can then be defined in one of two ways. In the first instance, duration dependence within a given phase can then be defined as the continuation probability $\Pr (S_t = j \mid S_{t-1} = j)$. If this probability provides a complete description of the process within the phase, the process will be a first-order Markov where duration independence is present. When data are discrete, the time spent in the j^{th} phase up to t-1 is just the sum of past St, so that it is clear that duration dependence is a statement that $\Pr(S_t = j \mid S_{t-1} = j) \neq \Pr(S_t = j \mid S_{t-1} = j, S_{t-2} = j, .., S_0 = j)$. In the second instance the implications of duration dependence for the density of the X_i are derived. A comparison is then made of the density of the data on X_i with that expected under duration dependence. In addition, the paper provides an important distinction between discrete and continuous time frameworks. The authors present a wide variety of tests as strong or weak form depending upon the focus of the tests. Weak form tests are based on some characteristic of the underlying constant hazard density (geometric in discrete time and exponential in continuous time). A weak form test might involve checking if the relationship between selected moments of the random variable X implied by a geometric density are satisfied. Strong form tests would compare some nonparametric estimate of a density from the data with the hypothesized parametric form, e.g., the geometric. In the study the chi-square goodness-of-fit test stands as the strong form moment based test in discrete time while the regression-based test is used as a weak form test assuming durations are Markov processes. Empirical applications to stock market cycles of strong and weak tests find strong evidence of positive duration dependence for both bull and bear durations.

Ohn *et al.*, (2004) revisited the work of Diebold and Rudebusch (1990) on business cycles. In addition to finding evidence of an increasing hazard in post-war contractions as did Diebold and Rudebusch, the authors also found some evidence of positive duration dependence in pre-war contractions. Moreover, Ohn et *al.,* revealed strong evidence of positive duration dependence for pre-war expansions but very little in the post-war years. The study, examining duration dependence of US bull and bear markets, established that both bull and bear phases displayed duration dependence.

Bull and bear markets are a common way of describing cycles in equity prices. Pagan and Sossounov (2003) develop an algorithm that seems to be quite good in locating periods in time that have been thought of as bull and bear markets in US equity prices. Once the turning points are established, characteristics of the phases can be identified. The authors show that the nature of bull and bear markets will depend upon the type of data generating process (DGP) for capital gains in the market such as random walks, GARCH models, and models with duration dependence. If equity prices follow a random walk, for example, all the characteristics of bull and bear markets will depend solely upon the mean and volatility of capital gains. The results show that a pure random walk provides as good an explanation of bull and bear markets as the more complex statistical models. The authors further go on to say that it is clear that the random walk with drift does quite well at replicating the bull and bear markets actually observed.

Maheu and McCurdy (2000) identify bull and bear markets in stock returns by using a Markov-switching model that incorporates duration dependence. Tests are performed on four specifications of duration-dependent Markov switching (DDMS) models where duration is allowed to affect the transition probabilities. Duration can be important in capturing volatility clustering but can also have explanatory power for the conditional return. Maheu and McCurdy study nonlinear duration dependence jointly in the conditional mean and conditional variance of stock market returns.
The model sorts returns into a high-return stable state and a low-return volatile state, respectively labelled bull and bear markets respectively. The primary objective of the study is to investigate duration dependence as a source of nonlinearity in stock market cycles. Asset-pricing theory suggests that dependence in expected returns from a time-varying risk premium, stochastic rational bubbles, fads, learning about regimes, and irrational behaviour by investors will show up in a nonlinear fashion. The empirical results find declining hazard functions, i.e., negative duration dependence in both the bull and bear market states using monthly data from 1834-1995. This means that the probability of leaving the state declines with duration in that state. For example, as the bull market persists, investors may become more optimistic about the future and hence wish to invest more in the stock market. The authors conclude that there exists evidence of nonlinear behaviour in monthly stock returns.

Duration dependence has also been related to the stochastic bubble explanation for nonlinear returns. McQueen and Thorley (1994) investigate duration dependence in stock market data by sorting the data into regimes taking into account censoring and estimating a parametric hazard function. The authors argue that for bubbles to exhibit the characteristics of a long-run up in price followed by a crash, the bubbles process must be skewed, with many small positive abnormal returns and relatively few large negative abnormal returns. For such bubbles to be rational, the bubble must be explosive and positive, i.e., the expected value of the bubble must be increasing over time to compensate the investor for the possibility of a crash. Therefore bubbles result in observed abnormal returns that exhibit duration dependence. The authors show that a testable implication of stochastic rational bubbles is that high returns will exhibit negative duration dependence, that is, the probability of observing the end of a run of high returns will decline with the length of a run. Rational speculative bubbles suggest nonlinear patterns in returns. The results show evidence of non-random behaviour in monthly real returns that is consistent with the presence of bubbles.

Another major contribution to characterising bull and bear markets and testing for duration dependence comes from Lunde and Timmermann (2004). Their algorithm to identify local peaks and troughs in stock prices draws from the definition of bull and bear markets provided by Sperandeo (1990). Given that the authors use daily stock prices data, the algorithm is designed to filter out the small unsystematic noises that are characteristics of such high frequency data. Both nominal and real stock prices are subject to analysis. The first set of tests in the paper compare distributional properties of the actual duration data with simulated data generated from benchmark models, for example, random walk and GARCH models. The former model is rejected for both bull and bear regimes whereas the latter model, even if it fits better the observed duration data, is inconsistent with the observation of long bull markets observed. The findings are supported by non-parametric tests such as the Wilcoxon, Mann and Whitney that test for the equality of mean duration and the Kolmogorov-Smirnov test that analyse the general differences in the two populations. Turning to the duration dependence tests, the authors derive log-likelihood functions for discreetly measured data by adopting a strategy suggested by Fahrmeir (1992). A logit link or logistic form of the transition probability is specified and two separate models of hazard rates are considered: a static model without covariates and a model that incorporates time-varying covariates. The time-varying covariate included in the study is interest rates, which are argued to be linked to the underlying state of the economy and business cycles, and to be a key determinant of stock returns in the literature. Generally, the authors find evidence of duration dependence that contradict the benchmark models of stock prices even after allowing for volatility clustering and a state variable in terms of interest rates. Bull markets show evidence of negative duration dependence while bear markets exhibit duration dependence that is non-monotone in duration, that is, the hazard function is U-shaped.

3.2.3 Bull and Bear markets

The general consensus in the industry is that bull markets are movements in the stock market in which prices are rising and the understanding is that prices will continue moving upward. During this time, economic production is high, jobs are plentiful and inflation is low. Bear markets are the opposite – stock prices are falling and the view is that they will continue falling. The economy will slow down, coupled with a rise in unemployment and inflation. Bull and bear markets are partly a result of the supply and demand for securities. Investor psychology, government involvement in the economy and changes in economic activity also drive the market up or down. These forces combine to make investors bid higher or lower prices for stocks. One popular view found in the various online financial dictionaries is that to qualify as a bull or bear market, a market must have been moving in its current direction by about 20% of its value for a sustained period. Small, short-term movements lasting days do not qualify; they may only indicate corrections or short-lived movements.

The terms 'bear' and 'bull; are said to have been used in the securities world since the early 18th century when stock exchange trading became popular in London. In reality, experts have many differing views on what constitutes a bull or bear market. One definition of bull and bear markets is from Sperandeo (1990) who defines bull and bear markets as follows:
"Bull market: A long-term … upward price movement characterised by a series of higher intermediate … highs interrupted by a series of higher intermediate lows.
Bear market: A long-term downtrend characterised by lower intermediate lows interrupted by lower intermediate highs."

Another definition used by the Global Financial Data is that during a bull market, the market must rise by at least 40%, preferably to a new high in the market, and that during a bear market, the market must decline by at least 15%. One broad definition of a bull market was brought forward by Charles Dow of 'Dow-Jones' who defined it a "broad upward movement". Some of the most infamous bear markets are generally agreed to be the Wall Street crash in October 1929 followed by the Great Depression. It was reported that, at its worst level, the Dow dropped 89% from its high of 306 in September 1929 to 41.22 points in July 1932. It took the index more than two decades to fully recover. Going forward several decades, the bear market of 1973-74 hit both the UK and the US hard, although it was worse in the UK than anywhere else. The world economy was in chaos. There was stagflation – high inflation, with fears that it would spiral out of control, linked with recession. A currency crisis emerged as countries abandoned fixed exchange rates. The price of oil had also risen sharply because of the Arab oil embargo. In the UK, fears of further industrial unrest under the new labour government compounded the situation. Another infamous bear market in the US was the one that occurred in 1987, when the stock market crashed amid soaring interest rates and rising inflation. The Wall Street Journal reported that the Dow had fallen 36% from a peak of 2722 points in late August to a low of 1738 in mid-October. However, this time it took the Dow less than two years to recover. There are several well-known bulls in American history. The longest-lived bull market in the US history is the one that began in 1991 and ended in 2000. Other major bulls occurred in the 1920s, the late 1960s and the mid-1980s. However, they all ended in recessions or market crashes.

One important question for practitioners is whether it is possible to predict bull and bear markets? Investors turn to theories and complex calculations to try to figure out in advance when the market will rise or fall. In reality, however, no perfect indicator has been found. In their attempts to predict the market, economists use technical analysis. Technical analysis is based on an examination of the price and volume movements of individual stocks, sectors, or the market as a whole. By charting historic information the technical analyst is searching for clues as to the future direction of the market, sector or stock. Distinctive patterns emerge in charting which are used to make market direction or momentum decisions. Technical analysis is based on two fundamental assumptions. First, all historic price and volume patterns exhibited by a stock represent the total market perception of what is known or knowable about the individual stock. Thus, past price and volume behaviour is indicative of future movements. Second, the market does not move in a random manner. Long-term patterns develop in the market which have sub-trends within them. An adept technical analyst is able to identify and exploit trend defining patterns. Market technicians depend on more than just price and volume data for identifying turning points in the market. Dow Theory, Elliot Wave Theory, pattern identification, moving averages, advance/decline, charting styles, odd lots, short selling, put/call ratio, relative strength indicators, Fibonacci levels are all tools of the technical analyst.

3.2.4 Applications of Technical Analysis in bull and bear markets

Dow Theory

The original form of technical analysis is referred to as Dow Theory and was developed by Charles Dow, founder of the Dow Jones financial news service and first editor of the Wall Street Journal. Dow Theory is predicated on the idea that a market has discernible cycles. The cycles average four years but may vary in length (2-10 years). Each cycle is divided into primary, secondary and minor trends. The primary trend in Dow theory refers to the long-term directional movement of the market. Established up trends in the markets are referred to as bull markets, and average two and a half years. Downtrends in the market having an average duration of a year and a half are referred to as bear markets. While the duration of either the primary trends may vary, identifying the long-term market trend is the essential task of Dow Theorists. Secondary patterns emerge in Dow Theory which are counter to the established primary trend. In a bull market, a secondary trend may be identified as a retracement of between 10% and 66% of the previous price move up. A secondary trend is not as long lived and may last from several weeks to several months. The minor trends in Dow Theory are inter-day or inter-week movements in price activity which are inconsequential to either the secondary or primary trends. The minor trends are of interest to contrarians and professional traders who have the experience and ability to enter into a significant number of day trades.

Elliot Wave Theory

Elliot Wave Theory is an outgrowth of the original technical market analysis of Dow Theory. Elliot Wave Theory postulates that the market movements of each cycle are defined and predictable. A bull market is defined by a five wave movement. Bull markets are characterised by three major moves with the trend interrupted by two secondary moves against the trend. Bear markets are characterised by a three wave structure, two major moves with the trend and a single move against the trend. Elliot Wave Theory is a highly subjective form of technical analysis. Each practitioner may use a different strategy point for the wave count they use.

The Dow Theory is meant to offer insights and guidelines from which to begin careful study of the market movements and price action. The Dow Theory, although written by Charles Dow, was refined by William Hamilton who identified three steps to both primary bull markets and primary bear markets. Hamilton noted that the first stage of a bull market was largely indistinguishable from the last reaction rally of a bear market. Pessimism, which was excessive at the end of the bear market still reigns at the beginning of a bull market. It is a period when the public is out of stocks, the news from Corporate America is bad and valuations are usually at historical lows. However, it is at this stage that the so-called "smart money" begin to accumulate stocks. In the first stage of a bull market stocks begin to find a bottom and quietly firm up. When the market starts to rise, there is widespread disbelief that a bull market has begun. After the first leg peaks and starts to head back down, the bears come out proclaiming that the bear market is not over. It is at this careful stage that careful analysis is warranted to determine if the decline is a secondary movement. If it is a secondary move, then the low forms above a previous low, followed by a quiet period as the market firms and finally an advance will begin. When the previous peak is surpassed, the beginning of the second leg and a primary bull will be confirmed.

The second stage of a primary bull market is usually the longest and sees the largest advance in prices. It is a period marked by improving business conditions and increased valuations in stocks. Earnings begin to rise again and confidence starts to mend. The third stage of a primary bull market is marked by excessive speculation and the appearance of inflationary pressures.

Just as accumulation is the hallmark of the first stage of a primary bull market, distribution marks the beginning of a bear market. As the "smart money" begin to realise that business conditions are not quite as good as once thought, they start to sell stocks. The public is still involved in the market at this stage and becomes willing buyers. There is little in the headlines to indicate a bear market is at hand and general business conditions remain good. While the market declines, there is little belief that a bear market has started and most forecasters remain bullish. After a moderate decline, there is a reaction rally that retraces a portion of the decline. Hamilton noted that reaction rallies were quite swift and sharp. As with his analysis of secondary moves in general, Hamilton noted that a large percentage of the losses would be recouped in a matter of days or perhaps weeks. This quick and sudden movement would invigorate the bulls to proclaim the bull market alive and well. However, the reaction high of the secondary move would be lower than the previous high. After making a lower high, a break below the previous low would confirm that this was indeed the second stage of a bear market.

As with the primary bull market, stage two of a primary bear market provides the largest move. This is when the trend has been identified as down and business conditions begin to deteriorate. Earnings estimates are reduced, shortfalls occur, profit margins shrink and revenues fall. As business conditions worsen, the sell-off continues. By the final stage of a bear market, all hope is lost and stocks are frowned upon. Valuations are low but the selling continues as participants seek to sell no matter what. The news from Corporate America is bad, the economic outlook bleak and not a buyer is to be found. The market will continue to decline until all the bad news is fully priced into stocks. Once stocks fully reflect the worst possible outcome, the cycle begins again.

One main criticism of the Dow Theory is that it is not really a theory. Neither Dow nor Hamilton wrote proper academic papers outlining the theory and testing the theorems. The ideas of Dow and Hamilton were put forth through their editorials in the Wall Street journal. The Dow Theory is also criticised for being too late in its prediction. The trend does not change from bearish to bullish until the previous reaction high has been surpassed. Many traders feel that this is simply too late and miss much of the move.

3.3 Data and Methodology

To investigate the properties of bull and bear markets, we obtain a data set of daily stock prices for eleven international markets, namely the United States (US), the United Kingdom (UK), France (FR), Germany (GY), Switzerland (SW), Netherlands (NL), Japan (JP), Italy (IT), Greece (GR), Portugal (PT) and Spain (SP). These countries were chosen out of the 30 Organisation for Economic Cooperation and Development (OECD) nations to represent the industrialised world, the selection being made on the basis of availability of data. The source is DataStream, an online database covering all listed companies on major exchanges of the world. For each country an index is chosen to represent the country's aggregate market index. The S&P 500 is used as an index for the US and for all other countries, except for Germany and Spain, where a total market index is used. Due to partial unavailability of data in the total market index for Germany, the DAX 30 index is used instead. The same problem is encountered for Spain and to correct this, the MADRIDZ index is used. The UK and US have observations starting on 1/1/1965. France, Germany, Italy, Switzerland, Netherlands and Japan start on 1/1/1973. Spain's price index starts on 2/3/1987 while Greece's starts on 1/1/1988 and Portugal's on 2/1/1990. All observations end on 1/2/2006.

We also obtain inflation data for those eleven markets from DataStream since adjusting for inflation is also important. Inflation has been higher since World War II and was especially strong in the 1940s and 1970s. Inflation reduces the size of bull markets and increases the size of bear markets. Inflation has varied considerably over the sample period and the drift in nominal prices does not have the same interpretation during low and high inflation periods. To deal with this issue, we follow the procedure set forth in Lunde and Timmermann (2004) to construct a daily inflation index. We use monthly data on the consumer price index or retail price index obtained from DataStream and convert it into daily inflation rates by solving for the daily inflation rate such that the daily price index grows smoothly and at the same rate between subsequent values of the monthly consumer price index. Finally, we divide the nominal stock price by the consumer price index to get a daily index for real stock prices.

Taxes are the one variable that we do not factor in. Taxes vary from one country to another, vary over time, vary between different income tax brackets, and differ for dividends and capital gains. Given all these complications, we have left taxes out of our calculations.

In order to formalise bull and bear states in terms of movements between local peaks and troughs, we follow the procedure described by Lunde and Timmermann (2004). An earlier study of Fabozzi and Francis (1977) consider a definition of bull markets based on substantial up and down movements. In their definition, a substantial move in stock prices occurs whenever the absolute value of stock returns in a given month exceeds half of one standard deviation of the return distribution. Such definitions do not reflect long-run dependencies in stock prices and ignore information about the trend in stock price levels. By Lunde and Timmermann's definition, the stock market switches from a bull to a bear state if stock prices have declined by a certain percentage since their previous local peak within that bull state. Likewise, the authors define a switch from a bear to a bull state if stock prices experience a similar percentage increase since their local minimum within that state. This definition, according to the authors, does not rule out sequences of negative (positive) price movements in stock prices during a bull (bear) market as long as their cumulated value does not exceed a certain threshold. By abstracting from the small unsystematic price movements that dominate time series as noisy as daily price changes this definition is better suited to capture long-run dependencies in the underlying drift in stock prices.

To characterise the idea of a series of increasing highs interrupted by a series of higher intermediate lows, we let I_t be a bull market indicator variable taking the value 1 if the stock market is in a bull state at time t, and zero otherwise. Time is measured on a discrete scale and we assume that the stock price at the end of period t is P_t. We suppose that at t_0 the stock market is at a local maximum and we define the stochastic process $P^{max}_{t0} = P_{t0}$, where P_{t0} is the stock price at time t_0. Let λ be a scalar defining the threshold of the movements in stock prices that trigger a switch between bull and bear markets. We assign s_{max} and s_{min} to be the upper and lower barriers, that is, those variables will record when a switch between bull and bear markets is triggered. The stopping time variables are defined by the following conditions in a bull market:

$$s_{max}\,(P^{max}_{t0}, t_0, \lambda) = \inf\{\, t_{0+s}: P_{t0+s} \geq P^{max}_{t0}\}$$
$$s_{min}\,(P^{max}_{t0}, t_0, \lambda) = \inf\{\, t_{0+s}: P_{t0+s} \geq (1-\lambda)\, P^{max}_{t0}\} \qquad (1)$$

where $s \geq 1$.

Essentially, what we are doing is looking at the next stock price at time t_{0+s} and determining whether it is equal or greater than the stock price at time t_0 or less than the stock price at t_0 by a percentage corresponding to λ. We look at each stock price until any one of these two conditions are satisfied. Then the $\min(s_{max}, s_{min})$ is the first time that the price process crosses one of the two barriers $\{\, P^{max}_{t0,}\ (1-\lambda)\ P^{max}_{t0}\}$. If $s_{max} < s_{min}$, we update the local maximum in the current bull market state:

$$P^{max}_{t0+\,s_{max}} = P_{t0+\,s_{max}} \qquad (2)$$

This means that the bull market continues between t_{0+1} and $t_{0+}\,s_{max}$, that is, $It_{0+1} = \ldots = I_{t0+}\,s_{max} = 1$.

If $s_{min} < s_{max}$ so that the stock price at $t_{0+}\,s_{min}$ has declined by a fraction of λ since its local peak,

$$P_{t0+}\,s_{min} < (1-\lambda)\ P^{max}_{t0} \qquad (3)$$

then the bull market has switched to a bear market which prevailed from t_{0+1} to $t_{0+}\,s_{min}$, that is, $I_{t0+1} = \ldots = I_{t0+}\,s_{min} = 0$. In the latter case, we set $P^{min}_{t0+}\,s_{min} = P_{t0+}\,s_{min}$.

If the starting point at t_0 is a bear market state, the upper and lower stopping times are defined as follows:

$$s_{min}\,(P^{min}_{t0}, t_0, \lambda) = \inf\{\, t_{0+s}: P_{t0+s} \leq P^{min}_{t0}\}$$
$$s_{max}\,(P^{min}_{t0}, t_0, \lambda) = \inf\{\, t_{0+s}: P_{t0+s} \geq (1+\lambda)\ P^{min}_{t0}\} \qquad (4)$$

This definition of bull and bear states divides the data on stock prices into mutually exclusive and exhaustive bull and bear subsets. The resulting indicator function, I_t, gives rise to a random variable, T, which measures the duration of bull or bear markets. This is simply given as the time between successive switches in I_t. Just as Lunde and Timmermann (2004) state, the focus on local peaks and troughs allows us to concentrate in the systematic up and down movements in stock prices and to filter out short-term noise. This is an important consideration for data as noisy as daily stock price changes. The last observation in the duration data is right censored since the end of the study is on 1/2/2006 and we do not know whether the markets continue in the same phase after 1/2/2006.

Duration dependence

A key feature of duration data is its duration dependence, if any. Duration dependence refers to how the hazard rate changes with time, that is it refers to $\frac{dh(t)}{dt}$.

If $\frac{dh(t)}{dt} = 0$, then there is no duration dependence, which is to say that the hazard does not vary with duration.

If $\frac{dh(t)}{dt} > 0$, then there is positive duration dependence. That means that the probability of the spell ending at any given duration, given that it has reached that duration, increases with the duration.

Finally, if $\frac{dh(t)}{dt} < 0$, then there is negative duration dependence. That means that the probability of a spell ending at any given duration, given that that it has reached that duration, decreases with the duration. There are a number of parametric forms for hazards models and the particular parametric form chosen determines the general shape of the hazard function.

The remaining sub-sections of this section outline the parametric procedures that are used in our duration dependence tests. We will fit parametric models to failure time data. The models for the response variable consist of a linear effect composed of the covariates and a random disturbance term. In our case, however, we have no covariates as the main question we are trying to answer is whether the probability of exiting a state (i.e., a bull or bear market) depends on how long one has spent in it. This is known as duration dependence. The distribution of the random disturbance term can be taken from a class of distributions that includes the normal, logistic, extreme value, and, by using a log transformation, the exponential, Weibull, lognormal, loglogistic and three-parameter gamma distribution. For the purpose of this paper, we will study the exponential, Weibull, lognormal and loglogistic distributions.

The model assumed for the response T is:

$$\log T_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta k X_{ik} + \sigma \epsilon_i \qquad (5)$$

where T_i is the log of the failure times, $\beta_{0 \ldots}$ β_k is a matrix of covariates or independent variables (usually including an intercept term), σ is an unknown scale parameter and ϵ_i is a vector of errors assumed to come from a known distribution (such as the standard normal distribution). The distribution may depend on additional shape parameters. These models are equivalent to accelerated failure time models when the log of the response is the quantity being modelled. The effect of the covariates in an accelerated failure time model is to change the scale, not the location, of a baseline distribution of failure times. So far, the only differences between the model in equation (5) and the usual linear regression model are that (i) there is a σ before the ϵ and (ii) the dependent variable is set to log scale. The σ can be omitted, which requires that the variance of ϵ be allowed to vary from one data set to another. But it is simpler to fix the variance of ϵ at some standard value (e.g., 1.0) and let σ change in value to accommodate changes in the disturbance variance. As for the log transformation of T, its main purpose is to ensure that predicted values of T are positive, regardless of the values of the X's and the β's. In a linear regression model, it is typical to assume that ϵ_i has a normal distribution with a mean and variance that is constant over i, and that the ϵ's are independent across observations. The lognormal model is based on these assumptions. Other models allow distributions for ϵ besides the normal distribution but retain the assumption of constant mean and variance, as well, as independence across observations.

Exponential model

The exponential hazard model has a particularly simple form when expressed as a hazard function, namely, $h(t) = \sigma$.

That is, the hazard is constant, and the process is said to be "memoryless." The name comes from the fact that this hazard implies a cumulative distribution function (CDF) for the durations as $F(t) = 1 - e^{-\sigma t}$, which is the CDF for the exponential distribution. Thus, the durations have an exponential distribution when the hazard is constant.

Weibull distribution

Modified slightly from the exponential model the Weibull model offers a different perspective of hazard. It retains the assumption that ϵ has a standard extreme-value distribution but relaxes the assumption that $\sigma = 1$. The Weibull hazard is what we get when the durations have a Weibull distribution, given in CDF form by

$F(t) = 1 - e^{(-(\mu/\sigma)t^\wedge(1/\sigma))}$, where μ is the intercept and σ is the duration parameter.

The corresponding hazard function is given by

$$h(t) = e^{(-\mu/\sigma)}(1/\sigma)t^{(1/\sigma)-1}$$

Duration models may have different parameterisations but they are all equivalent. Wooldridge (2002) defines a Weibull hazard function as $h(t) = \alpha\beta t^{\beta-1}$ where α and β are equivalent to $e^{(-\mu/\sigma)}$ and $(1/\sigma)$ respectively in our models.

For the Weibull model, the distribution forces the hazard to be either monotonically increasing or monotonically decreasing.

If $\sigma > 1$ hazard decreases with time.
If $0.5 < \sigma < 1$ hazard increases at a decreasing rate.
If $0 < \sigma < 0.5$ hazard increases an increasing rate.
If $\sigma = 0.5$, the hazard function is an increasing straight line with an origin of 0.

Lognormal distribution

If the durations have a lognormal distribution (so that the exponential of the durations has a normal distribution), then the hazard is given by

$$h(t) = (1/(t\sigma\sqrt{2}\pi)\ e^{[-1/2\{\ln(t)-\mu/\ \sigma\}^\wedge 2]})/\ (1-\Phi\ (\ln(t)-\mu/\ \sigma))$$

where σ is the standard distribution of the log durations, Φ is the standard normal cumulative distribution function. The lognormal model has a nonmonotonic hazard function. The hazard is 0 when t = 0. When σ is large the hazard peaks so rapidly that the function is almost indistinguishable from those like Weibull and loglogistic.

If $\sigma > 1$, hazard decreases with time.
If $\sigma < 1$, hazard increases with time.

Loglogistic distribution

If the log duration is assumed to have a logistic distribution, the resulting hazard function is given by

$$h(t) = (e^{(-\mu/\sigma)}(1/\sigma)t^{(1/\sigma)-1})/(1 + e^{(-\mu/\sigma)}t^{1/\sigma})$$

This parametric form for the hazard allows a variety of shapes, depending in particular on the value of σ.

If $\sigma < 1$, the hazard starts at 0, rises to a peak and then declines toward 0 (increasing hazard).
If $\sigma > 1$, then the hazard behaves like a decreasing Weibull hazard, that is, the hazard is again monotonically decreasing to zero with time but it is unbounded as t approaches zero.
If $\sigma = 1$, then the hazard equals α at t = 0 and decreases monotonically to zero after that.

3.4Empirical Results

It is natural that the null hypothesis for the exponential model tests for no duration dependence, or equivalently, a constant hazard rate, implying that the bull and bear states are random and therefore the possibility of a state ending is independent of the length of time spent in the state. On the other hand, the alternative hypothesis defines the existence of duration dependence. The remaining three parametric models ascertain whether duration dependence is positive or negative based on the parameter coefficient. Insight into how our definition divides real stock prices into bull and bear states can be seen from Figures 1a to 1k which use the unadjusted price index to show the sequence of consecutive bull and bear market durations over the sample periods 1965-2006, 1973-2006, 1988-2006, 1990-2006, and 1987-2006 for the eleven international markets. These figures use a barrier, λ, of 15 percent which divides the eleven international markets into a number of bull and bear markets as shown in Table 3-1.

Figure 3-1a: USA Daily Price Series 1965-2006

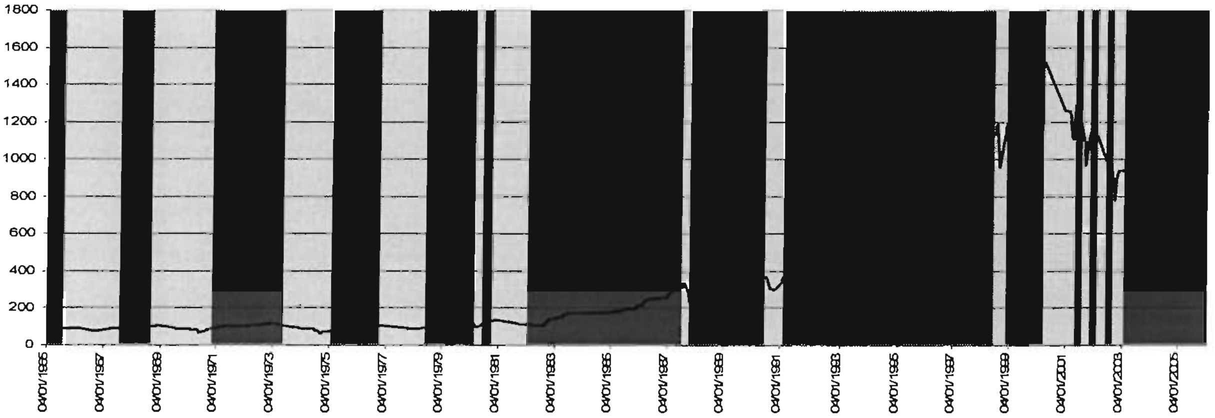


Figure 3-1b: UK Daily Price Series 1965-2006

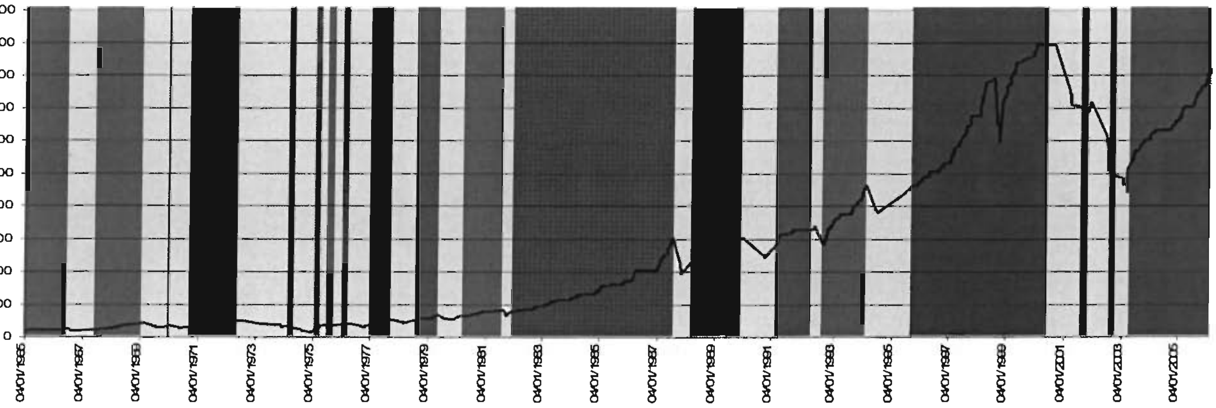


Figure 3-1c: France Daily Price Series 1973-2006

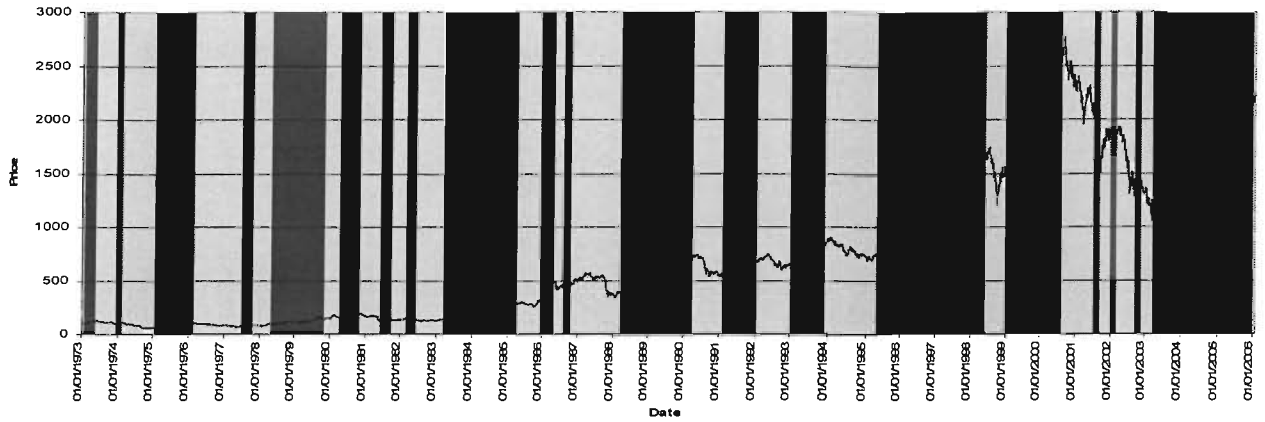


Figure 3-1d: Germany Daily Price Series 1973-2006

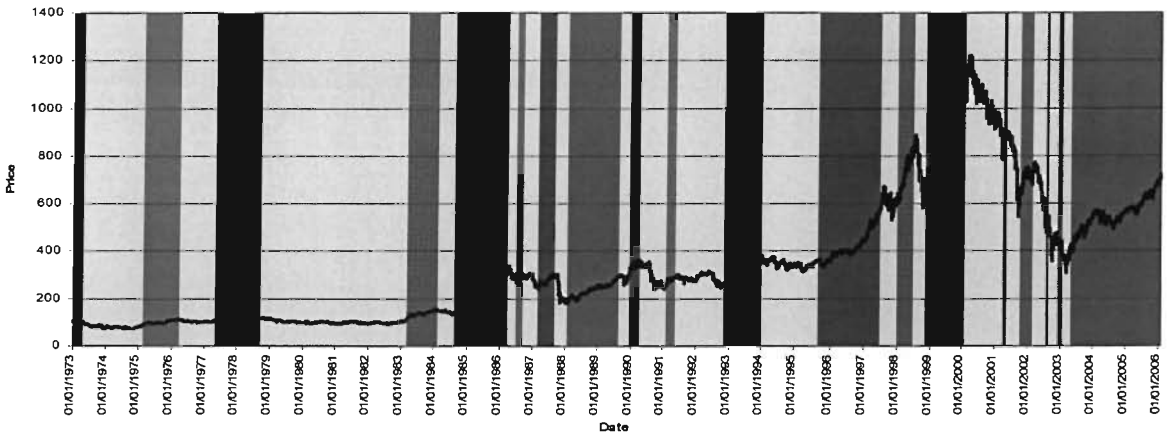


Figure 3-1e: Netherlands Daily Price Series 1973-2006

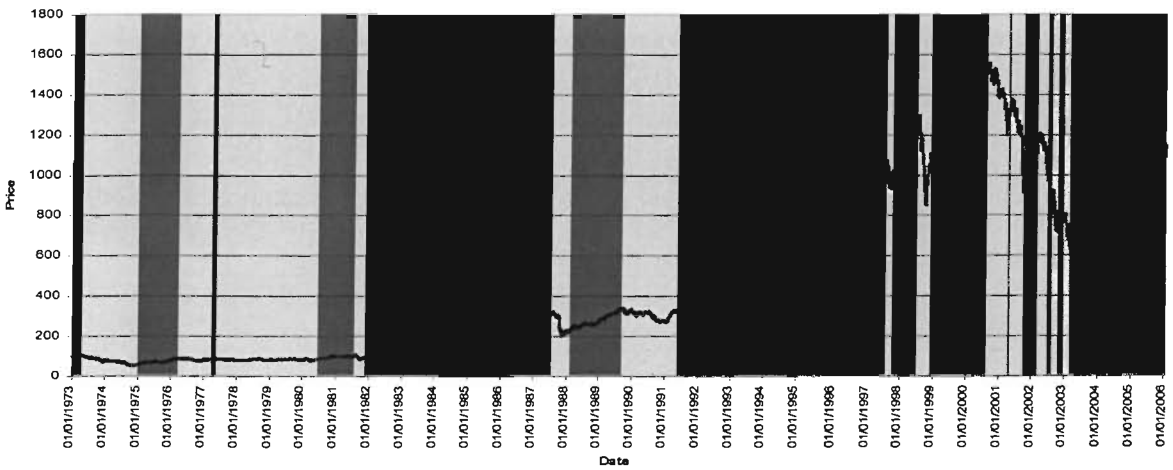


Figure 3-1f: Switzerland Daily Price Series 1973-2006

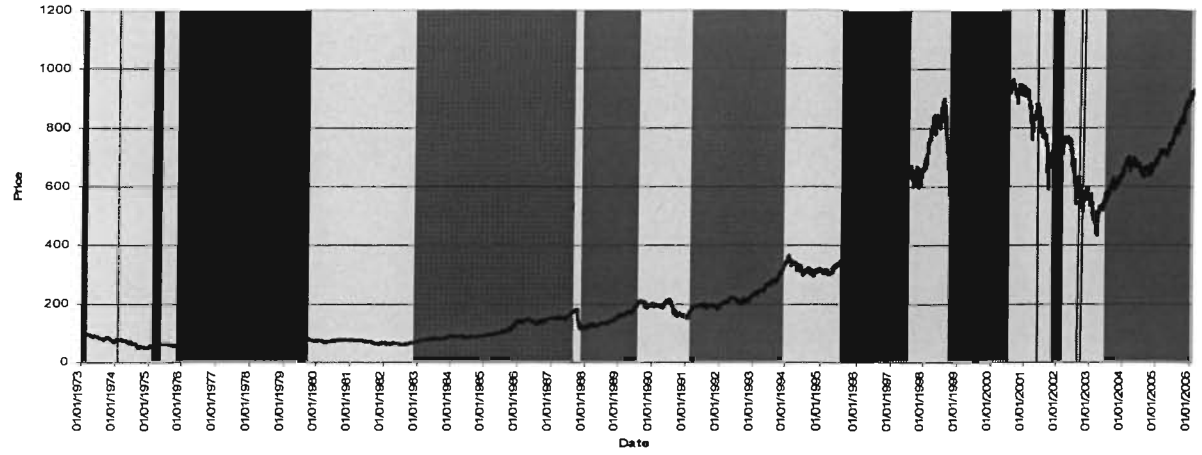


Figure 3-1g: Japan Daily Price Series 1973-2006

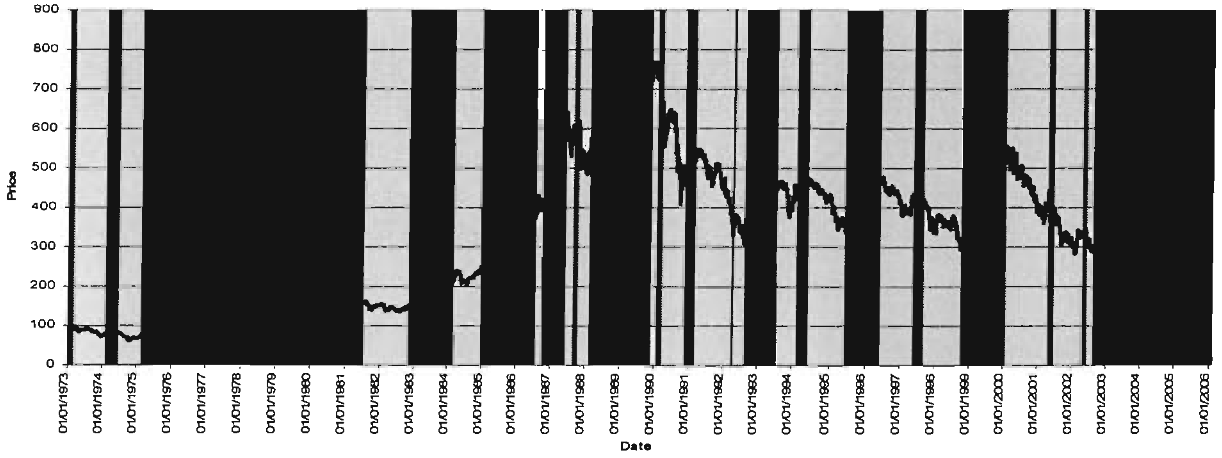


Figure 3-1h: Italy Daily Price Series 1973-2006

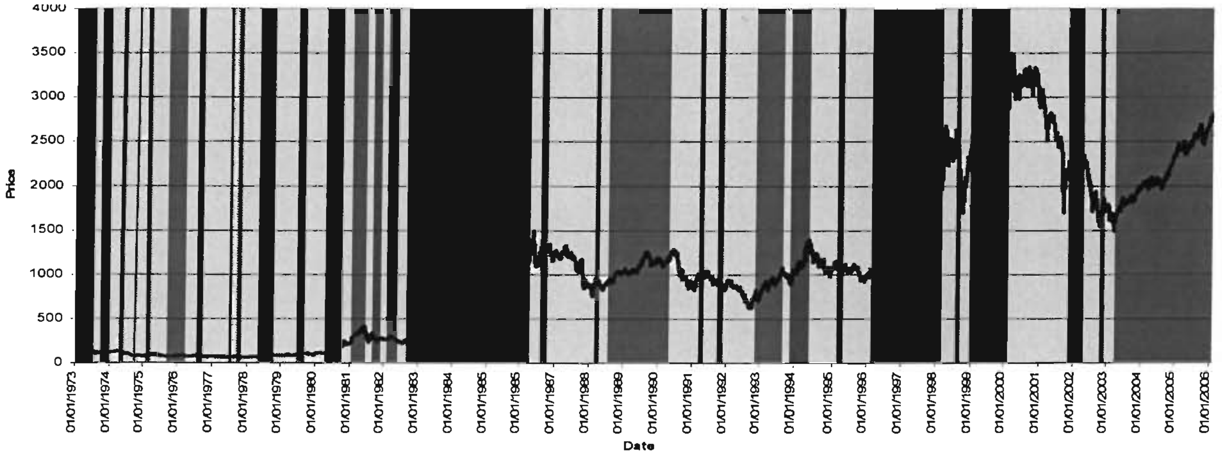


Figure 3-1i: Greece Daily Price Series 1988-2006

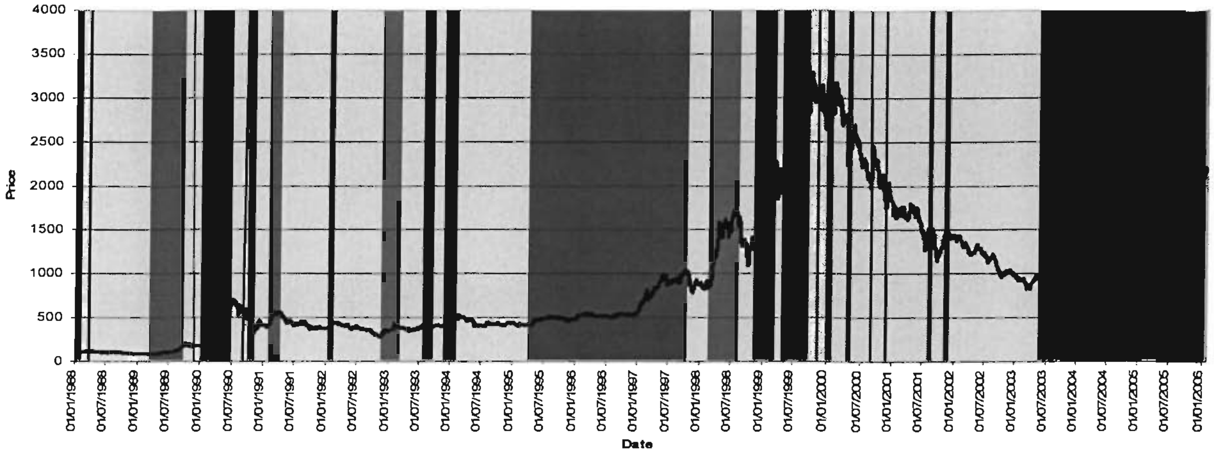


Figure 3-1j: Spain Daily Price Series 1987-2006

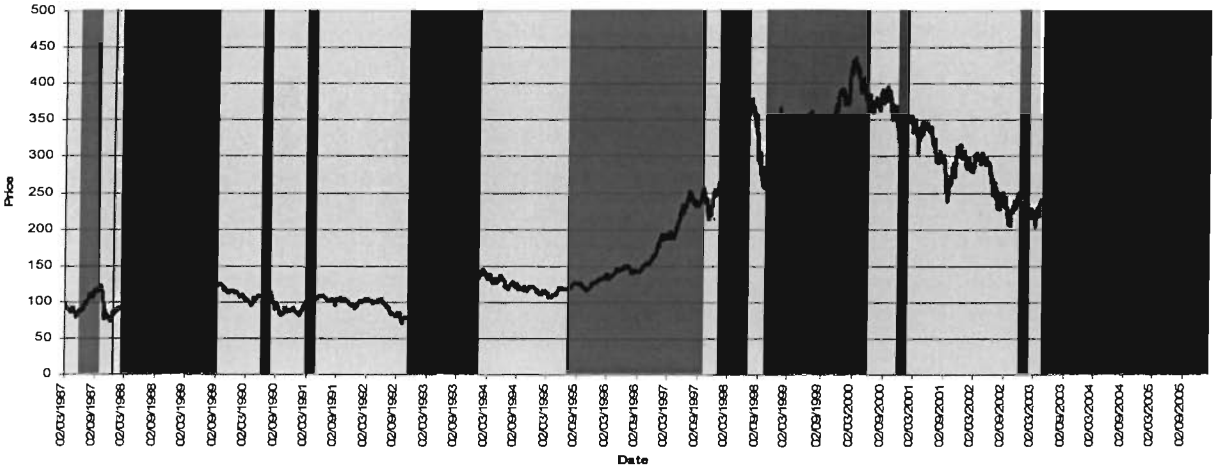
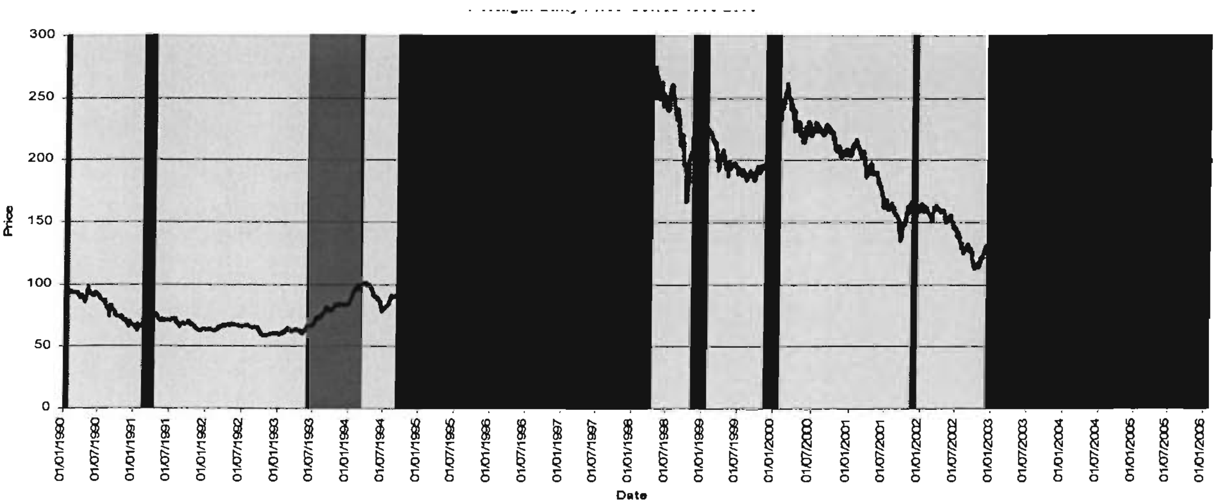


Figure 3-1k: Portugal Daily Price Series 1990-2006



The next section illustrates the bull and bear states of the eleven countries.

United States

Many of the bull markets are very long, the longest lasting from January 1991 to July 1998 for the United States. The US stock market has been one of the world's strongest in the past century, and this is reflected in its performance. The worst bear market of the sample period was in 1973-1974, where the market was in a bear state for 333 days. At the time, the OPEC crisis, Watergate, inflation and recession were the main factors contributing to the depressed state of the economy. Over the September 1981 to August 1982 period, the market was in a bear state for 242 days, the main reasons for such a state being high interest rates, the second OPEC crisis, recession and inflation. Other bear markets were shorter and shallower, except for the 2000-2002 years where the Internet bubble, an overvalued market, recession and corporate malfeasance contributed to plunging the economy in a bear state.

Europe

Those bull and bear periods in the United States have in a way led the way for the distinction of those two states in the economy of the other international markets. The 1972-1974 bear market was the worst bear market of the 20th century for the United Kingdom as OPEC, runaway inflation and political problems decimated investor confidence. The longest lasting bull market for the period was from November 1981 to July 1987 lasting 1485 days. French stocks have followed the bear and bull market patterns of the rest of the world. However, Dr. Brian Taylor, President of Global Financial Data, Inc., which provides a guide to global bull and bear markets has found that French bear markets usually lasted longer than those in other countries, usually topped out before the rest of the world and recovered later. French stocks, it was found, lost half their value during the 2000-2002 bear market, exceeding the declines that occurred in 1973-1974. The longest bull market lasted 830 days from May 1995 to July 1998. Germany followed the same trends as the other countries with the 1973-1974 decline and the 1987 crash, as well as the 2000-2002 crash. Italian stocks were the worst performing stocks of any major country during the 20th century. Italy has never developed an equity culture similar to that in the Anglo-Saxon countries and as such bear markets in Italy have been deeper and longer that in any other country. The 1987 bear market began in 1986 and the Gulf War bear market was followed by a second decline in stocks in 1992 when the lira sank after the European currency crisis. Netherlands had its longest bull period from March 1991 to August 1997 while the longest bear period extended from August 1973 to November 1974. Switzerland's longest bull period covered December 1982 to October 1987 while the bear market of longest duration was over the period September 1981 to July 1982. The longest bull period of 712 days in Greece was from May 2003 to January 2006 while a bear market of 264 days lasted from March 2002 to March 2003. In addition, Portugal's most lengthy bull market covered August 1994 to April 1998 while the longest bear market was from May 2000 to September 2001. Finally, Spain's longest bull market in the sample studied was from April 2003 to February 2006 while the longest bear market of 350 days lasted from May 2000 to September 2001.

Japan

Japan's stock market has shown a very low correlation with the rest of the world's stock markets because of its distance from and lack of integration with the rest of the world's financial markets. It suffered the longest bear market over the period October 1997 to October 1998, totalling 252 days but was barely affected by the 1987 crash. Its longest bull market lasted 1706 days over the period January 1975 to August 1981.

Tables 3-2a and 3-2b present the summary statistics for bull and bear market durations for daily price series. The descriptive statistics for bull and bear markets are reported in months for easier understanding although our analysis was carried out using daily data. Panels A through D of the tables show the summary statistics when different filters, that is, different percentages triggering a switch between bull and bear markets are used for comparison purposes. From Panel A where a filter of 10% is in effect, we find that the monthly mean duration for a bull market ranges from 1.21 months for Greece to 13 months for Switzerland. The US, UK and Netherlands have means of over five months with 7.22 months for the US, 5.93 months for the UK and 6.97 months for Netherlands. We do not report minimum durations as this variable may not be of significance, considering the minimum number of days a market is in a bull or bear state may be short-term noise due to the filter being triggered. We could impose a restriction on our algorithm by deciding on the minimum time that can be spent in a particular phase[4]. However, we find that constraining a bear market to have too low durations would produce many spurious cycles. The US has the highest maximum duration of 59.5 months in a bull market whereas Greece is again the country with the shortest length of 8.70 months in a bull market. The remaining countries have maximum durations ranging from 30.4 months for Switzerland to 17.93 months for Germany. Panel B presents the findings for a filter of 15%. The monthly mean duration of a bull market increases for all countries ranging between 18.11 months for the US and 3.02 months for Greece. Switzerland, Netherlands and the UK follow closely behind with mean durations of 14.24, 13.64 and 12.73 respectively. France, Germany, Portugal, Spain and Japan have fairly similar durations of 8 to 9 months. The country with the maximum duration for a bull market is again the US at 64.90 months followed by Japan at 56.87 months. Netherlands, UK and Switzerland follow close behind while the remaining countries have maximum durations ranging between 32.60 to 23.73 months.

In Panel C, we find that the mean durations have increased further which is intuitive since the filter barrier has been increased to 20%. This means that since there needs to be a higher percentage increase or decrease to mark a switch between bull and bear markets, the market tends to stay in that particular state longer. Since λ is arbitrarily chosen, it is important to investigate the effect of λ on the results. In Figure 3-2a and 3-2b we plot densities of a US bull and bear market durations normalised by their individual standard deviations and using filter sizes of λ= 10%, 15%, 20%, 25%. We only present the US standardised durations as the remaining markets have similar shapes for each of the corresponding filters. We find that for a bull market, the filter sizes of 10% and 15% have the same basic shape while the same is true of filter sizes 20% and 25%. The flatter shape for the latter two filters may be because of the limited number of observations. Hence this suggests that duration dependence is robust across filter sizes.

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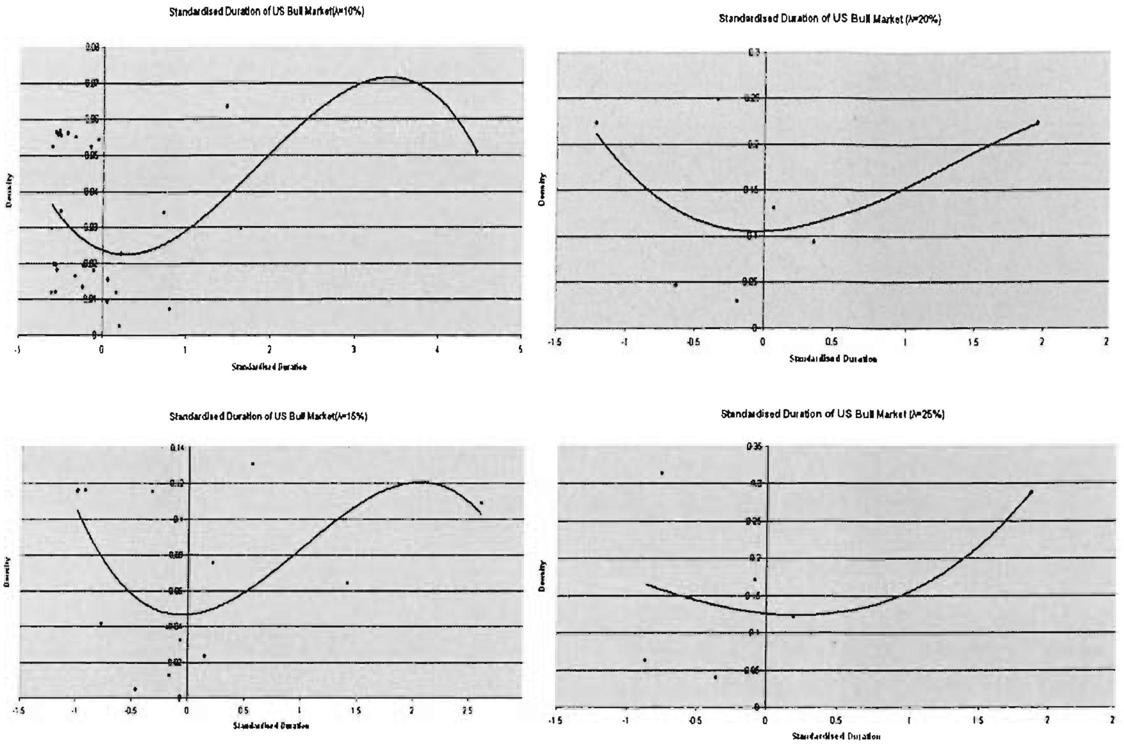
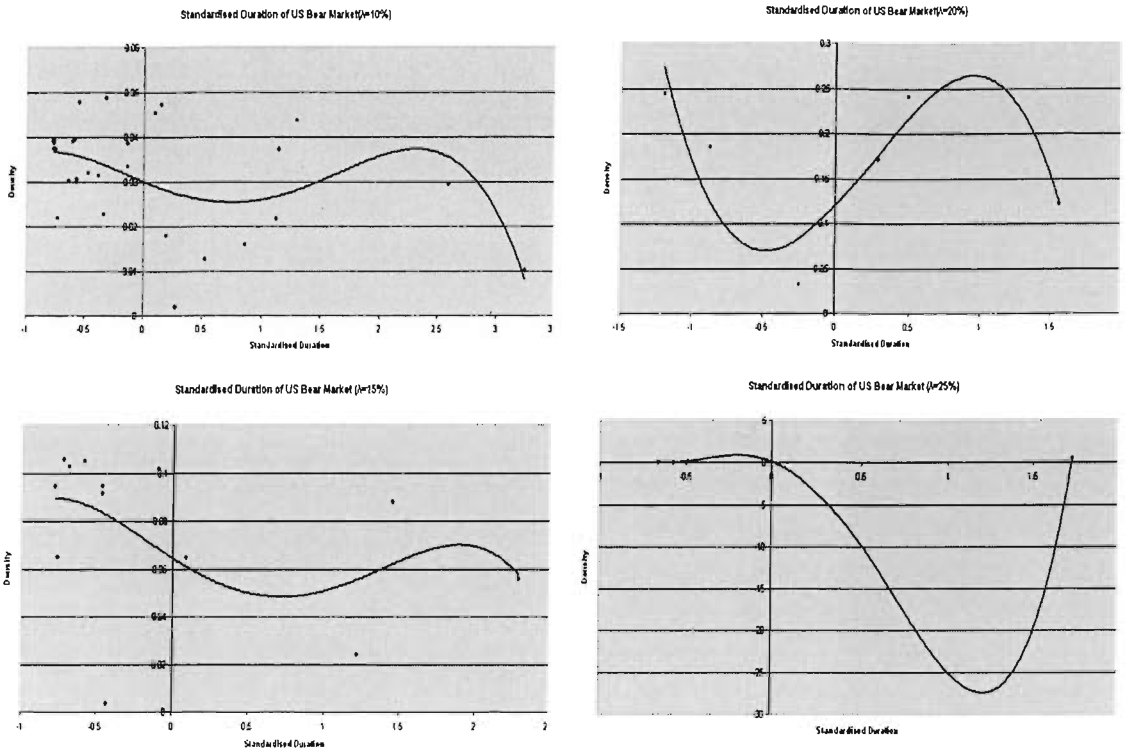
[4] In his paper, Hamilton (Hamilton, 1919) regarded the main or primary trend as 'the broad upward and downward movements known as bull and bear markets' while the secondary reaction was an 'important decline in a primary bull market or rally in a primary bear market. These reactions usually last from three weeks to as many months.'

Figure 3-2a: Standardised Duration for a Bull Market



For a bear market, filter sizes 10% and 15% again show the same basic shape but flatter than for filter size 20%. The 25% filter, on the other hand, is U-shaped. Although, we can say that the results of duration dependence are robust across filter sizes 10% and 15% we can assume from the shape of the graph that the results are also robust for the 20% size. However, we cannot extend this assumption to the 25% filter.

Figure 3-2b: Standardised Duration for a Bear Market



The US once again has the highest mean duration at 40.71 months, followed by the UK at 30.44 months and Netherlands at 28.34 months. The other markets have monthly mean durations ranging from 18.31 for Japan to 5.8 for Greece. Japan is the country with the highest maximum duration of 107.17 months for a bull market followed by the US (104.77 months). Panel D shows the statistics with a 25% filter. Again the monthly mean duration has increased for all markets. From the observations in Table 3a, we conclude that the US, UK, Netherlands, Switzerland have somewhat similar monthly mean durations with France, Germany, Japan, Portugal, Spain, Italy and Greece lagging not far behind.

Table 3-2b shows the findings for a bear market. We find that the monthly mean duration for a bear market is less than that for a bull market which is not surprising given the historical study of the stock market cycles. The monthly means start off quite low for the 10% filter but gradually increase when filters of 15%, 20% and 25% are used. Thus for a filter of 15%, the US has a monthly mean duration of 2.86 months for a bear market. Portugal has the highest mean duration of 4.55 months while Greece has the lowest (1.44 months). The remaining countries have mean durations ranging between those two values. The country with the longest bear market duration is Germany at 27.90 months. With a filter of 20%, Germany once again has the highest mean durations of 4.54 months and the highest maximum length that a market is in a bear state. At 25%, Portugal tops the list with the highest mean duration of 10.80 months.

Table 3-3a displays the summary statistics for bull market durations using daily real price series. The mean durations for a 10 % filter range between 0.97 months for Greece and 6.75 months for the US. Mean durations are higher for the unadjusted price series than for the daily real price series confirming that inflation reduces the mean duration for bill markets. One exception is Germany where the unadjusted price series has a slightly lower mean duration. The US has the highest maximum duration of 59.5 months for a bull market and Greece has the lowest at 4.9 months. The remaining countries have maximum durations ranging from 17.4 months for Japan to 30.4 months for Switzerland. With a filter of 15%, mean durations are seen to increase with Switzerland having the highest mean duration of 13.59 months for a bull market. Greece has again the lowest mean duration of 2.54 months. Similarly to the 10 % filter, the 15 % filter shows mean durations that are lower than for the unadjusted price series. The US has once again the highest maximum duration of 64.87 months while Germany has the lowest at 16.53 months. Filters of 20 % and 25 % show results that run in a similar trend.

Table 3-3b depicts the findings for a bear market using the daily real price series. In Panel A, with a filter of 10 % we find that the mean durations have increased from the unadjusted price series and this is consistent with the presence of inflation. One exception is Switzerland which shows a mean duration of 3.08 in the unadjusted price series and 2.21 in the real price series. Portugal shows the highest mean duration at 4.05 months while Greece has the lowest at 1.13 months. Once again Portugal presents the highest maximum duration 15.33 months while Italy shows the lowest at 4.7 months. Panel B, where we use a filter of 15 % confirms the fact that inflation increases the duration of a bear market. The US, however, shows a negligible decrease in the mean duration from 2.86 months for the unadjusted series to 2.84 months for the real price series. Germany is seen to have the highest maximum duration of 29.60 months while France has the lowest at 8.73 months. Panels C and D present results in a similar thread.

In this study, we examine duration dependence using four parametric hazards models which are the exponential model, the Weibull model, the loglogistic model and the lognormal model. Table 3-4 presents the findings of four parametric tests of duration dependence in daily price series for a bull market. The results are presented in four panels which utilise different filters. For the exponential model, the scale parameter, σ, is forced to 1 and the model tests whether the hazard function is constant (H_0: $\sigma = 1$). For a filter of 10%, we reject the null hypothesis of a constant hazard, or no duration dependence, for all countries except Netherlands (p-value: 0.32). We conclude that duration dependence does exist for all countries except Netherlands when using a 10% filter. With a 15% filter in place, we reject the constant hazard hypothesis for Netherlands (p-value: 0.03), Switzerland (p-value: 0.01), Italy (p-value: 0.01) and Greece (p-value: <0.0001), suggesting that the remaining countries exhibit no duration dependence. Panel C shows only Italy and Greece with p-values less than 0.05, thus revealing duration dependence when a 20% filter is used while Panel D finds that only Italy (p-value: 0.004) displays duration dependence with a 25% filter. Our conclusions for the exponential model is that the majority of countries exhibit no duration dependence when filters of 15%, 20% and 25% are used.

The Weibull model determines whether the parameter estimate, σ, is monotonically increasing or decreasing. For the Weibull model, we retain the assumption that ϵ has a standard extreme-value distribution but we relax the assumption that $\sigma = 1$. Panels A and B show that the scale parameter estimate, σ, is greater than 1 for all countries. This, therefore, indicates the presence of negative duration dependence. The findings are further confirmed by p-values which are less than 0.0001 (H_0: $\sigma < 1$; H_a: $\sigma > 1$) suggesting that the null hypothesis of increasing hazard functions is soundly rejected. Looking at Panel C which uses a 20% filter, we find that the US, the UK, and Netherlands have parameter estimates falling between 0.5 and 1 which means that the hazard increases at a decreasing rate. However, p-values of 0.0002, 0.0004 and 0.0007 for the three countries respectively indicate that we reject the null hypothesis of increasing hazards. Thus all countries continue to exhibit negative duration dependence. In the last panel, the US and UK, in addition to France, continue to show estimates for σ as being less than 1. Corresponding p-values for those countries are 0.0001, 0.0023 and 0.0003 respectively, suggesting that the null hypothesis of positive duration dependence can be rejected. The other countries, except for Portugal (p-value: 0.0287), show negative duration dependence as evidenced by their parameter estimates which are all greater than 1 and p-values which are less than 0.05. Thus, we find that with the Weibull model an overwhelming majority of countries exhibit negative duration dependence.

The loglogistic model tests the shape of the hazard function in order to confirm or deny the existence of positive or negative duration dependence. Panel A which uses a 10% filter reveals that the UK, Netherlands, Italy and Greece have parameter estimates less than 1 which is an indication of increasing hazards. However, their p-values which are less than 0.05 allow the rejection of the null hypothesis of positive duration dependence. All other markets show evidence of σ estimates being greater than 1, thus indicating negative duration dependence (confirmed by p-values being less than 0.05). Panel B shows the same results with, this time, France, Japan and Italy having σ parameters being less than 1. Again the p-values for those three countries are found to be less than 0.05 which means that the null hypothesis of increasing hazards can be rejected. In Panel C, all markets except the US (p-value: 0.0033), the UK (p-value: 0.0007), Netherlands (p-value: 0.0005), Switzerland (p-value: 0.0011) and Spain (p-value: 0.0003) exhibit σ estimates greater than 1. Since all p-values are less than 0.05, the null hypothesis of increasing hazards can be rejected. With a 25% filter, the US (p-value: 0.0032), UK (p-value: 0.0023), France (p-value: 0.0002) and Spain (p-value: 0.0005) still reveal a parameter estimate falling between 0.5 and 1, thus pointing towards positive duration. However, the p-values which are all less than 0.05 allow for the rejection of the null hypothesis of increasing hazards. Hence for the logistic model the presence of negative duration dependence is confirmed for all markets.

In a similar manner to the loglogistic and Weibull models, the lognormal models test the presence of decreasing and increasing hazards models. Panels A, B and C find that the parameter estimates for the hazard function are all greater than 1 for all eleven markets, thus indicating negative duration dependence. P-values of less than

0.05 confirm the findings. In Panel D, the same can be said of all countries except the US and the UK which show positive duration dependence as evidenced by their σ estimate being greater than 1. However, both countries have p-values of 0.0006 thus allowing the null hypothesis of increasing hazards to be rejected. The conclusion is therefore, that for the lognormal, loglogistic and Weibull model, negative duration dependence is present in the majority of the markets for all filters used.

Table 3-5 presents the parametric tests of duration dependence in daily price series for a bear market. The null hypothesis for the exponential model once again tests the presence of a constant hazard (H_0: $\sigma =1$), or no duration dependence (H_a: $\sigma \neq 1$). In Panel A, we reject the null hypothesis of no duration dependence for all countries except France(p-value: 0.43), Switzerland (p-value: 0.20), Italy (p-value:0.28), Portugal (p-value:0.11) and Spain (p-value: 0.06). Panel B which uses a 15% filter reveals that duration dependence exists in the following markets: Germany (p-value; 0.02), Netherlands (p-value: 0.03), Italy (p-value: 0.01), Greece (p-value: 0.004) and Spain (p-value: 0.04). The remaining countries show no evidence of duration dependence. Panel C finds no duration dependence in all countries except Japan (p-value: 0.03) while in Panel D the results present no duration dependence for any market.

The Weibull model finds that, in Panel A, all parameter estimates are greater than 1 which is an indication of decreasing hazards and equivalently negative duration dependence. This is confirmed by p-values being less than 0.05. Panel B reveals that the only market showing a σ estimate less than 1 is Portugal but a p-value of 0.0006 indicates that the null hypothesis of positive duration dependence can be rejected. In Panel C the same can be said of the US (p-value: 0.0018), Switzerland (p-value: 0.0006) and Japan (p-value: <0.0001). Panel D which uses a 25% filter rule confirms that all markets except France (p-value: 0.0006), Germany (p-value: 0.0002) and Japan (p-value: 0.0005) show evidence of σ estimate greater than 1. Thus the overall finding for the Weibull model is that negative duration dependence seems to be predominant in all markets over the various filters.

Results for the loglogistic model are similar to the Weibull model. In Panel A, the UK, France, Switzerland, Italy and Greece reveal positive duration dependence as evidenced by their parameter estimates being less than 1. However, all p-values are less than 0.05 indicating that the null hypothesis of increasing hazards can be rejected. Panel B shows that the following countries, US, UK, Germany, Netherlands, Switzerland, and Portugal exhibit a σ estimate that is less than 1 but once again increasing hazard functions can be rejected on the basis of p-values being less than 0.05. Panel C provides results in a similar trend with the US (p-value: 0.0019), France (p-value: <0.0001), Switzerland (p-value: 0.0007), Japan (p-value: 0.0002), Italy (p-value: <0.0001) and Spain (p-value: 0.0002) showing σ estimates being less than 1. Panel D which uses a filter rule of 25% shows that the majority of markets exhibit present a σ estimate that is less than 1 with only Italy (p-value: <0.0001), Greece (p-value: <0.0001) and Portugal (p-value: 0.0183) presenting greater than 1 estimates. However, the hypothesis of increasing hazards can be rejected on the basis of p-values being less than 0.05. Our conclusion for the loglogistic model would seem to be that the all markets over the 10%, 15%, 20% and 25% filter rules exhibit negative duration dependence or decreasing hazard functions.

When using the lognormal model, all markets in the 10% and 15% rule show negative duration dependence (p-values are all less than 0.05). Over the 20% and 25% filters, the only country showing σ estimate greater than 1 is Japan. However, with a p-value of 0.0001 and 0.0004 in the 20% and 25% filters respectively, we are able to reject the null hypothesis of positive duration dependence. Thus, we find that with the lognormal model, there is a prominence of negative duration dependence in all markets and this with all filter rules.

Table 3-6 which shows the parametric tests of duration dependence in a daily real price series confirms that the lognormal, loglogistic and Weibull model all seem to overwhelmingly generate parameter estimates that are greater than 1, thus indicating negative duration dependence in bull markets of the eleven international markets over all filter rules. This is further confirmed by p-values being less than 0.05. Table 7 presents the duration tests for a bear market using the daily real price series. There are no surprises again here and the conclusion is that the Weibull model, the loglogistic model, and the lognormal model show negative dependence in bear markets of the eleven countries.

3.5Conclusion

This study has adopted the algorithm mentioned in Lunde and Timmermann (2004) to study bulls and bear markets in daily stock prices. We introduced a fairly new technique called survival analysis to document duration dependence in daily aggregate stock prices of eleven international markets. We characterised a bull market as being a series of increasing highs interrupted by a series of higher intermediate lows and a bear market as being a downward trend consisting of lower intermediate lows interrupted by lower intermediate highs (Sperandeo, 1990). The study used a set of filter rules which identified different percentages for triggering a switch between bull and bear markets. We utilised four parametric methods which are the lognormal, loglogistic, Weibull and exponential models to specify different hazard functions.

Our models showed negative duration dependence in the bull market indicating that the probability of a bull market ending at any given duration, given that it had reached that duration, decreased with duration in the market cycle. For the bear market, the lognormal, the loglogistic and Weibull models revealed negative duration dependence. Negative duration dependence implied that more mature bull and bear markets were more robust to failure than younger bull and bear markets.

The presence of duration dependence provided evidence of deviations from the random walk model. Although this might imply a rejection of the efficient market hypothesis, long-run dependencies in stock prices have had important implications for the interpretation of the sources of movements in stock prices and should not be discarded as insignificant. Two explanations for predictable price behaviour have been offered in the literature, namely temporary 'fads', (Poterba and Summers, 1988; Shiller, 1989; and Delong *et al.*, 1990) and time-varying required returns (Fama and French, 1988a, 1988b). In general, the existence of 'fads' implies some degree of market inefficiency and , thus the possibility of earning excess profits, while the presence of time-varying required returns is consistent with rational pricing in an efficient market.

One possible explanation for declining hazards could be irrational investors such as noise traders. The model would allow stock prices to deviate from fundamental prices. The declining hazards found in all models could be interpreted as a momentum effect in the market. For example, as a bull market persisted, investors could become more optimistic about the future and hence wish to invest more in the stock market. This would result in a decreasing probability of switching out of the bull market. Similarly, the length of a bear market could be related to the amount of pessimism about future returns by investors. This would lead to a substitution from equity into other expected high-return instruments such as treasury bills.

Table 3-1. Number of bull and bear markets for eleven international markets

Market	Bull	Bear
United States	14	13
United Kingdom	19	18
France	20	19
Germany	19	18
Netherlands	14	13
Switzerland	14	13
Japan	19	18
Italy	30	29
Greece	24	23
Portugal	8	7
Spain	12	12

Table 3-2a. Summary Statistics of Bull Market Durations for Daily Price Series

A: Filter = 10%			
Country	Mean	Median	Max
US	7.22	3.33	59.50
UK	5.93	2.10	27.23
France	4.86	3.77	25.10
Germany	3.29	1.17	17.93
Netherlands	6.97	4.70	26.17
Switzerland	13.00	3.60	30.40
Japan	4.63	2.00	30.17
Italy	2.73	1.55	24.93
Greece	1.21	0.53	8.70
Portugal	4.24	1.47	22.83
Spain	4.33	1.45	25.07
B: Filter = 15%			
US	18.11	14.93	64.90
UK	12.73	10.70	49.50
France	9.19	6.60	27.67
Germany	8.13	7.87	25.03
Netherlands	13.64	6.85	55.80
Switzerland	14.24	10.22	42.07
Japan	9.07	4.33	56.87
Italy	5.16	1.82	32.60
Greece	3.02	0.42	23.73
Portugal	9.03	2.08	32.27
Spain	8.01	4.10	24.57
C: Filter = 20%			
US	40.71	34.37	104.77
UK	30.44	23.87	82.60
France	15.07	10.40	50.37
Germany	13.52	10.83	38.23
Netherlands	28.34	20.47	63.17
Switzerland	14.85	20.68	64.37
Japan	18.31	7.72	107.17
Italy	9.05	3.68	32.70
Greece	5.80	2.03	22.97
Portugal	5.98	1.98	20.17
Spain	10.73	10.40	27.67
D: Filter = 25%			
US	44.84	38.40	99.37
UK	46.46	29.32	100.90
France	23.73	17.47	63.40
Germany	24.08	11.23	97.00
Netherlands	40.55	19.85	108.97
Switzerland	16.54	15.77	109.30
Japan	26.17	7.80	128.77
Italy	9.86	4.43	32.23
Greece	6.94	3.03	22.90
Portugal	17.58	14.58	41.10
Spain	10.64	10.30	22.97

Table 3-2b. Summary Statistics of Bear Market Durations for Daily Price Series

A: Filter = 10%			
Country	Mean	Median	Max
US	1.58	0.80	8.10
UK	1.20	0.83	6.67
France	1.38	1.18	5.30
Germany	1.36	0.68	7.73
Netherlands	1.55	0.73	7.77
Switzerland	3.08	0.93	7.47
Japan	1.61	1.12	8.33
Italy	1.12	0.63	4.70
Greece	0.87	0.42	6.43
Portugal	3.25	2.57	12.63
Spain	1.45	1.10	8.53
B: Filter = 15%			
US	2.86	1.17	11.10
UK	1.98	0.77	6.80
France	2.04	1.40	6.50
Germany	3.65	1.18	27.90
Netherlands	1.50	0.50	11.00
Switzerland	2.20	0.90	7.30
Japan	2.82	1.72	8.40
Italy	1.85	0.77	10.33
Greece	1.44	0.37	8.80
Portugal	4.55	3.87	11.77
Spain	2.67	1.00	11.67
C: Filter = 20%			
US	3.39	3.43	7.40
UK	3.87	2.43	11.37
France	2.25	2.53	5.13
Germany	4.54	1.72	22.77
Netherlands	3.24	1.63	9.63
Switzerland	2.58	4.37	12.33
Japan	6.02	4.50	15.30
Italy	2.98	2.07	11.40
Greece	2.04	1.03	6.43
Portugal	2.07	0.83	7.93
Spain	2.10	1.00	7.50
D: Filter = 25%			
US	3.87	0.00	13.53
UK	6.07	7.40	13.03
France	3.51	3.65	7.10
Germany	3.31	2.45	10.37
Netherlands	3.17	0.50	8.80
Switzerland	1.60	1.52	11.50
Japan	7.76	6.33	19.90
Italy	3.38	3.53	9.80
Greece	2.20	1.33	7.30
Portugal	10.80	13.37	18.77
Spain	2.40	0.97	7.23

Table 3-3a. Summary Statistics of Bull Market Durations for Daily Real Price Series

A: Filter = 10%

Country	Mean	Median	Max
US	6.75	3.33	59.50
UK	4.37	1.50	25.47
France	4.24	2.12	25.10
Germany	3.39	0.90	17.93
Netherlands	4.78	2.95	18.13
Switzerland	5.94	2.65	30.40
Japan	3.87	2.00	17.40
Italy	2.11	0.90	24.93
Greece	0.97	0.40	4.90
Portugal	4.00	1.22	22.73
Spain	4.13	1.97	25.07

B: Filter = 15%

Country	Mean	Median	Max
US	11.18	6.65	64.87
UK	11.21	10.20	49.03
France	7.47	2.90	25.07
Germany	6.46	5.40	16.53
Netherlands	12.47	7.20	55.43
Switzerland	13.58	15.50	42.00
Japan	8.58	3.60	48.67
Italy	3.81	0.93	24.30
Greece	2.54	0.47	23.73
Portugal	6.25	2.00	27.00
Spain	7.96	4.07	24.57

C: Filter = 20%

Country	Mean	Median	Max
US	22.26	14.38	79.33
UK	19.19	12.03	64.13
France	12.49	10.40	34.77
Germany	8.73	4.33	27.47
Netherlands	19.36	13.17	63.17
Switzerland	23.05	20.13	64.17
Japan	18.21	7.73	106.90
Italy	6.67	4.00	23.30
Greece	4.78	1.60	22.97
Portugal	6.53	1.93	19.57
Spain	10.32	10.40	27.67

D: Filter = 25%

Country	Mean	Median	Max
US	32.90	22.67	97.00
UK	25.60	20.40	60.80
France	14.62	17.47	34.40
Germany	15.54	10.23	64.50
Netherlands	28.58	15.27	89.33
Switzerland	22.24	19.55	63.63
Japan	25.58	7.83	127.20
Italy	10.95	11.00	28.20
Greece	8.16	7.67	22.90
Portugal	9.59	11.67	18.43
Spain	10.35	10.28	22.90

Table 3-3b. Summary Statistics of Bear Market Durations or Daily Real Price Series

A: Filter = 10%

Country	Mean	Median	Max
US	2.49	0.82	13.33
UK	1.45	1.20	7.17
France	1.70	1.20	5.57
Germany	1.65	1.00	8.73
Netherlands	1.97	0.90	13.30
Switzerland	2.21	1.30	10.83
Japan	1.89	1.03	9.97
Italy	1.27	0.83	4.70
Greece	1.13	0.43	7.33
Portugal	4.05	2.63	15.33
Spain	2.15	1.17	8.53

B: Filter = 15%

Country	Mean	Median	Max
US	2.84	1.20	11.97
UK	3.27	1.42	16.80
France	2.39	1.98	8.73
Germany	4.00	1.15	29.60
Netherlands	3.36	0.93	18.20
Switzerland	4.24	0.98	21.00
Japan	3.49	2.00	14.33
Italy	2.40	0.93	11.63
Greece	1.89	0.57	9.10
Portugal	5.59	3.43	14.90
Spain	2.98	1.37	11.67

C: Filter = 20%

Country	Mean	Median	Max
US	5.95	5.03	21.10
UK	3.95	1.43	15.80
France	3.51	3.67	7.30
Germany	4.54	1.07	27.93
Netherlands	6.84	3.57	30.10
Switzerland	5.42	4.37	12.73
Japan	6.16	4.50	15.30
Italy	4.64	4.15	17.20
Greece	2.98	1.67	8.83
Portugal	8.01	4.92	23.87
Spain	2.65	2.27	8.07

D: Filter = 25%

Country	Mean	Median	Max
US	8.50	7.53	18.33
UK	4.81	2.00	13.13
France	3.36	3.48	7.23
Germany	5.50	2.23	24.20
Netherlands	3.65	3.02	9.17
Switzerland	4.30	3.40	11.83
Japan	8.13	6.35	19.90
Italy	7.65	5.57	20.37
Greece	5.73	4.93	13.13
Portugal	10.64	9.25	23.60
Spain	3.58	1.83	7.30

Table 3-4. Parametric Tests of Duration Dependence in Daily Price Series (Bull Periods)

	Log-normal			Log-logistic			Weibull			Exponential		
Country	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	P-value	Log-Likelihood
Panel A: Filter =10%												
US	2.17	0.28	-69.12	1.24	0.19	-69.43	1.73	0.25	-67.59	1.00	0.00	-77.16
UK	1.64	0.19	-71.96	0.95	0.13	-72.45	1.43	0.18	-72.49	1.00	0.01	-77.14
France	1.92	0.23	-71.60	1.06	0.16	-71.37	1.41	0.20	-68.19	1.00	0.03	-71.62
Germany	1.86	0.20	-86.76	1.12	0.14	-88.29	1.61	0.20	-87.29	1.00	0.00	-96.84
Netherlands	1.74	0.25	-48.34	0.96	0.16	-47.97	1.20	0.21	-44.86	1.00	0.32	-45.49
Switzerland	2.09	0.31	-50.72	1.23	0.21	-51.27	1.64	0.28	-49.63	1.00	0.01	-54.65
Japan	2.05	0.25	-73.68	1.22	0.17	-74.75	1.70	0.23	-72.94	1.00	0.00	-82.49
Italy	1.61	0.16	-101.91	0.90	0.10	-101.48	1.37	0.14	-101.05	1.00	0.01	-106.41
Greece	1.59	0.17	-87.98	0.96	0.11	-89.64	1.42	0.16	-89.20	1.00	0.01	-94.68
Portugal	1.97	0.39	-28.49	1.17	0.27	-28.78	1.77	0.39	-29.26	1.00	0.02	-33.74
Spain	2.07	0.32	-46.38	1.22	0.22	-46.80	1.84	0.31	-47.13	1.00	0.00	-55.79
Panel B: Filter =15%												
US	1.96	0.39	-28.14	1.05	0.25	-27.84	1.29	0.30	-26.03	1.00	0.33	-36.68
UK	2.13	0.36	-40.18	1.18	0.24	-40.00	1.47	0.29	-37.77	1.00	0.08	-40.04
France	1.39	0.23	-34.28	0.79	0.15	-34.30	1.07	0.20	-33.16	1.00	0.73	-33.22
Germany	1.96	0.33	-38.73	1.01	0.21	-37.82	1.24	0.25	-35.29	1.00	0.34	-35.88
Netherlands	2.30	0.46	-30.27	1.33	0.31	-30.47	1.75	0.40	-29.49	1.00	0.03	-33.39
Switzerland	2.75	0.55	-32.60	1.70	0.38	-33.23	2.07	0.49	-31.85	1.00	0.01	-37.87
Japan	1.64	0.28	-35.60	0.93	0.18	-35.60	1.40	0.26	-35.55	1.00	0.10	-37.55
Italy	1.62	0.22	-56.48	0.96	0.15	-57.18	1.53	0.22	-58.50	1.00	0.01	-64.03
Greece	2.12	0.32	-51.24	1.27	0.21	-51.88	2.10	0.33	-53.87	1.00	<0.0001	-70.01
Portugal	2.10	0.58	-16.24	1.22	0.39	-16.28	1.83	0.55	-16.62	1.00	0.08	-19.26
Spain	1.91	0.41	-23.80	1.04	0.26	-22.48	1.39	0.35	-22.84	1.00	0.25	-23.80
Panel C: Filter =20%												
US	1.62	0.47	-12.13	0.79	0.29	-11.67	0.92	0.32	-10.54	1.00	0.81	-10.57
UK	1.52	0.38	-15.42	0.74	0.23	-14.74	0.91	0.27	-13.46	1.00	0.73	-13.51
France	2.00	0.41	-26.28	1.01	0.25	-25.48	1.24	0.31	-23.79	1.00	0.42	-24.21
Germany	2.04	0.42	-26.56	1.12	0.27	-26.29	1.41	0.34	-25.00	1.00	0.22	-26.11
Netherlands	1.26	0.34	-12.32	0.76	0.23	-12.58	0.93	0.29	-11.78	1.00	0.80	-11.81
Switzerland	1.64	0.44	-14.21	0.89	0.29	-14.07	1.04	0.34	-12.96	1.00	0.90	-12.97
Japan	1.98	0.47	-19.86	1.14	0.32	-19.97	1.66	0.43	-19.86	1.00	0.08	-22.41
Italy	2.24	0.39	-38.90	1.33	0.26	-39.31	1.76	0.35	-38.18	1.00	0.02	-43.14
Greece	2.69	0.54	-32.44	1.68	0.37	-33.08	2.23	0.51	-32.57	1.00	0.00	-40.94
Portugal	1.97	0.54	-15.81	1.15	0.36	-15.87	1.68	0.52	-16.12	1.00	0.14	-17.94
Spain	1.64	0.42	-16.36	0.97	0.28	-16.52	1.28	0.38	-16.21	1.00	0.45	-16.58
Panel D: Filter =25%												
US	0.52	0.16	-4.02	0.30	0.11	-4.13	0.49	0.16	-4.42	1.00	0.00	-6.14
UK	0.87	0.27	-6.85	0.54	0.19	-7.16	0.71	0.25	-6.80	1.00	0.19	-7.21
France	1.10	0.28	-12.90	0.66	0.19	-13.19	0.87	0.25	-12.65	1.00	0.60	-12.76
Germany	2.01	0.51	-17.84	1.22	0.35	-18.17	1.67	0.47	-17.89	1.00	0.11	-19.98
Netherlands	1.67	0.53	-10.38	1.05	0.37	-10.68	1.32	0.48	-10.26	1.00	0.49	-10.59
Switzerland	1.88	0.55	-13.08	1.09	0.37	-13.19	1.38	0.46	-12.60	1.00	0.38	-13.15
Japan	1.84	0.54	-13.05	1.10	0.37	-13.25	1.65	0.51	-13.40	1.00	0.15	-15.11
Italy	2.79	0.53	-35.25	1.71	0.37	-35.88	2.14	0.48	-34.59	1.00	0.00	-42.18
Greece	2.45	0.56	-24.23	1.43	0.38	-24.41	1.82	0.49	-23.65	1.00	0.06	-26.81
Portugal	3.07	1.30	-8.43	1.78	0.88	-8.47	1.95	1.02	-8.08	1.00	0.28	-9.14
Spain	1.35	0.37	-13.08	0.82	0.25	-13.30	1.04	0.34	-12.95	1.00	0.90	-12.96

Table 3-5. Parametric Tests of Duration Dependence in Daily Price Series (Bear Periods)

	Log-normal			Log-logistic			Weibull			Exponential		
Country	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	P-value	Log-Likelihood
Panel A: Filter =10%												
US	1.75	0.22	-61.29	1.04	0.15	-62.39	1.42	0.20	-60.02	1.00	0.03	-63.60
UK	1.59	0.19	-69.71	0.96	0.13	-71.22	1.35	0.17	-69.10	1.00	0.04	-72.15
France	1.50	0.18	-62.04	0.84	0.12	-62.15	1.12	0.16	-58.51	1.00	0.43	-58.88
Germany	1.74	0.19	-82.94	1.05	0.13	-84.73	1.44	0.18	-81.67	1.00	0.01	-87.00
Netherlands	1.93	0.28	-49.78	1.18	0.19	-51.02	1.59	0.26	-49.08	1.00	0.01	-53.86
Switzerland	1.55	0.23	-42.68	0.88	0.15	-42.86	1.26	0.21	-41.53	1.00	0.20	-42.61
Japan	1.74	0.21	-67.02	1.04	0.15	-68.29	1.40	0.19	-65.32	1.00	0.03	-68.73
Italy	1.43	0.14	-94.28	0.82	0.09	-95.02	1.13	0.12	-90.72	1.00	0.28	-91.40
Greece	1.59	0.17	-86.70	0.96	0.12	-88.69	1.42	0.16	-87.50	1.00	0.01	-93.33
Portugal	2.04	0.40	-27.69	1.17	0.28	-27.97	1.51	0.35	-26.33	1.00	0.11	-28.26
Spain	1.77	0.27	-43.73	1.05	0.19	-44.53	1.42	0.24	-46.60	1.00	0.06	-45.14
Panel B: Filter =15%												
US	1.67	0.33	-25.14	0.98	0.22	-25.44	1.39	0.30	-24.72	1.00	0.18	-26.02
UK	1.49	0.25	-32.76	0.87	0.17	-33.16	1.22	0.23	-32.02	1.00	0.33	-32.64
France	1.76	0.29	-37.71	1.03	0.20	-38.21	1.28	0.25	-35.58	1.00	0.25	-36.47
Germany	1.69	0.28	-34.96	0.92	0.19	-34.77	1.55	0.27	-35.38	1.00	0.02	-39.43
Netherlands	1.69	0.33	-25.30	0.98	0.23	-25.55	1.63	0.33	-26.10	1.00	0.03	-29.91
Switzerland	1.30	0.26	-21.88	0.79	0.18	-22.45	1.14	0.25	-22.03	1.00	0.57	-22.23
Japan	1.93	0.32	-37.38	1.13	0.22	-37.87	1.39	0.28	-35.26	1.00	0.15	-36.76
Italy	1.78	0.23	-57.93	1.07	0.16	-59.03	1.56	0.23	-58.12	1.00	0.01	-64.13
Greece	1.91	0.28	-47.51	1.18	0.20	-48.76	1.70	0.28	-47.99	1.00	0.00	-54.61
Portugal	1.12	0.30	-10.72	0.65	0.20	-10.86	0.88	0.27	-10.26	1.00	0.66	-10.34
Spain	2.01	0.41	-25.43	1.24	0.29	-26.06	1.73	0.40	-25.43	1.00	0.04	-29.04
Panel C: Filter =20%												
US	1.07	0.31	-8.92	0.61	0.21	-9.01	0.76	0.26	-8.16	1.00	0.34	-8.44
UK	2.11	0.53	-17.33	1.30	0.37	-17.73	1.65	0.49	-16.87	1.00	0.14	-18.60
France	1.58	0.32	-22.55	0.91	0.22	-22.72	1.09	0.27	-20.82	1.00	0.73	-20.88
Germany	1.98	0.40	-25.21	1.12	0.27	-25.35	1.59	0.36	-24.53	1.00	0.07	-27.12
Netherlands	1.79	0.48	-14.01	1.01	0.32	-14.05	1.32	0.41	-13.24	1.00	0.42	-13.67
Switzerland	1.16	0.31	-10.95	0.67	0.21	-11.13	0.86	0.27	-10.26	1.00	0.60	-10.36
Japan	0.71	0.17	-9.67	0.40	0.11	-9.76	0.69	0.17	-10.38	1.00	0.03	-11.29
Italy	1.71	0.29	-33.22	0.97	0.20	-33.32	1.26	0.25	-31.32	1.00	0.29	-32.04
Greece	1.78	0.35	-25.93	1.10	0.24	-26.65	1.44	0.33	-25.49	1.00	0.15	-27.00
Portugal	1.75	0.47	-13.83	1.04	0.32	-14.09	1.49	0.44	-13.76	1.00	0.24	-14.83
Spain	1.53	0.36	-16.58	0.84	0.24	-16.49	1.17	0.31	-15.72	1.00	0.59	-15.90
Panel D: Filter =25%												
US	1.50	0.48	-9.13	0.90	0.33	-9.33	1.39	0.48	-9.36	1.00	0.39	-9.89
UK	1.57	0.50	-9.35	0.99	0.35	-9.68	1.18	0.46	-8.98	1.00	0.69	-9.08
France	1.15	0.29	-12.44	0.63	0.19	-12.39	0.75	0.23	-10.99	1.00	0.25	-11.38
Germany	1.12	0.28	-12.23	0.67	0.19	-12.56	0.98	0.27	-12.33	1.00	0.95	-12.33
Netherlands	1.37	0.43	-8.68	0.87	0.31	-9.01	1.29	0.45	-9.02	1.00	0.51	-9.31
Switzerland	1.45	0.42	-10.76	0.92	0.29	-11.14	1.34	0.43	-11.05	1.00	0.41	-11.51
Japan	0.71	0.21	-6.49	0.42	0.14	-6.64	0.69	0.21	-6.94	1.00	0.08	-7.54
Italy	1.94	0.37	-29.13	1.09	0.25	-29.27	1.27	0.30	-26.71	1.00	0.35	-27.29
Greece	2.00	0.45	-21.13	1.23	0.31	-21.66	1.58	0.41	-20.60	1.00	0.13	-22.42
Portugal	1.93	0.79	-6.23	1.17	0.56	-6.38	1.30	0.68	-5.80	1.00	0.65	-5.94
Spain	1.05	0.28	-10.25	0.62	0.20	-10.51	1.05	0.30	-11.00	1.00	0.87	-11.01

Table 3-6. Parametric Tests of Duration Dependence in Daily Real Price Series (Bull Periods)

	Log-normal			Log-logistic			Weibull			Exponential		
Country	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	P-value	Log-Likelihood
Panel A: Filter =10%												
US	2.09	0.27	-65.63	1.20	0.18	-66.01	1.67	0.24	-64.16	1.00	0.00	-72.54
UK	1.79	0.20	-85.26	1.01	0.13	-85.34	1.50	0.18	-84.50	1.00	0.00	-91.39
France	1.83	0.22	-72.17	1.03	0.15	-72.01	1.47	0.20	-70.52	1.00	0.01	-75.40
Germany	1.84	0.21	-82.32	1.12	0.14	-83.95	1.60	0.20	-82.92	1.00	0.00	-91.54
Netherlands	2.02	0.27	-62.61	1.16	0.18	-62.92	1.49	0.23	-59.88	1.00	0.02	-63.93
Switzerland	1.85	0.26	-51.78	1.06	0.18	-52.01	1.45	0.23	-50.30	1.00	0.04	-53.48
Japan	1.96	0.24	-72.23	1.16	0.16	-73.23	1.57	0.22	-70.81	1.00	0.00	-77.16
Italy	1.52	0.14	-106.08	0.85	0.09	-105.65	1.41	0.14	-108.57	1.00	0.00	-116.11
Greece	1.58	0.16	-89.38	0.96	0.11	-91.38	1.37	0.16	-90.18	1.00	0.01	-94.43
Portugal	1.96	0.39	-28.46	1.16	0.27	-28.71	1.79	0.39	-29.36	1.00	0.02	-34.14
Spain	1.93	0.30	-44.93	1.13	0.20	-45.29	1.72	0.29	-45.69	1.00	0.01	-52.43
Panel B: Filter =15%												
US	1.77	0.31	-34.89	1.00	0.21	-34.94	1.39	0.27	-33.95	1.00	0.13	-35.67
UK	1.80	0.30	-37.16	0.97	0.20	-36.70	1.27	0.25	-34.86	1.00	0.27	-35.68
France	2.07	0.33	-44.03	1.19	0.22	-442.12	1.57	0.29	-42.67	1.00	0.03	-46.20
Germany	1.62	0.27	-35.20	0.88	0.17	-34.67	1.08	0.22	-32.21	1.00	0.72	-32.28
Netherlands	2.30	0.46	-30.27	1.33	0.31	-30.47	1.75	0.40	-29.49	1.00	0.03	-33.39
Switzerland	2.44	0.50	-28.71	1.47	0.35	-29.17	1.77	0.44	-27.77	1.00	0.05	-30.98
Japan	1.62	0.27	-35.34	0.92	0.18	-35.37	1.36	0.25	-35.21	1.00	0.13	-36.86
Italy	1.79	0.23	-63.27	1.05	0.15	-63.83	1.57	0.22	-63.95	1.00	0.00	-70.29
Greece	2.02	0.29	-54.39	1.22	0.20	-55.23	1.90	0.29	-56.33	1.00	0.00	-68.32
Portugal	1.93	0.50	-17.79	1.11	0.33	-17.80	1.76	0.49	-18.49	1.00	0.08	-21.21
Spain	1.91	0.41	-23.78	1.03	0.26	-23.45	1.38	0.35	-22.82	1.00	0.25	-23.76
Panel C: Filter =20%												
US	1.66	0.40	-18.23	0.87	0.25	-17.85	1.16	0.32	-17.09	1.00	0.60	-17.27
UK	1.45	0.31	-20.59	0.87	0.21	-20.94	1.17	0.28	-20.37	1.00	0.54	-20.61
France	1.47	0.30	-22.69	0.89	0.21	-23.11	1.12	0.27	-22.07	1.00	0.66	-22.18
Germany	1.56	0.31	-25.34	0.93	0.21	-25.66	1.27	0.29	-25.23	1.00	0.34	-25.84
Netherlands	1.76	0.45	-16.78	1.04	0.31	-16.99	1.32	0.39	-16.31	1.00	0.38	-16.84
Switzerland	1.62	0.44	-14.15	0.91	0.29	-14.11	1.11	0.35	-13.27	1.00	0.08	-13.32
Japan	1.98	0.47	-19.88	1.15	0.32	-20.01	1.67	0.43	-19.92	1.00	0.08	-22.55
Italy	2.21	0.40	-36.54	1.32	0.27	-36.98	1.71	0.36	-35.84	1.00	0.03	-39.95
Greece	2.60	0.50	-34.41	1.62	0.34	-35.09	2.27	0.49	-35.03	1.00	0.00	-45.22
Portugal	2.11	0.63	-14.06	1.24	0.42	-14.15	1.72	0.58	-14.20	1.00	0.16	-15.83
Spain	1.98	0.51	-17.86	1.10	0.33	-17.73	1.40	0.42	-17.15	1.00	0.32	-17.85
Panel D: Filter =25%												
US	1.27	0.37	-10.61	0.68	0.24	-10.49	0.91	0.29	-9.90	1.00	0.75	-9.94
UK	0.94	0.24	-11.67	0.59	0.17	-12.11	0.81	0.22	-11.80	1.00	0.37	-12.07
France	1.62	0.37	-19.95	0.94	0.25	-20.10	1.10	0.31	-18.77	1.00	0.74	-18.83
Germany	1.87	0.45	-19.38	1.13	0.31	-19.71	1.50	0.41	-19.24	1.00	0.19	-20.58
Netherlands	1.86	0.54	-13.05	1.09	0.37	-13.17	1.38	0.46	-12.61	1.00	0.39	-13.14
Switzerland	1.63	0.44	-14.21	0.93	0.29	-14.24	1.14	0.36	-13.44	1.00	0.69	-13.54
Japan	1.98	0.58	-13.49	1.20	0.40	-13.73	1.76	0.55	-13.83	1.00	0.11	-16.01
Italy	2.12	0.46	-64.84	1.16	0.30	-24.64	1.38	0.37	-23.16	1.00	0.27	-24.02
Greece	2.14	0.55	-18.47	1.23	0.37	-18.55	1.53	0.47	-17.88	1.00	0.22	-19.03
Portugal	2.45	0.90	-10.15	1.32	0.59	-10.07	1.49	0.69	-9.57	1.00	0.46	-9.99
Spain	1.36	0.37	-13.11	0.82	0.25	-13.33	1.05	0.34	-13.00	1.00	0.88	-13.01

Table 3-7. Parametric Tests of Duration Dependence in Daily Real Price Series (Bear Periods)

Panel A: Filter =10%

	Log-normal			Log-logistic			Weibull			Exponential		
Country	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	Std Error	Log-Likelihood	Estimate	P-value	Log-Likelihood
US	1.94	0.25	-62.44	1.16	0.17	-63.63	1.65	0.24	-62.05	1.00	0.00	-69.62
UK	1.47	0.16	-75.65	0.83	0.11	-75.89	1.11	0.14	-71.45	1.00	0.44	-71.79
France	1.37	0.16	-60.64	0.77	0.11	-60.80	1.07	0.14	-57.95	1.00	0.64	-58.07
Germany	1.86	0.21	-81.48	1.13	0.14	-83.32	1.50	0.19	-79.73	1.00	0.01	-85.70
Netherlands	1.86	0.24	-59.18	1.10	0.17	-60.19	1.54	0.23	-58.24	1.00	0.01	-63.73
Switzerland	1.83	0.26	-50.55	1.06	0.12	-51.13	1.41	0.23	-48.53	1.00	0.06	-51.08
Japan	1.73	0.21	-66.81	1.04	0.14	-68.14	1.44	0.20	-65.92	1.00	0.02	-70.09
Italy	1.57	0.15	-106.69	0.92	0.10	-108.07	1.21	0.13	-102.02	1.00	0.11	-103.63
Greece	1.64	0.17	-89.81	0.98	0.12	-91.53	1.43	0.16	-89.85	1.00	0.00	-95.80
Portugal	2.12	0.42	-28.24	1.22	0.29	-28.52	1.56	0.36	-26.84	1.00	0.09	-29.12
Spain	1.73	0.26	-43.29	1.01	0.18	-43.88	1.35	0.23	-41.76	1.00	0.12	-43.49
Panel B: Filter =15%												
US	1.84	0.32	-34.49	1.05	0.21	-34.71	1.45	0.28	-33.30	1.00	0.09	-35.45
UK	1.38	0.23	-31.34	0.85	0.16	-32.25	1.27	0.23	-32.11	1.00	0.23	-33.09
France	1.78	0.28	-39.90	1.05	0.19	-40.54	1.31	0.25	-37.89	1.00	0.19	-32.07
Germany	1.91	0.32	-37.18	1.08	0.22	-37.35	1.74	0.31	-37.63	1.00	0.01	-44.20
Netherlands	1.70	0.33	-25.37	0.99	0.23	-25.63	1.62	0.34	-26.13	1.00	0.04	-29.51
Switzerland	1.53	0.31	-22.12	0.91	0.21	-22.55	1.50	0.32	-23.12	1.00	0.10	-25.23
Japan	2.16	0.36	-39.43	1.30	0.25	-40.18	1.61	0.32	-37.77	1.00	0.04	-41.23
Italy	1.82	0.23	-62.51	1.07	0.16	-63.44	1.51	0.21	-61.52	1.00	0.01	-66.54
Greece	2.03	0.29	-53.14	1.25	0.20	-54.44	1.81	0.28	-53.72	1.00	0.00	-62.97
Portugal	1.13	0.28	-12.36	0.67	0.19	-12.59	0.95	0.27	-12.16	1.00	0.84	-12.17
Spain	2.08	0.43	-25.84	1.30	0.30	-26.53	1.72	0.40	-25.54	1.00	0.05	-28.81
Panel C: Filter =20%												
US	1.50	0.35	-16.45	0.94	0.25	-16.99	1.26	0.34	-16.31	1.00	0.43	-16.71
UK	2.03	0.43	-23.40	1.20	0.30	-23.73	1.57	0.39	-22.59	1.00	0.11	-24.59
France	1.62	0.33	-22.82	0.84	0.22	-22.41	0.95	0.25	-19.83	1.00	0.85	-19.85
Germany	1.91	0.37	-26.86	1.07	0.25	-26.92	1.67	0.35	-26.78	1.00	0.03	-30.59
Netherlands	1.61	0.40	-15.16	0.97	0.28	-15.47	1.42	0.39	-15.25	1.00	0.25	-16.24
Switzerland	1.22	0.33	-11.31	0.72	0.23	-11.53	0.91	0.29	-10.66	1.00	0.76	-10.71
Japan	0.66	0.16	-9.01	0.38	0.11	-9.18	0.67	0.17	-9.99	1.00	0.01	-11.07
Italy	1.78	0.31	-31.94	1.01	0.21	-32.03	1.26	0.26	-29.74	1.00	0.32	-30.39
Greece	1.85	0.35	-28.48	1.16	0.25	-29.33	1.50	0.33	-28.01	1.00	0.11	-29.97
Portugal	1.27	0.37	-9.96	0.80	0.26	-10.34	1.13	0.37	-10.13	1.00	0.71	-10.21
Spain	1.51	0.36	-16.48	0.76	0.22	-15.95	1.02	0.28	-14.81	1.00	0.94	-14.82
Panel D: Filter =25%												
US	0.95	0.27	-8.19	0.56	0.19	-8.30	0.73	0.25	-7.73	1.00	0.22	-8.12
UK	2.04	0.51	-17.06	1.24	0.35	-17.41	1.64	0.48	-16.70	1.00	0.14	-18.43
France	1.33	0.30	-17.07	0.73	0.20	-17.01	0.85	0.24	-15.10	1.00	0.51	-15.26
Germany	1.37	0.32	-15.61	0.83	0.22	-15.99	1.33	0.33	-16.32	1.00	0.30	-17.06
Netherlands	1.16	0.34	-9.41	0.72	0.24	-9.77	0.96	0.32	-9.27	1.00	0.89	-9.28
Switzerland	1.48	0.40	-12.70	0.94	0.28	-13.18	1.23	0.38	-12.56	1.00	0.55	-12.80
Japan	0.73	0.21	-6.63	0.43	0.14	-6.82	0.68	0.21	-6.89	1.00	0.01	-7.54
Italy	1.80	0.38	-22.09	0.94	0.24	-21.63	1.16	0.30	-19.81	1.00	0.59	-19.98
Greece	1.85	0.46	-16.28	0.96	0.29	-15.95	1.17	0.36	-14.55	1.00	0.64	-14.68
Portugal	1.59	0.56	-7.53	0.99	0.39	-7.77	1.26	0.53	-7.34	1.00	0.62	-7.51
Spain	0.94	0.25	-9.49	0.58	0.18	-9.88	0.79	0.24	-9.41	1.00	0.36	-9.69

4. Using Survival Analysis Approach to Model the Duration of Sovereign Debt Default

Empirical work, so far, has been concentrated on investigating the importance of various economic factors in establishing the debt servicing capacity of borrowers. This study adds a new dimension to the existing literature in that it focuses on the length, or more specifically, the duration of a default period. The paper investigates the effect of certain macroeconomic and balance sheet variables on the duration of three types of debt, namely foreign currency bank debt, local currency debt and foreign currency bond debt by utilizing a survival analysis approach. The findings suggest that both macroeconomic and balance sheet variables contribute to some extent in predicting the length of default of the three types of debt. In addition, for all three types of debt, the fit of the model is improved by combining macroeconomic and balance sheet variables in one model. However, the explanatory power of this model as illustrated by the likelihood ratio statistic is best for foreign currency bank debt default.

4.1 Introduction

Beginning in the mid-1970s, with the rapid growth in sovereign external debt, debt servicing problems have become a topic of considerable importance. Due to the increase in international lending, banks have devoted a significant amount of work to assessing country credit risk. In the banking area, with the international banking system being a major creditor of less-developed countries (LDCs), country risk analysis has become essential. Goodman (1977) surveys the different methods of country risk analysis used by big US banks and finds that the banks employ methods ranging from fully qualitative to quantitative evaluation methods. With regards to less developed countries, several studies have been performed to study and predict debt servicing problems. One of the most recent studies carried out by Somerville and Taffler (2001) reviews the different empirical studies dealing with debt servicing problems. The main focus of previous studies has been on specifying statistical methods to determine a country's debt servicing capacity or rescheduling probabilities. Empirical work has been focused on investigating the importance of various economic factors in establishing the debt servicing capacity of borrowers. This study adds a new dimension to the existing literature in that it focuses on the length, or more specifically, the duration of a sovereign debt default period.

The aim of this paper is to investigate the effect of certain macroeconomic and balance sheet variables on the duration of three types of debt, namely foreign currency bank debt, local currency debt and foreign currency bond debt. The sample of emerging market sovereign issuers in default comes from the Standard & Poor's database and runs from 1975 to 2004. Default, as defined by Standard & Poor's is "the failure to meet a principal or interest payment on the due date (or within the specified grace period) contained in the original terms of the debt issue." In addition to defining default, Standard & Poor's clarifies the area of foreign currency bonds with the issuer being considered in default when either the scheduled debt service is not paid on the due date, or an exchange offer of new debt contains terms that are less favourable than the original issue. For bank loans, the issuer is in default when either the scheduled debt service is not paid on the due date or a rescheduling of principal and/or interest is agreed to by creditors at less favourable terms than the original loan.

Such rescheduling agreements covering short and long-term bank debt are considered defaults even when, for regulatory reasons, creditors deem forced rollover of principal to be voluntary.

An article published by Standard & Poor's titled "Sovereigns defaults set to fall again in 2005" estimates that the number of rated and unrated sovereigns in default on bonds and bank loans has decreased from 2004. The history of sovereign defaults over the past 30 years has been mostly the default on foreign currency bank debt. Standard & Poor's identified 82 sovereigns that have defaulted on their foreign currency bank debt while 17 have defaulted on their foreign currency bond debt. There was a total of 15 issuers who defaulted on both their foreign currency bank and bond debt.

It is only quite recently that the pace of default on foreign currency bonds has started to pick up. Standard & Poor's has proposed a number of reasons for the convergence of default rates on bond and bank debt. Some of those are the repayment of large amounts of bank debt through Brady bond exchanges and buybacks, the low volume of new cross-border bank lending to governments, and increasing new bond issuance by sovereigns of lesser credit quality. The default on local currency has been less than the default on foreign currency as evidenced in the Standard & Poor's database, where 24 issuers have been found to default on their local currency obligation. Defaults that come under the heading of local currency default are defaults on central bank notes that take the form of partial conversion into new currency (as in Ghana in 1979 and 1982), and defaults on bonds as reflected in the unilateral extension of maturities (as in Russia and Ukraine), arrears on debt service (Gabon), the redenomination of foreign currency debt into local currency debt (as in Argentina in 2002), or the abrogation of inflation-linked indexes embedded in the terms of the issues (as in Brazil in 1986-1987 and 1990).

In this study, we use a survival analysis approach to specify an appropriate model for the survival data. According to R.G. Miller (1981), survival analysis is a loosely defined statistical term that encompasses a variety of statistical techniques for analysing positive-valued random variables. Typically the value of the random variable is the time to occurrence of an event. Event occurrence represents an individual's transition from the one "state" to another "state." Thus, the value of the random variable is the length of time that elapses from the beginning of the event until its end or until the measurement is taken which may precede termination. The only requirement for survival analysis is that, in any particular research setting, the states be both mutually exclusive (non-overlapping) and exhaustive. In this paper the event of interest is defined as the length of time it takes for a country to leave the state of default, given that it is already in default.

Our findings reveal that the length of a default period depends on macroeconomic variables as well as balance sheet variables for all types of debt default. Models that include only macroeconomic variables are good in that they have some explanatory power. However, when balance sheet variables are added to the macroeconomic model, we find that the explanatory power increases, although not by a significant amount.

The rest of this chapter is organised as follows. Section 2 reviews the literature on the origins of debt and debt servicing capacity and explores the theory behind survival analysis. Section 3 describes the data and methodology. Section 4 presents the empirical results and section 5 concludes.

4.2 Literature Review

Survival analysis has not been used extensively in financial economics. In business, survival analysis has been used to mark the transition from contraction to expansion cycles and vice versa (Sichel, 1991). It has also been used in stock cycles to denote the transition from a bull to a bear market or vice versa (McQueen and Thorley, 1994). In the banking field, a study by Thomas, Thomas, Tang and Bozetto (2003) employed survival analysis to study customers' financial policy purchase. This changed the objective from the traditional marketing focus of whether or not customers would purchase financial products to estimating how long customers would wait before their next purchase (Thomas *et al.*, 2003).

However, as far as we can ascertain, no studies have been done that use a survival analysis approach to model the length of default of sovereign markets. Empirical work that has been done so far on sovereign debt has focused mainly on the debt crisis, predicting debt rescheduling and measuring debt servicing capacity, and the relationship between sovereign ratings and default or currency crises. We include in Appendix I a comprehensive background on survival analysis and its related applications.

4.2.1 Origins of the Debt Crisis

The origins of the debt crisis lie in the mid-1970s, when a combination of oil price shocks, high prices for commodities, and low real interest rates led many lending and borrowing countries to contract loan obligations which proved unsustainable when these conditions changed. Overly optimistic assumptions about economic growth, declining terms of trade, inappropriate domestic economic policies, petro-dollar recycling, corruption, and excessive military expenditure contributed to the building crisis. By the early 1980s, many countries in the developing world were experiencing difficulties in meeting their obligations as real interest rates rose, commodity prices fell, and the world entered a recession. Although some countries were successful in responding to these problems, others did not adjust quickly.

1982-1985: First Stage

The size and structure of developing country debt began to change during the 1982-1985 period. Large middle-income countries owed a considerable fraction of their debt to major commercial banks. In the beginning, there was real concern that a default would undermine the international banking system, as the debt often exceeded the capital base of many of these private institutions. Official creditors held most of the remaining debt. At this stage, most debtor and creditor governments and the financial community believed the debt crisis was due to short-term liquidity problems. They thought that short-term debt relief, such as extended repayment periods, combined with new money and macroeconomic reforms would be enough to return these countries to international creditworthiness and enhance their ability to finance economic growth. Large middle-income countries such as Brazil and Mexico were the focus of attention as they presumably posed the greatest threat to the world financial system.

Recognizing the uniqueness of each debtor country's debt situation, economy, and debt service capacity, creditor governments agreed to manage the debt crisis on a case-by-case basis. They also agreed that such a debt strategy should be supported by more open markets for trade and defined by sound economic reform as the basis for sustainable economic growth. The IMF and, to a lesser degree, the World Bank, were to be key players in the debt strategy. Their international "seal of approval" would ensure the establishment of economic reform programmes that would trigger both new money and debt relief from official and commercial creditors. Commercial banks and the Paris Club were also to have important roles in organizing debt restructuring in support of these programmes.

1985-1989: Second Stage

As commercial banks improved their balance sheets in the mid-1980s, the default of middle-income debtors posed less of a threat to the financial system. At the same time, it became evident that many debtors' economic problems were more structural than had been assumed earlier and required a longer-term response from debtors and creditors alike. Social and political factors delayed or undermined the implementation of reforms. Furthermore, private capital from within these countries fled abroad seeking greater and more secure rates of return. The absence of adequate domestic reform exacerbated the problem of capital flight and thus compounded the balance of payment difficulties. Although creditors revised debt rescheduling terms to provide a number of services such as longer repayment periods, capitalisation of interest by official lenders, and new lending by commercial banks and international financial institutions, they did not provide for debt or debt service reduction.

Introduced in 1985, the Baker Plan made new money available to sustain the levels of investment necessary to restore growth and thus allow the major debtors to outgrow their debt. Negotiations between debtor countries and creditor institutions led to an agreement on a "menu of options." The debt problem of the poorer developing countries was qualitatively different from that of the large middle-income countries. Many of the debt-distressed poor countries had a larger debt burden in relation to their economic size and potential. Moreover, these countries relied heavily on the export earnings of one or two commodities. A significant decline in the terms of trade for these commodities during the first half of the decade severely impaired the countries' capacity to service debt or resume growth.

1989 to Present: Third Stage

In early 1989, it was suggested that the international financial institutions use their resources to help debtor countries exchange old commercial debt for new, government-backed bonds. The benefit would be a significant reduction in the principal or in the interest rate payable of the new debt.

The Brady Plan acknowledged the need to combine the objectives of the debt strategy with those of development policies. The Brady Plan proposals also recognized that the debtors had to adopt policies to attract both direct and indirect investment and that debt/equity swaps could be a useful component of such a strategy. Several Latin American countries used other debt conversion mechanisms, such as debt buy-back and debt-for-nature swaps. The 1988 Toronto Economic Summit urged the Paris Club to adopt new measures, now known as the "Toronto Terms," for easing the debt burdens of the poorest countries. These terms provided for either debt or debt service reduction or extended repayment periods for official bilateral debt. At the Houston Economic Summit in 1990, the Group of Seven asked the Paris Club to review the Toronto Terms' implementation and to consider assisting lower-middle-income countries. Because the commercial debt of the poorest countries is small in absolute terms, future measures to help these debt-distressed countries must emphasize grant or highly concessional external finance as well as greater debt reduction.

4.2.2 Sovereign Credit Ratings

Country risk has become increasingly the focus of attention of not only banks and international institutions, but also governments. Country risk has become a topic of rising importance over the last 20 years with the increasing indebtedness of less developed countries and the escalating incidence of debt rescheduling being forced to the forefront. Country risk reflects the ability and willingness of a country to service its financial obligations and as such, assessment of country risk is of vital consequence to the international financial community.

Hoti and McAleer (2004) review the literature relating to empirical country risk models according to established statistical and econometric criteria used in estimation, evaluation and forecasting. This study reviews 50 published empirical studies on country risk and finds that the literature is essentially two decades old. In addition, the authors find that there is no leading journal in the literature on country risk.

Another study done by Saini and Bates (1984) surveys the quantitative approaches to country risk analysis and provides a review of the various shortcomings of the empirical studies with respect to the definition of the dependent variable, the quality and availability of data, specification of models, appropriateness of statistical procedures, and the ability to adequately forecast debt servicing difficulties based on the analysis of past experience.

A primary function of country risk assessment is to anticipate the possibility of debt repudiation, default or delays in payment by sovereign borrowers. Commercial risk rating agencies have compiled sovereign ratings as measures of credit risk associated with sovereign countries. Calverley (1990) surveys the methods used to assess country credit-risk, which range from desk research and country visits, through checklist systems, scenario analysis, scoring systems, and multivariate techniques, to formal country specific econometric models.

If the credit rating agencies use all available information on the economic "fundamentals" to form their rating decisions, then credit ratings should help predict defaults if the macroeconomic indicators on which the ratings are based have some predictive power. Recent studies have found that the determinants of credit ratings provide support for the basic premise that ratings are linked with certain economic fundamentals. Cosset and Roy (1991) find that country risk ratings respond to some of the macroeconomic variables suggested by theory. In particular, they find that both the level of per capita income and propensity to invest affect positively the rating of a country. Cantor and Packer (1996a) found that per capita GDP, inflation, external debt, indicators of default history and economic development are all significant determinants of sovereign ratings.

Trevino and Thomas (2000) researched the statistical determinants of local currency sovereign ratings and concluded that the criteria underlying local currency sovereign ratings were consistent with a theoretical framework relating external and domestic debt whereby the fiscal balance, the income per capita and the rate of inflation played a significant role in explaining the ratings. In looking at foreign currency ratings, Trevino and Thomas's (2000) empirical results indicated that economic fundamentals played a significant role in determining a sovereign's foreign currency credit rating. In addition, the study found that financial balance sheet variables were also significant explanatory variables of foreign currency credit ratings. The authors also found that systematic differences existed in foreign currency sovereign credit ratings across rating agencies and across geographic regions. Different rating agencies used different criteria and different weightings to determine credit ratings. Moreover, the agencies differed in the ratings they gave to sovereigns within specific geographic regions and while analysing the agencies individually, the authors found that identical foreign currency ratings from different agencies conveyed different information.

Sovereign credit ratings play an important part in determining countries' access to international capital markets and the terms of that access. In principle, there is no reason to expect that sovereign credit ratings should systematically predict currency crises. In practice, however, in emerging market economies there is a strong link between currency crises and default. Hence if credit ratings are forward-looking and currency crises in emerging market economies are linked to defaults, it follows that downgrades in credit ratings should systematically precede currency crises. A study by Reinhart (2002) shows that sovereign ratings systematically fail to predict currency crises but do considerably better in predicting defaults. Downgrades in credit ratings usually follow currency crises, possibly suggesting that currency instability increases the risk of default.

As more countries are added to the list of rated sovereigns, the information content of ratings becomes more important. Sovereign credit ratings are taken as indicators of the likelihood that a country will default. Hence, it is hardly surprising that those countries with the lowest ratings are those that are unable to borrow from international capital markets and are dependent on official loans from multilateral institutions or governments. In a cross-sectional setting sovereign credit ratings play a crucial role in distinguishing across borrowers.

4.2.3 Previous studies on Debt Servicing Capacity

The literature on predicting debt servicing problems of less-developed countries is as old as that on country risk which makes sense as the two research areas are complementary. Frank and Cline (1971) were among the first researchers to find a way of measuring debt servicing capacity. Their aim was to find an index or indicator which was both simple and could predict very well the likelihood that a less developed country would experience debt servicing difficulties. The methodology used consisted of a discriminant analysis which took into account the differences in variability of the factors used to device the index among debt rescheduling countries by assigning each observation to one of two possible populations: default or non-default. Frank and Cline used eight indicators of debt servicing capacity, namely the debt service ratio, the growth rate of exports, an export fluctuation index, the ratio of non-compressible imports to total imports (non-compressible imports were essentially intermediate goods, capital goods and basic foodstuffs), per capita income, the ratio of debt amortization to total outstanding debt, the ratio of imports to Gross National Product, and the ratio of imports to reserves. Their results showed that it was possible to obtain very high prediction rates using the debt service ratio, the imports to reserve ratio and the ratio of debt amortization to total outstanding debt.

Feder and Just (1977) expanded on Frank and Cline's paper to try and identify the more important economic factors which were determinants of default probabilities. They used logit analysis to assume that a discrete 'event' took place after the combined effect of certain economic variables reached some threshold level. This study used nine economic indicators of debt servicing capacity, an improvement on the number of indicators used by Frank and Cline. Seven of those indicators were the same as those used in the Frank and Cline study. The other two indicators were capital inflows and growth of per capita domestic product. Capital flows were thought to be important because they took the form of loans, grants, direct investments and transfer payments and were considered to be an essential source of foreign exchange receipts which could be used for debt service. Growth of per capita domestic product was considered a factor influencing debt service capacity in the long run. The results of the study showed that, in addition to the three significant predictors in the Frank and Cline paper, per capita income, export growth and capital inflows were also important predictors of debt servicing capacity.

Taffler and Abassi (1984) describe the development of an operational discriminant model for predicting debt rescheduling among developing countries that combine both indicators of monetary policy and debt servicing capacity. The function derived consisted of four variables, two measuring debt servicing capacity directly and the other two monetary policy indicators. The model was found to exhibit ex ante predictive ability and to be quite robust to the major structural changes in the economic environment since it was developed.

Lloyd-Ellis, McKenzie and Thomas (1989) improved on the logit model set up by Feder, Just and Ross (1981), Cline (1984) and Avramovic (1958). Up until the Lloyd-Ellis *et al.* paper researchers had focused on a set of traditional 'ratio' variables. The authors introduced new variables which reflected a country's balance sheet structure more accurately. These variables were available with only a short publication lag as compared to the traditional variables which sometimes took up to several years to be published. The authors also introduced variables to capture changes in attitudes as well as in the terms and conditions available from rescheduling. In the 1970's and 1980's, developing countries had to service their debts before they could seek a rescheduling. However, changing attitudes made debtors aware that they could get better terms by rescheduling. Thus, this meant that it was sometimes optimal to default or reschedule. The results of the Lloyd-Ellis *et al.* study indicated that both traditional macroeconomic variables and country balance sheet variables made a significant contribution to predicting rescheduling. Moreover, changes in attitudes had a say in whether to reschedule or not.

Bäcker (1992) used the same model as Lloyd-Ellis *et al.* to predict rescheduling but lengthened the prediction lag period. The author found that a longer prediction lag improved the significance of the macroeconomic variables relative to the balance sheet data. He concluded that macro variables were proxies for more fundamental longer-term determinants of a country's solvency while balance sheet variables provided more information about the country's current liquidity.

All models used in previous debt servicing studies have been probability-based models such as probit, logit, discriminant, linear or log-linear regression models. Survival analysis has not been used extensively in financial economics. In the business field, survival analysis has been used to mark the transition from contraction to expansion cycles and vice versa (Sichel, 1991). It has also been used in stock cycles to denote the transition from a bull to a bear market or vice versa (McQueen and Thorley, 1994). However, as far as we can ascertain, there are no studies of sovereign issuers that use a survival analysis approach to model the length of debt default, of sovereign issuers.

4.3 Data & Methodology

4.3.1 Description of Independent Variables

The independent variables include eleven macroeconomic variables (Table 4-1) and seven balance sheet variables (Table 4-2). A brief description of these variables follows and their expected effect on the hazard function and length of default is presented in Table 4-3.

Macroeconomic Variables

A. Debt Service Ratio

The debt service ratio is the most commonly used indicator of debt servicing capacity. It is defined as the ratio of total debt service to exports of goods and services. The data is from the World Development Indicators database of the World Bank and runs from 1975 to 2002. The justification for the use of the debt service ratio as an indicator of debt servicing capacity is that an increase in the debt service ratio indicates increased vulnerability to foreign exchange crises. Frank and Cline (1971) state that any shortfall in foreign exchange earnings or capital imports which is not covered by exchange reserves must be met by reducing imports. Since debt service is a fixed obligation, the higher the debt service ratio, the greater is the relative burden on import reduction for a given shortfall in foreign exchange. Therefore, a country that is already in default would have a hard time meeting its debt obligations. However, we have to be cautious in interpreting the debt service ratio. All the ratio does is indicate the proportion of foreign exchange earnings that are free to purchase imports. If foreign exchange earnings are high relative to import demand, a high debt service ratio can be maintained. In addition, a country with good credit standing in international money markets may be able to finance a high debt service ratio by a high level of borrowing. Furthermore, a high ratio of debt service to exports may be perfectly acceptable if there exist current account surpluses which enable the debt service to be met.

B. Export to GDP ratio

This ratio is a long-term indicator of economic growth financed by foreign capital. A high export to GDP ratio can show that high earnings of foreign capital can provide for continuous servicing of external debt. Thus, with a reduction in debt servicing problems, this can mean that if a country is in default, it would have a higher propensity to become default free. This independent variable is obtained from the World Bank World Development Indicators database and covers the period 1975-2002.

C. Exports

The debtor country must be able to service its debt and the way to do so is to have an amount of domestic income and earnings equivalent to the debt service. The country is then be in a position to convert that domestic income into the required foreign exchange and this is mainly achieved through exports. A country with a high level of exports will usually be seen as being capable of servicing its debt, and will therefore not stay in default long if it is already in that state. The exports variable is retrieved from the IFS database and covers the period 1975 to 2003.

Countries that have pursued outward-oriented policies and have experienced favourable terms of trade have avoided debt problems. These countries have done so by raising their payment capacity through the rapid expansion of exports. This view is exemplified by countries that have been able to reduce their debt burdens relative to exports in the 1980's when growth of exports was higher than growth of interest payments. In general, economies which pursue export-led growth as opposed to a strategy of import substitution grow faster, industrialise sooner and have higher rates of productivity growth. This is due to a strong and positive association between growth in exports and growth in output. Exports act as a source of growth because they result in technological diffusion and permit exposure to larger markets and greater competition.

D. Exports Growth Rate

A country with a high exports growth rate is less likely, all else equal, to default on its debt as exports are the main source of foreign exchange earnings which can be used to service debt. Four-year growth rates are calculated and averaged over the 8 years preceding the year of observation.

E. Imports

An increase in the level of imports which cannot be supported by foreign exchange earnings might result in a debtor country not being able to service its debt and staying for a longer time in default. Imports from 1975 to 2003 are extracted from the IFS database.

F. Fiscal Balance

A large fiscal deficit suggests that a government is not able or willing to tax its citizenry to cover current expenditures or to service its debt. The higher the government deficit is, the lower its perceived ability to service debt, and so a country in default will be susceptible to staying in that state for a longer period. Fiscal balance is calculated as the average annual central government deficit (-) or surplus (+) relative to GDP for the previous year. The data comes from the IFS database and covers the period 1975 to 2001.

G. Inflation

A high rate of inflation points to structural problems in the government's finances. When a government appears unable or unwilling to pay for current budgetary expenses through taxes or debt issuance, it must resort to inflationary monetary policies. Increases in price which may have adverse effects on investment and growth may undermine popular support for government and are fertile ground for a sovereign local currency default. Countries that are in default and present a high rate of inflation would tend to stay in default for a longer period. Inflation is calculated as the average Consumer Price Inflation rate for the previous three years. It is extracted from the IFS database for the period 1975-2001.

H. Real GDP Growth

Real GDP growth is calculated at the average annual real GDP growth on a year by year basis for the previous four years. A relatively high rate of economic growth suggests that a country's existing debt burden will become easier to service over time. A country with a high real GDP growth would be an indication that a default period will not last very long. The variable is obtained from the IFS database for the period 1975-2001.

I. Imports to Reserves Ratio

Reserves include gold, holding of dollars or sterling and net position at the IMF which is the ceiling of permissible borrowing less the amount of borrowings already incurred. A larger ratio of imports to reserves suggests a lower debt servicing capacity and by extension, a longer default period. The data is extracted from the IFS database for the period 1975 to 2003.

J. GDP per Capita

Sovereigns with low GDP per capita may be less able to solve debt service difficulties and this might indicate a longer default period. The variable comes from the IMF World Economic Outlook database and covers the period 1981-2004.

K. External Debt to Exports Ratio

A high external debt to exports ratio is more likely to result in debt servicing problems and to cause a longer default period. This ratio is calculated as the total external debt relative to exports for the previous year. The external debt variable comes from the OECD, External Debt Statistic database and cover the period 1982 to 2002.

Balance Sheet variables

The following balance sheet variables are used in the study:

1. Long-term debt relative to Total Bank borrowing
2. Medium-term debt relative to Total Bank borrowing
3. Short-term debt relative to Total Bank borrowing
4. Country's total bank debt relative to total bank lending for the sample
5. Undisbursed credit commitments[5] relative to Total Bank Debt
6. Foreign Exchange Reserves relative to IMF Quota
7. Use of IMF Credit relative to IMF Quota

The fist five variables are obtained from the Bank for International Settlement (BIS) database while the last two variables come from the IFS database. The period covered is 1983 to 2002.

From Kindleberger's (1978) and Minsky's (1982) description of financial crises, it is hypothesised that, in response to a deteriorating cash-flow position, liquid assets, which are, foreign exchange reserves and undisbursed credit commitments will fall. IMF credit may then be sought as banks begin to extend only short-term loans. If the crisis is country-specific its own debt relative to total debt will fall. Therefore, higher levels of foreign exchange reserves, undisbursed credit commitments and long-term debt relative to total bank debt show an ability to service debt and indicate that a default period might be curtailed soon. On the other hand, high levels of short-term debt relative to total bank debt and a higher ratio of use of IMF credit to IMF quota should result in poor debt service capability and thus a longer default period.

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[5] Undisbursed credit commitments and backup facilities refer to the unutilised portions of (i) binding contractual obligations, including guarantees; and (ii) commitments which reporting banks would regard themselves as obliged to honour whatever the circumstances. Only those commitments which, if utilised, would give rise to an international claim are reported.

4.3.2 Methodology

This paper aims at modelling the duration of default of certain emerging market countries as a function of several potential explanatory variables. The variable of interest in the analysis of duration is the length of time that elapses from the beginning of some event either until its end or until the measurement is taken, which may precede termination of the study. The process being observed may have begun at different points in calendar time for the different individuals in the sample. In this paper, the dependent variable is the length of time that a country has defaulted on its foreign currency bank debt, or local currency debt or foreign currency bond debt. This data comes from the Standard & Poor's database and covers the period 1975 to 2004.

All of the standard approaches to survival analysis are probabilistic or stochastic. That is, the times at which events occur are assumed to be realisations of some random process. It follows that T, the event time for some particular country, is a random variable having a probability distribution. There are many different models for survival data, and what often distinguishes one model from another is the probability distribution for T. A simple approach to duration would be to apply regression analysis to the sample of observed events. The assumption then would be that conditional on an X that has remained fixed from $T= 0$ to $T=t$, t has a normal distribution, as we commonly do in regression. However, normality does not seem to be appropriate for a number of reasons, one of which is that duration is positive by construction while a normally distributed variable can take negative values. The distribution of survival times can be characterised by three equivalent functions, namely the survival function, the probability density function or the hazard function. We will be focusing on the survival function and the hazard function in this study.

1. Survival Function

This function denoted by S(t) is defined as the probability that an individual survives longer than t:

$$\begin{aligned} S(t) &= P(\text{a country stays in default longer than } t) \\ &= P(T>t) \qquad (1) \end{aligned}$$

From the definition of the cumulative distribution function F(t) of T,

$$S(t) = 1 - P(\text{a country leaves default before time t}) = 1 - F(t) \quad (2)$$

S(t) is a non increasing function of time t with the properties S(t) = 1 for t = 0 and S(t) = 0 for t = ∞, that is the probability of surviving at least at the time 0 is 1 and that of surviving an infinite time is 0.

2. Probability Density Function

Like any other continuous random variable, the survival time T has a probability density function defined as the limit of the probability that an individual fails in the short interval t to t + Δt per unit width Δt, or simply the probability of failure in a small interval per unit time. It can be expressed as:

$$f(t) = \lim_{\Delta t \to 0} \frac{P\{\text{a country leaves default in the interval } (t, t + \Delta t)\}}{\Delta t} \quad (3)$$

The density function has the following two properties:

1) f(t) is a non-negative function:
   $f(t) \geq 0$ for all $t \geq 0$
   $f(t) = 0$ for $t < 0$
2) The area between the density curve and the t-axis is equal to 1.

3. Hazard Function

The hazard function h(t) of survival time T gives the conditional failure rate. This is defined as the probability of failure during a very small interval, assuming that the individual has survived to the beginning of the interval, or as the limit of the probability that an individual fails in a very short interval, t to t + Δt, given that the individual has survived to time t:

$$h(t) = \lim_{\Delta t \to 0} \frac{P\{\text{a country that is in default at time t leaves default in the interval } (t, t + \Delta t)\}}{\Delta t} \quad (4)$$

The hazard function can also be defined in terms of the cumulative distribution function F(t) and the probability density function f(t):

$$h(t) = \frac{f(t)}{1 - F(t)} \text{ or } \frac{f(t)}{S(t)}$$

We have opted to use the Cox regression model (1972), also known as the proportional hazards model to fit continuous-time data. The aim is to assess the relation between the distribution of the survival time and the independent variables. One advantage in using the Cox regression method is that it does not require the specification of some particular probability distribution to represent survival times. Furthermore, the Cox regression makes it relatively easy to incorporate time-dependent covariates. Finally, the Cox method can readily accommodate both discrete and continuous measurement of event times. One point to keep in mind is that once we introduce time-dependent variables in a Cox regression model, it is no longer accurate to call it a proportional hazards model. This is because the time-dependent covariates will change at different rates for different individuals, so the ratios of their hazards cannot remain constant. The principal disadvantage of the Cox regression model is that we lose the ability to test hypotheses about the shape of the hazard function.

The model can be specified as follows:

$$\text{Log } h(t_{ij}) = \log h_0(t_j) + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \ldots + \beta_p X_{pij} \text{ or,} \qquad (5)$$

$$h(t_{ij}) = h_0(t_j).e^{[\beta 1X1ij \,+\, \beta 2X2ij \,+\ldots+\, \beta pXpij]}, \qquad (6)$$

where log $h(t_{ij})$ represents the logarithm of the hazard function, X_{1ij} to X_{pij} represents the independent variables for each country i in period j and $h_0(t_j)$ is the hazard function of the underlying survival distribution when all X variables are equal to 0. A partial likelihood function is used to estimate the β's. The dependent variable represents the hazard of leaving the state of default. By extension, we can say that the higher the hazard of leaving the state of default is, the shorter the length of the default period is. The macroeconomic variables are run over two time periods, 1975-2001 and 1982-2001, while the balance sheet variables are run over the period 1983-2002. Univariate regressions are run with each of the independent variables and multivariate regressions with a combination of independent variables are run to determine the explanatory significance of the covariates.

4.4 Empirical Results

4.4.1 Graphical Representation

Figures 4-1a to 4-1c depicts a graphical representation of the survivor function for all three types of debt. Plotted estimates of the survivor function show that the probability of staying in default is high for a duration of 1 year and decreases as duration of default increases. One point to note in the graph for local currency is the long periods of constant survival probability. This is due to the fact that no country experiences the event (getting out of default) from default lengths 5 to 15. The presence of other countries in the data set that are still at risk contribute to keeping the survival probability at a constant rate during this period.

Figure 4-1a: Graphical Representation of Survivor Function (Foreign Currency Bank Debt)

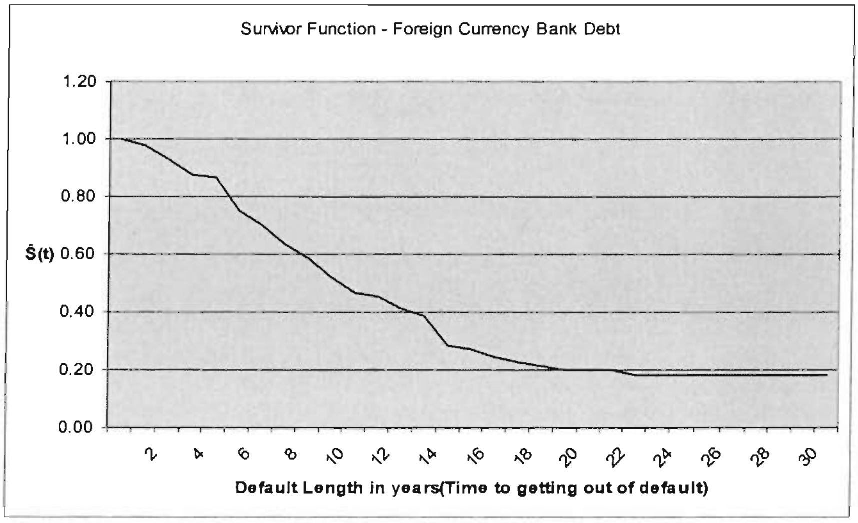


Figure 4-1b: Graphical Representation of Survivor Function (Local Currency Debt)

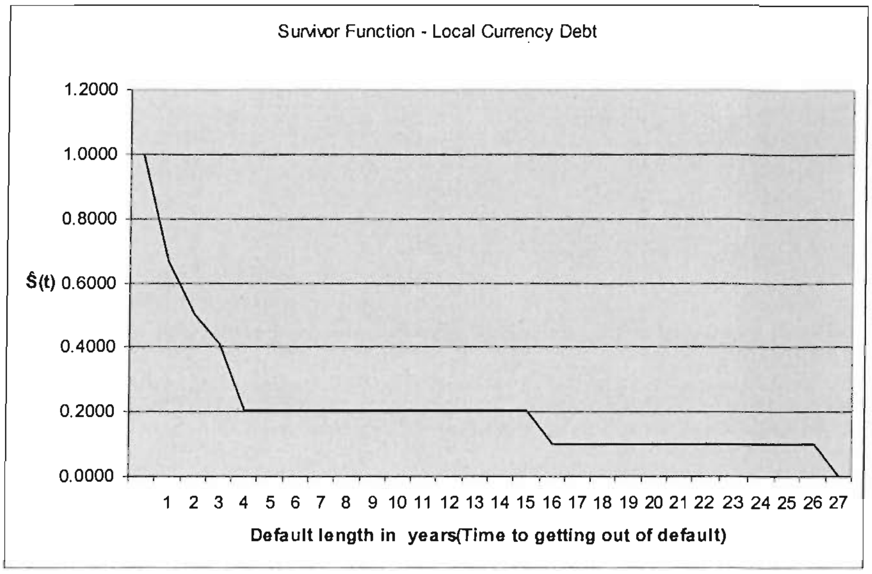
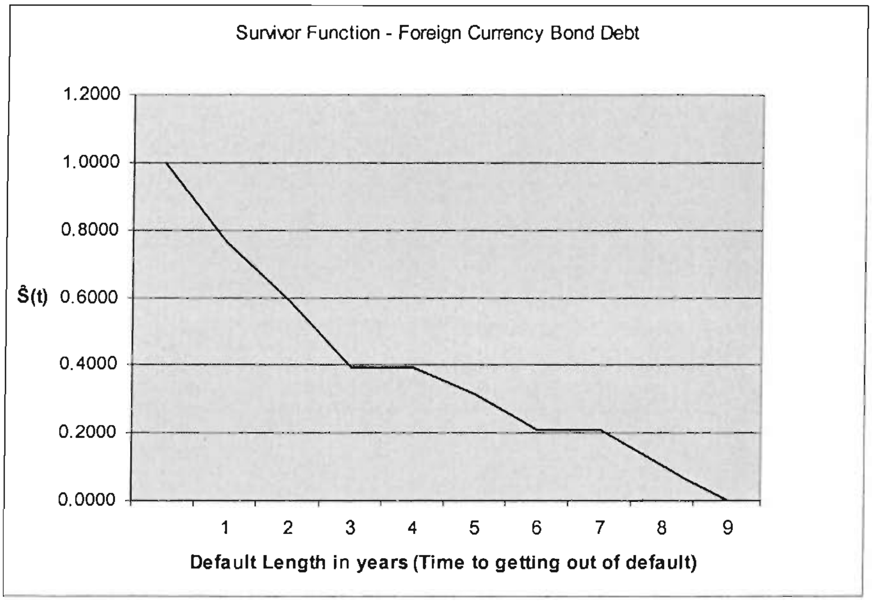


Figure 4-1c: Graphical Representation of Survivor Function (Foreign Currency Bond Debt)



$\hat{S}(t)$ is the survivor function

Figures 4-2a to 4-2c plots the hazard function for the three types of debt. The hazard function is always positive and has no upper bound. However, the estimates of the hazard function are too erratic to be meaningful.

Figure 4-2a: Graphical Representation of Hazard Function (Foreign Currency Bank Debt)

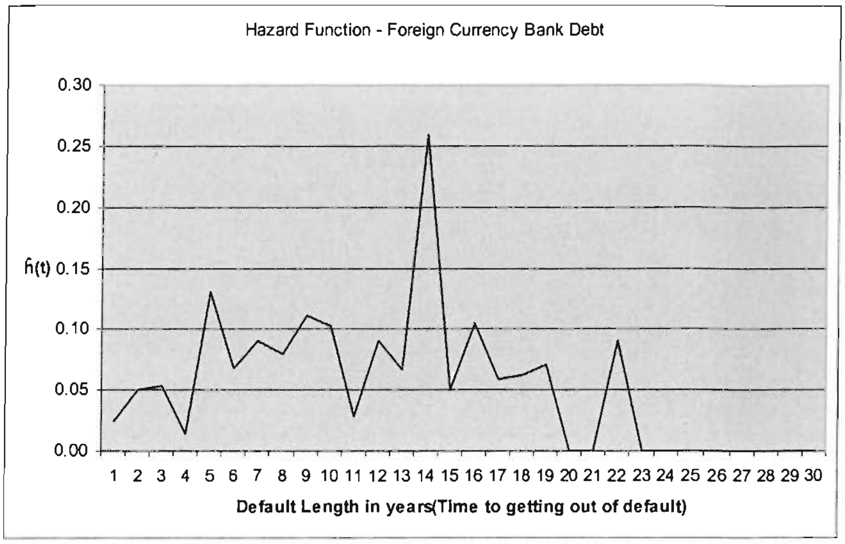


Figure 4-2b: Graphical Representation of Hazard Function (Local Currency Debt)

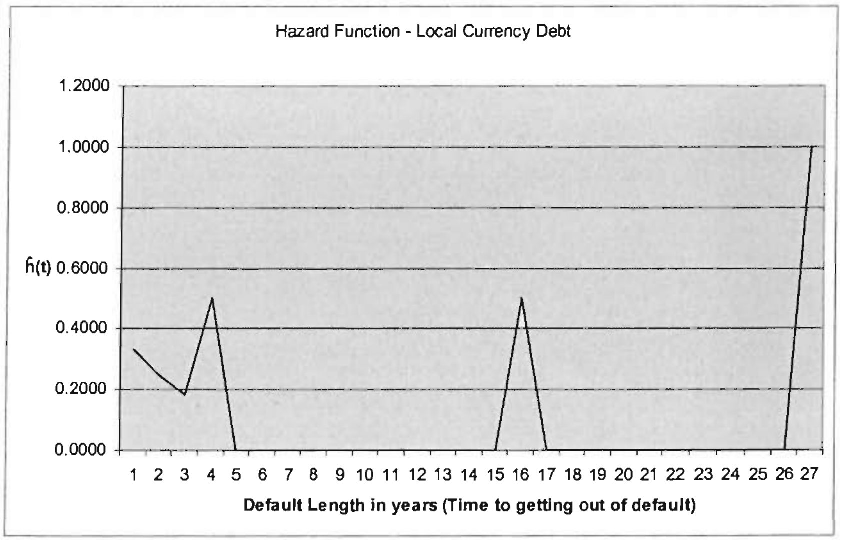
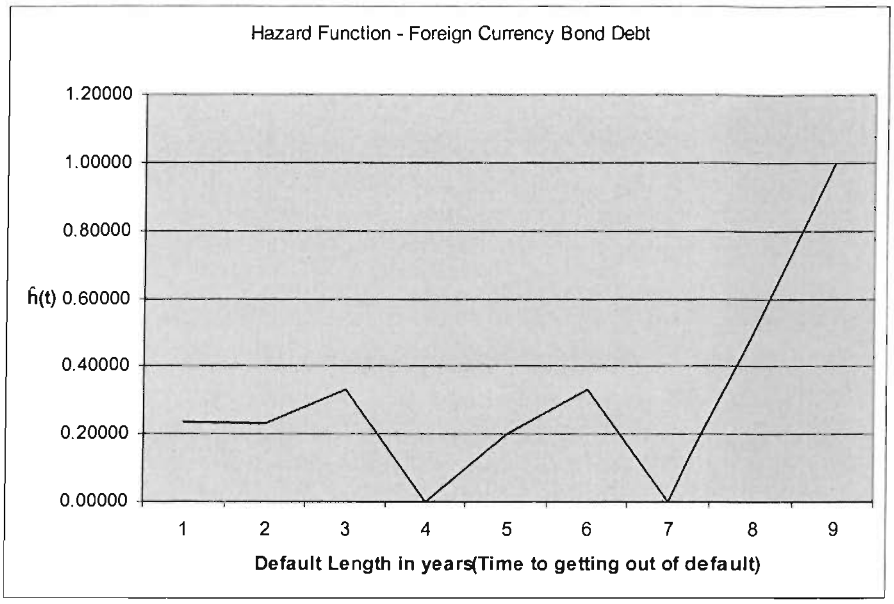


Figure 4-2c: Graphical Representation of Hazard Function (Foreign Currency Bond Debt)



ĥ(t) is the hazard function

As a result, we graph the cumulative hazard function, Ĥ(t). The cumulative hazard function shown in Figures 4-3a to 4-3c is the total amount of accumulated risk that a country has faced from the beginning until the present. Because Ĥ(t) literally accumulates hazard, examination of its changing level over time tells us about the shape of the underlying hazard function.

Figure 4-3a: Graphical Representation of Cumulative Hazard Function (Foreign Currency Bank Debt)

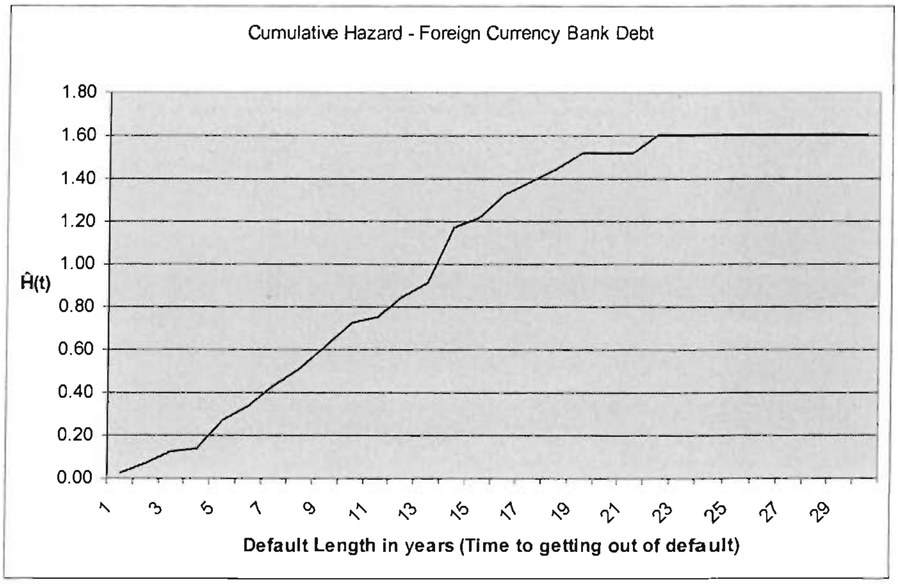


Figure 4-3b: Graphical Representation of Cumulative Hazard Function (Local Currency Debt)

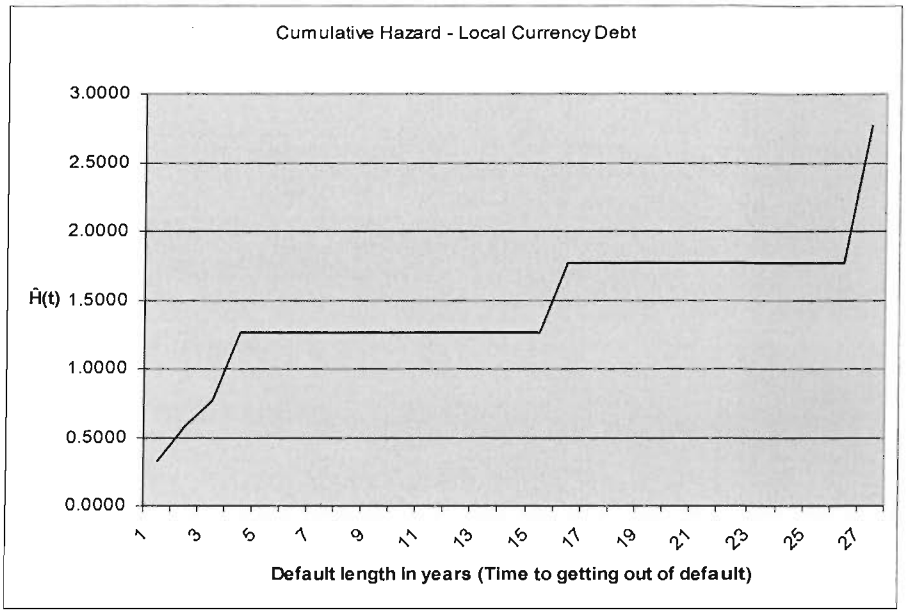
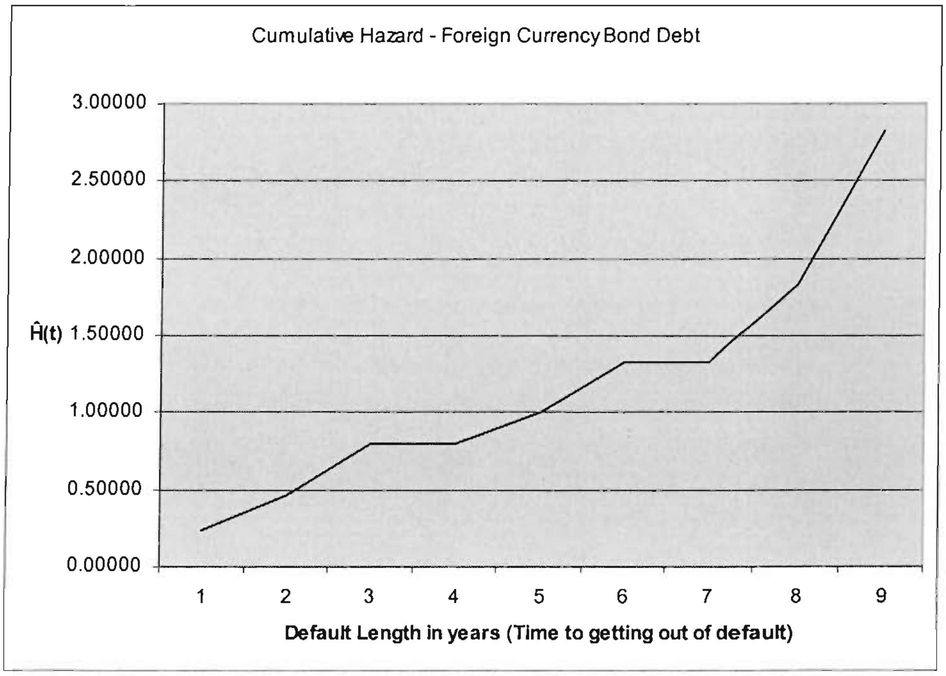


Figure 4-3c: Graphical Representation of Cumulative Hazard Function (Foreign Currency Bond Debt)



Ĥ(t) is the cumulative hazard function

The risk profiles of the three types of debt are studied graphically in Figure 4-4a-c by comparing the hazard and cumulative hazard function. The risk profile for foreign currency bank debt shows that the hazard function rises and then falls while the cumulative hazard function is nonmonotonic. With the increase and decrease in the hazard function, we infer the directional change through the changing rate of increase in the cumulative hazard function. When $\hat{h}(t)$ rises slowly, the rate of increase in $\hat{H}(t)$ is small; when $\hat{h}$ (t) accelerates, the rate of increase in $\hat{H}(t)$ is rapid. When $\hat{h}$ (t) finally falls, the rate of increase in $\hat{H}(t)$ finally diminishes. Whenever the rates of increase in a cumulative hazard function change in magnitude over time, we infer that the hazard function reaches either a peak or a trough. The local currency debt cumulative hazard function has about the same shape as for the foreign currency bank debt, but the slope increases at a decreasing rate, which means that the hazard function is a diminishing one. One explanation for that is that for the first three years, a smaller amount of risk is added to the prior cumulative level. The hazard function for the foreign currency bond debt increases linearly over time. It is further evident in the cumulative hazard function, which increases more rapidly at each successive instant because a larger amount of risk is added to the prior cumulative level.

Figure 4-4a: Risk Profiles (Foreign Currency Bank Debt)

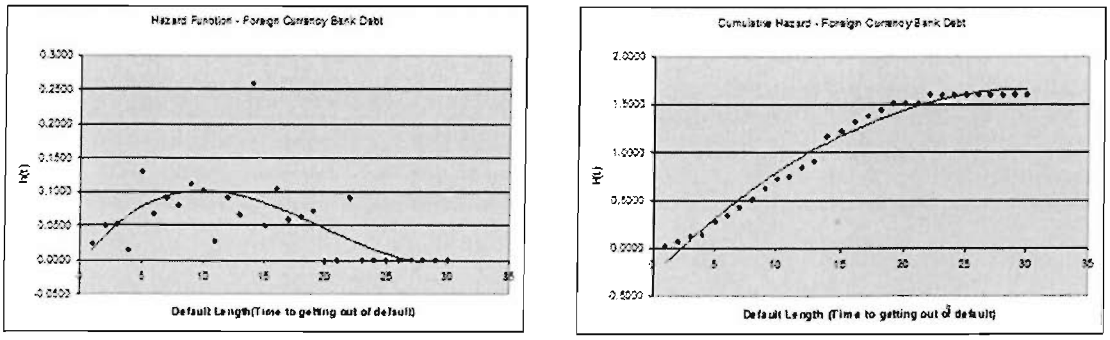


Figure 4-4b: Risk Profiles (Local Currency Debt)

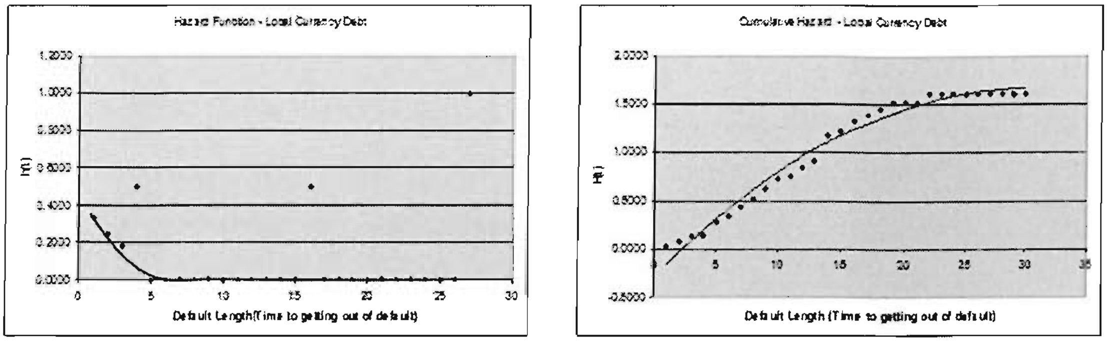
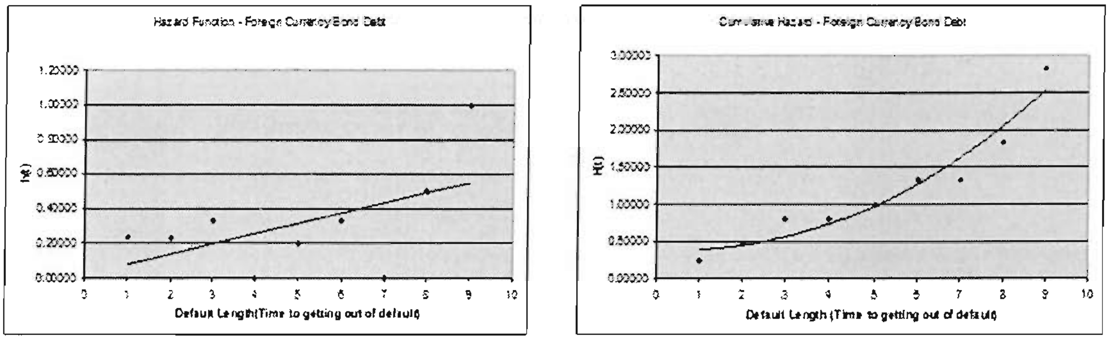


Figure 4-4c: Risk Profiles (Foreign Currency Bond Debt)



4.4.2 Univariate Results

Table 4-4 shows the results of univariate regressions on foreign currency bank debt default as a function of each independent variable. Nine variables are significant at the 5% significance level[6], although only imports, inflation and real GDP growth present the correct sign. The only balance sheet variables that are significant at the 5% level and present the correct signs are medium-term and long-term debt relative to total bank debt. Table 4-5 shows the same univariate regressions but this time the dependent variable is the duration of local currency debt default. Seven

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[6] Tables 4-4 to 4-9 show (standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean. For discussion purposes, only those coefficients significant at the 5% level are considered.

macroeconomic variables well as all balance sheet variables are significant. However, once again, only the imports and inflation variables show the correct sign. Medium-term, long-term and undisbursed credit commitments relative to total bank debt are the only balance sheet variables revealing the correct signs. Table 4-6 presents the findings for the foreign currency bond debt regressions. The balance sheet variables show similar results as for local currency debt default and foreign currency bank debt default. Out of eleven macroeconomic variables, only inflation, and real GDP growth are significant and show the proper sign. We specify the COVS (AGGREGATE) option in the PROC PHREG statement to obtain robust estimates of the covariance matrix. When this option is specified, this robust estimate is used in the Wald tests for testing the global null hypothesis and null hypotheses of individual parameters.

4.4.3 Multivariate Regressions

4.4.3.1 Foreign Currency Bank Debt

Model 1 in Table 4-7 includes all the macroeconomic variables for the foreign currency bank debt default study over the period 1975 to 2001. Observations are conducted for 47 countries. Seven out of the nine independent variables are significant at the 5% significance level. Only five out of those seven covariates, however, have the correct sign, and those are the level of exports, the exports growth rate, level of imports, inflation and real GDP growth. The positive coefficient for the debt service ratio shows that the higher the debt service ratio is, the higher the hazard of leaving the default state is, which suggests a shorter default period. This finding contradicts the results of Frank and Cline (1971) whereby a high debt service ratio was an indicator of increased vulnerability to foreign exchange crises as well as an inability to service debt which in turn would suggest a longer default period. The exports and exports growth rate variables show positive and significant coefficients. A high level of exports indicates a shorter period of default as illustrated by the high hazard of leaving the state of default. A similar conclusion can be drawn for the exports growth rate variable. The imports variable has a negative coefficient indicating that with higher level of imports, the hazard of leaving the state of default is lower. Therefore, a country with a high level of imports that cannot be sustained by foreign exchange earnings may be susceptible to being in a longer period of default on foreign currency bank debt. The negative coefficient on the inflation variable points out that a high level of inflation predicts a low hazard of leaving the default state, hence showing that increases in prices may lead to monetary crises which will lengthen the period of default of a country. The imports to reserves ratio variable, although significant at the 5% level, presents a positive relationship with the hazard function. However, the conventional view is that a large ratio of imports to reserves suggests a lower debt servicing capacity and thus a greater probability of staying in default longer. The two remaining variables that are not significant also do not show the correct sign.

Model 2 shows the same macroeconomic variables as above and two additional ones, external debt to exports and GDP per capita, over the 1982-2001 period. Observations of foreign currency bank default are recorded for 46 countries. Once again the similar results can be noted for the nine variables that are common to the 1975-2001 period. The two new variables are not significant and have the wrong sign. Model 3 includes all the balance sheet variables over the period 1983-2002 for 79 countries. Out of seven variables, six are significant. According to conventional view, in periods of cash-flow or liquidity crises an increase in medium-term, long-term and undisbursed credit commitments relative to total bank debt indicates that a country is less likely to have debt servicing difficulties, and thus will have a shorter debt period. This is also revealed by an increase in foreign exchange reserves. However, an increase in short-term debt and country bank debt relative to total bank debt is more likely to result in debt servicing problems and longer default periods. An increase in the use of IMF credit is also an indicator of similar results. Model 3 shows that out of all significant covariates, only medium-term debt and undisbursed credit commitments relative to total bank debt have the expected positive sign. All other variables have signs that contradict the conventional view. The positive sign observed on short-term debt and country debt relative to total bank debt, and use of IMF credit suggest that the higher those ratios are, the higher is the hazard of leaving the state of default. The negative coefficient for foreign exchange reserves relative to IMF quota indicates a longer period of default as the hazard of leaving the state of default is lower.

Model 4 features both macroeconomic variables and balance sheet variables. 46 countries are observed during a time period ranging from 1983 to 2001. Out of eighteen independent covariates, nine are significant but only the level of imports, inflation, real GDP growth and long-term debt relative to total bank debt present the correct sign. The debt service ratio loses its significance from Model 1 while the export to GDP variable becomes significant but presents the wrong sign. The negative coefficient suggests that a high export to GDP ratio predicts a longer default period as the hazard of leaving the default state is low. Both the exports and the exports growth rate variables lose their significance from Model 1, as does the imports to reserves ratio.

The short-term debt, and country-debt relative to total bank debt as well as the use of IMF credit relative to IMF quota variables all retain their significance from Model 3. However, they show the wrong sign. The long-term debt relative to total bank debt has a significant coefficient and presents the correct sign. The higher the long-term debt relative to total bank debt is, the higher the hazard of leaving the default state is. This coincides with what conventional view declares.

The β values taken to the exponential and then subtracting 1 (e^{β} -1) give the percent increase or decrease in the expected survival time for each one-unit increase in the independent variable. In Model 4, for example, a one-unit increase in real GDP growth is associated with a 1.4% decrease in the expected time to leaving the state of default, holding all other covariates constant. We look at the likelihood ratio (LR) statistic to determine the best model. A loose definition of the likelihood is that it is the probability of the observed data being explained by a particular model. The likelihood ratio is approximately distributed as a χ^2 variable with the appropriate degree of freedom. If the null hypothesis were true we would expect a small value of the LR. From Table 4-7, it appears that model 4, containing both macroeconomic and balance sheet variables is the best model to explain the observed data.

4.4.3.2 Local Currency Debt

Model 5 of Table 4-8 displays the duration of local currency debt default as a function of macroeconomic variables over the period 1975 to 2001. Out of the nine macroeconomic variables, four are significant at the 5% level and show the correct sign, namely the level of exports, imports, inflation and real GDP growth. The coefficient for the inflation variable has the correct sign indicating that this is consistent with Standard & Poor's view that the rate of inflation is the single most important leading indicator of sovereign local currency credit trends (Beers 1995). Theoretically, a rise in expected inflation will lead to a rise in interest rates, which in turn, will increase the debt burden further and may lengthen the default period. Real GDP growth and exports have a positive effect on the hazard of getting out of default and, by extension, can be said to predict shorter default periods. A high level of imports indicates a low hazard of moving out of the default state. The likelihood ratio statistic tests the joint significance of the explanatory variables, that is, tests the hypothesis that all coefficients are 0. The null hypothesis that the nine macroeconomic variables considered together do not have a significant impact on the length of default of local currency debt is rejected according to the χ^2 (d.f = 9) distribution.

Model 6 of Table 4-8 reveals eleven macroeconomic variables over the period 1982 to 2001. Once again, the variables common to the 1975-2001 period reveal the correct signs and are significant at the 5% level. The two new variables, external debt to exports ratio and GDP per capita are not significant and the latter variable has an incorrect sign. Model 7 presents all balance sheet variables for 23 countries over the period 1983-2002. Two variables out of seven are significant. However, neither of those shows the correct sign. The explanatory value of this set of variables is only moderately significant relative to the explanatory value of macroeconomic variables.

Model 8 is one where both macroeconomic variables and balance sheet variables are included in the model. Six independent variables are found to be significant but only medium-term debt relative to total bank debt reveals the correct positive sign. There is clearly a marked reduction in the number of significant variables that are able to predict the length of default of foreign currency bank debt. The log likelihood ratio statistic shows that Model 8 is a better fit than Model 7 which contains only the balance sheet variables. In addition, the explanatory power, for a model with both macroeconomic and balance sheet variables, is higher for foreign currency bank debt than for local currency debt.

Comparing Model 4 and Model 8, we find that while there are no significant macroeconomic variables showing the correct sign for local currency debt, the level of imports, inflation and real GDP growth can explain the length of default of foreign currency bank debt. If we compare Tables 4-7 and 4-8, we find that over the periods 1975-2001 and 1982-2001 the same macroeconomic variables that explain the length of foreign currency bank debt default also explain length of local currency debt default apart from the exports growth rate. Model 3 and Model 7 which compare the balance sheet variables in foreign currency bank debt and local currency debt show that medium-term debt and undisbursed credit commitments relative to total bank debt are fit for explaining duration of foreign currency bank debt default there are no significant balance sheet variables with the correct sign for local currency debt default.

4.4.3.3 Foreign Currency Bond Debt

Model 9 of Table 4-9 depicts the duration of foreign currency bond debt as a function of macroeconomic variables over the period 1975 to 2001. While four variables out of nine are significant at the 5% level, only the export to GDP ratio, the level of inflation and the imports to reserves ratio show the proper sign. As the export to GDP ratio increases, the hazard of leaving the default state also does, suggesting that high earnings of foreign capital could easily service debt, and shorten the default period.

Model 10 presents eleven macroeconomic variables over the period 1982-2001. Again, the results reflect those for the period 1975-2001. From the likelihood ratio statistic, it is clear that Model 10 is somewhat better than Model 9. However, both models reject the null hypothesis that the macroeconomic variables considered together have no significant impact on the length of default of foreign currency bond debt.

Model 11 includes only the balance sheet variables and covers the period 1983-2002. Four variables are found to be significant, but only the medium-term debt relative to total bank debt variable has the correct sign. Our results show that high long-term debt relative to total bank debt predicts low hazard of leaving the default state. However, this is contrary to the view that a loan maturity increase indicates financial stability and an ability to service debt. Similarly, undisbursed credit commitments relative to total bank debt also show a contradiction to the belief that an increase in undisbursed credit commitments might mean that a country is no longer facing a liquidity crisis and thus the length of the default period should be shorter. The last variable with an incorrect sign is the use of IMF credit relative to IMF quota. Our results associate a positive sign with the coefficient, suggesting that an increase in the use of IMF credit predicts an increase in the hazard of leaving the default state. However, this argument is not valid particularly in times of crisis when IMF credit may be sought if banks extend only short-term loans.

In Model 12, both macroeconomic and balance sheet variables are included. The results show that ten variables are significant. However, only the level of exports, imports, the exports growth rate and the real GDP Growth have the correct sign. The likelihood ratio statistic shows that Model 12 is better than Model 11 which contains only balance sheet variables. This suggests that including macroeconomic variables improve the fit of the model.

4.5 Conclusion

The analysis described in this chapter uses survival analysis to investigate the determinants of three types of debt defaults, namely foreign currency bank debt, local currency debt and foreign currency bond debt. Specifically, the analysis tests the null hypothesis that the independent variables considered together have no significant impact on the length of default.

In a model that includes both macroeconomic and balance sheet variables, our results show that the level of imports, inflation, real GDP growth and long-term debt relative to total bank debt are good predictors of the length of the default period for foreign currency bank debt. Looking at local currency debt, however, we find that the medium-term debt relative to total bank debt variable is the only significant variable showing the proper sign. The only variables good at explaining duration of foreign currency bond debt default are the level of imports, exports, the exports growth rate and real GDP growth.

In a model that includes only macroeconomic variables, our results indicate that the level of exports, imports, inflation and real GDP growth are the only predictors that are common to both foreign currency bank debt and local currency debt. Macroeconomic variables that are good at explaining duration of foreign currency bond debt default are the exports to GDP ratio, imports to reserves ratio and the level of inflation.

In a model with only balance sheet variables, medium-term debt relative to total bank debt is the only common variable found to explain the duration of foreign currency bank and bond debt default. No balance sheet variables have been revealed to be good at explaining duration of local currency debt default.

Finally, the findings suggest that both macroeconomic and balance sheet variables contribute to some extent in predicting the length of default of the three types of debt. The fit of the model is improved by combining macroeconomic and balance sheet variables in one model for all types of debt. However, the explanatory power of this improved model as illustrated by the likelihood ratio statistic is best for foreign currency bank debt default.

In order to illustrate our findings, we use the model which has been found to be the best one, from the likelihood ratio statistic, that is, the model for foreign currency bank debt featuring both macroeconomic and balance sheet variables. Those variables that are found to be significant and to have the correct sign are the level of imports, inflation, real GDP growth, and long-term debt relative to total bank debt. From the estimates of those four variables, we find that a one-unit increase in the level of imports is associated with a 0.03% increase, (e^{β}-1), in the expected time to leaving the state of default, holding all other variables constant, while a one percent increase in the level of inflation is associated with a 1.75% increase in the survival of default. On the other hand, a one percent increase in real GDP growth is associated with a 1.44% decrease in the expected time to leaving the state of default, holding all other covariates constant. Similarly, a one-unit increase in long-term debt relative to total bank debt will have the effect of reducing expected survival time in the state of default by 6.34%. Thus a country wishing to leave the state of default faster should follow the above strategies, that is, reducing the level of imports (especially if foreign exchange reserves are not up to par), level of inflation and should try to increase their real GDP growth and encourage banks to offer long-term loans since longer loan maturities are viewed as an indication of financial stability.

The model tried to find those variables that were significant at explaining the length of the debt default. For example, the higher the level of imports was, the lower the hazard of leaving default would be, hence a longer default. In other words, as the level of imports moved from year to year, the probability that a country left default (provided that it had already been in default at the beginning of the interval) in the next year became lower, thus indicating persistence in the default state. The model is in fact explanatory and not predictive. Predicting when default would end is beyond the scope of this study but could be investigated in future research where the hazard probabilities could be applied to determine how default in subsequent years would be modelled.

Table 4-1. Description of Macroeconomic Variables		
Macroeconomic Variables	*Definition*	*Data Period*
DEBT SERVICE RATIO	Ratio of total debt service to exports of goods and services for the previous year	World Development Indicators Database (World Bank)1975-2002
EXPORT/GDP	Exports relative to GDP for the previous year	IFS Database 1975-2002
EXPORTS	Exports lagged by a year	IFS Database 1975-2003
EXPORTS GROWTH RATE	Average of 4-year growth rates over the previous eight years	IFS Database 1975-2003
IMPORTS	Imports lagged by a year	IFS Database 1975-2003
FISCAL BAL	Average annual central government deficit (-) or surplus (+) relative to GDP for the previous year	IFS Database 1975-2001
INFLATION	Average Consumer Price Inflation rate for the previous three years	IFS Database 1975-2001
REAL GDP GROWTH	Average annual real GDP growth on a year-by-year basis for the previous four years	IFS Database 1975-2001
IMPORTS/RESERVES	Reserves include gold, holding of dollars or sterling and net position at the IMF	IFS Database 1975-2003
EXTERNAL DEBT/EXPORTS	Total external debt relative to exports for the previous year	External Debt: OECD, External Debt Statistics Database 1982-2002
GDP PER CAPITA	GDP Per capita for the previous year	IMF World Economic Outlook Database 1981-2004

Table 4-2. Description of Balance Sheet Variables		
Balance Sheet Variables	*Definition*	*Data Period*
SHORT-TERM DEBT/ TOTAL BANK DEBT	BIS reporting banks' cross-border claims on the country with maturity up to and including one year relative to total bank debt for the previous year	BIS Database 1983-2002
MEDIUM-TERM DEBT/ TOTAL BANK DEBT	BIS reporting banks' cross-border claims on the country with maturity over one year and up to two years relative to total bank debt for the previous year	BIS Database 1983-2002
LONG-TERM DEBT/ TOTAL BANK DEBT	BIS reporting banks' cross-border claims on the country with maturity over two years relative to total bank debt for the previous year	BIS Database 1983-2002
COUNTRY DEBT/SAMPLE DEBT	Country total bank debt relative to total bank debt of the sample for the previous year	BIS Database 1983-2002
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT	Undisbursed credit commitments relative to total bank debt for the previous year	BIS Database 1983-2002
FOREX RESERVES/IMF QUOTA	Foreign Exchange reserves relative to IMF quota for the previous year	IFS Database 1975-2002
USE IMF CREDIT/IMF QUOTA	Use of IMF credit relative to IMF quota for the previous year	IFS Database 1975-2002

Table 4-3. Expected Effect of Independent Variables on the Hazard Function and Length of Default

Independent Variable	*Hazard of Leaving Default State*	*Length of Default Period*
DEBT SERVICE	-	+
EXPORT/GDP	+	-
EXPORTS	+	-
EXPORTS GROWTH RATE	+	-
IMPORTS	-	+
FISCAL BAL	+	-
INFLATION	-	+
REAL GDP GROWTH	+	-
IMPORTS/RESERVES	-	+
EXTERNAL DEBT/EXPORTS	-	+
GDP PER CAPITA	+	-
SHORT-TERM DEBT/ TOTAL BANK DEBT	-	+
MEDIUM-TERM DEBT/ TOTAL BANK DEBT	+	-
LONG-TERM DEBT/ TOTAL BANK DEBT	+	-
COUNTRY DEBT/SAMPLE DEBT	-	+
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT	+	-
FOREX RESERVES/IMF QUOTA	+	-
USE IMF CREDIT/IMF QUOTA	-	+

Table 4-4. Univariate Regressions of Duration of Foreign Currency Bank Debt Default as a Function of Independent Variable

	Macroeconomic Variables	Balance Sheet Variables	-2 Log L	Likelihood Ratio
DEBT SERVICE	0.01608*** (0.0030)		8395.92	43.15 [<0.0001]
EXPORT/GDP	-0.00938*** (0.0022)		9492.94	18.27 [<0.0001]
EXPORTS	-0.00003*** ($5.0724\text{x}10^{-6}$)		9764.22	63.49 [<0.0001]
EXPORTS GROWTH RATE	-0.22096 (0.4387)		10145.48	0.3095 [0.5780]
IMPORTS	-0.00004*** ($6.0631\text{x}10^{-6}$)		9427.85	91.00 [<0.0001]
FISCAL BAL	-0.01053*** (0.0033)		5449.97	6.60 [0.0102]
INFLATION	-0.03120*** (0.0018)		8977.52	678.85 [<0.0001]
REAL GDP GROWTH	0.01978*** (0.0018)		7410.67	7.79 [0.0053]
IMPORTS/RESERVES	0.00201*** (0.0003)		7984.93	21.60 [<0.0001]
EXTERNAL DEBT/EXPORTS	-0.00021 (0.0024)		9116.42	0.01 [0.9285]
GDP PER CAPITA	-0.00016*** ($2.460\text{x}10^{-5}$)		10732.16	55.55 [<0.0001]
SHORT-TERM DEBT/TOTAL BANK DEBT		0.01045*** (0.0008)	8260.94	45.31 [<0.0001]
MEDIUM-TERM DEBT/ TOTAL BANK DEBT		0.02323*** (0.0031)	7408.59	25.66 [<0.0001]
LONG-TERM DEBT/ TOTAL BANK DEBT		0.00777*** (0.0009)	8037.73	33.17 [<0.0001]
COUNTRY DEBT/SAMPLE BANK DEBT		1.78910* (1.1126)	8353.78	2.59 [0.1077]
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT		0.00703* (0.0038)	7924.00	5.95 [0.0147]
FOREX RESERVES/IMF QUOTA		-0.17478*** (0.0181)	9259.41	156.24 [<0.0001]
USE IMF CREDIT/IMF QUOTA		0.13957*** (0.0452)	10034.96	50.63 [<0.0001]

(Standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean.

Table 4-5. Univariate Regressions of Duration of Local Currency Debt Default as a Function of Independent Variable

	Macroeconomic Variables	Balance Sheet Variables	-2 Log L	Likelihood Ratio
DEBT SERVICE	0.01218*** (0.0042)		1714.79	10.63 [0.0011]
EXPORT/GDP	-0.00882*** (0.0035)		2140.67	5.74 [0.0165]
EXPORTS	-0.00001** (5.617x10^{-6})		1974.71	8.46 [0.0036]
EXPORTS GROWTH RATE	1.53864* (0.8299)		2064.71	3.86 [0.0495]
IMPORTS	-0.00002*** (8.222x10^{-6})		1885.77	11.13 [0.0009]
FISCAL BAL	-0.01315** (0.0053)		1160.86	3.12 [0.0774]
INFLATION	-0.03105*** (0.0054)		1965.58	198.28 [<0.0001]
REAL GDP GROWTH	0.03435* (0.0249)		1743.96	1.07 [0.2999]
IMPORTS/RESERVES	0.00228*** (0.0005)		1865.79	10.40 [0.0013]
EXTERNAL DEBT/EXPORTS	-0.00578* (0.0043)		1823.88	1.11 [0.2925]
GDP PER CAPITA	-0.00007* (4.020x10^{-5})		2320.46	3.11 [0.0776]
SHORT-TERM DEBT/TOTAL BANK DEBT		0.01032*** (0.0013)	1691.11	14.67 [0.0001]
MEDIUM-TERM DEBT/ TOTAL BANK DEBT		0.16365*** (0.0280)	1544.03	17.80 [<0.0001]
LONG-TERM DEBT/ TOTAL BANK DEBT		0.02499*** (0.0032)	1683.87	16.24 [<0.0001]
COUNTRY DEBT/SAMPLE BANK DEBT		1.14305*** (0.4371)	1704.40	5.16 [0.0232]
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT		0.02743** (0.0125)	1696.15	3.17 [0.0750]
FOREX RESERVES/IMF QUOTA		-0.23114*** (0.0513)	1818.52	36.32 [<0.0001]
USE IMF CREDIT/IMF QUOTA		0.41365*** (0.0902)	2012.42	43.34 [<0.0001]

(Standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean.

Table 4-6. Univariate Regressions of Duration of Foreign Currency Bond Debt Default as a Function of Independent Variable

	Macroeconomic Variables	Balance Sheet Variables	-2 Log L	Likelihood Ratio
DEBT SERVICE	0.03929*** (0.0067)		1075.90	44.24 [<0.0001]
EXPORT/GDP	-0.01171* (0.0072)		1187.00	2.26 [0.1332]
EXPORTS	-9.58260x10^{-6}* (6.5633x10^{-6})		1145.87	2.60 [0.1071]
EXPORTS GROWTH RATE	-4.14871** (1.71754)		1269.34	7.59 [0.0059]
IMPORTS	-0.00002* (1.390x10^{-5})		1313.88	6.19 [0.0128]
FISCAL BAL	-0.00164 (0.0066)		975.68	0.05 [0.8244]
INFLATION	-0.02717*** (0.0038)		1250.81	98.10 [<0.0001]
REAL GDP GROWTH	0.01719*** (0.0020)		1180.31	5.56 [0.0184]
IMPORTS/RESERVES	0.00253*** (0.0006)		1166.02	5.97 [0.0145]
EXTERNAL DEBT/EXPORTS	0.01089* (0.0105)		1103.11	0.94 [0.3324]
GDP PER CAPITA	-0.00008* (4.750x10^{-5})		1334.63	2.64 [0.1043]
SHORT-TERM DEBT/TOTAL BANK DEBT		0.12683*** (0.0237)	1027.51	15.96 [<0.0001]
MEDIUM-TERM DEBT/ TOTAL BANK DEBT		1.26316*** (0.2385)	1023.14	18.40 [<0.0001]
LONG-TERM DEBT/ TOTAL BANK DEBT		0.12055*** (0.0244)	1032.69	8.85 [0.0029]
COUNTRY DEBT/SAMPLE BANK DEBT		1.32150*** (0.3825)	1035.09	7.83 [0.0051]
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT		0.43917*** (0.0930)	1033.86	7.68 [0.0056]
FOREX RESERVES/IMF QUOTA		-0.15239*** (0.0494)	1124.64	10.89 [0.0010]
USE IMF CREDIT/IMF QUOTA		0.51710*** (0.1385)	1120.24	26.29 [<0.0001]

(Standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean.

Table 4-7. Duration of Foreign Currency Bank Debt Default as a Function of Macroeconomic and/or Balance Sheet Variables

Period No. of Countries Independent Variables	1975-2001 47 Macroeconomic	1982-2001 46 Macroeconomic	1983-2002 79 Balance Sheet	1983-2001 46 Macroeconomic & Balance Sheet
	Model 1	Model 2	Model 3	Model 4
DEBT SERVICE	0.01025*** (0.0038)	0.00990** (0.0040)		0.00101 (0.0071)
EXPORT/GDP	-0.00156 (0.0047)	-0.00178 (0.0048)		-0.02905*** (0.0087)
EXPORTS	0.00012*** (2.460x10^{-5})	0.00011*** (2.560x10^{-5})		0.00006* (3.820x10^{-5})
EXPORTS GROWTH RATE	1.90642*** (0.6322)	1.66621** (0.7088)		0.78843 (0.9757)
IMPORTS	-0.00024*** (4.420x10^{-5})	-0.00021*** (4.550x10^{-5})		-0.00031*** (7.750x10^{-5})
FISCAL BAL	-0.00293 (0.0055)	0.00258 (0.0057)		-0.02634*** (0.0076)
INFLATION	-0.03066*** (0.0027)	-0.02976*** (0.0028)		-0.01733*** (0.0030)
REAL GDP GROWTH	0.01169*** (0.0017)	0.01236*** (0.0018)		0.01428*** (0.0035)
IMPORTS/RESERVES	0.00291*** (0.0007)	0.00292*** (0.0008)		0.00035 (0.0011)
EXTERNAL DEBT/EXPORTS		0.00562 (0.0101)		-0.00700 (0.0119)
GDP PER CAPITA		-0.00010* (5.550x10^{-5})		-0.00014* (8.480x10^{-5})
SHORT-TERM DEBT/TOTAL BANK DEBT			0.00667** (0.0027)	0.06035*** (0.0181)
MEDIUM-TERM DEBT/ TOTAL BANK DEBT			0.16867*** (0.0598)	-0.06870* (0.0569)
LONG-TERM DEBT/ TOTAL BANK DEBT			0.00247 (0.0083)	0.06144** (0.0264)
COUNTRY DEBT/SAMPLE BANK DEBT			2.75298** (1.2236)	37.12726*** (3.7442)
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT			-0.09332*** (0.0314)	-0.21016* (0.1258)
FOREX RESERVES/IMF QUOTA			-0.22088*** (0.0211)	-0.03191 (0.0403)
USE IMF CREDIT/IMF QUOTA			0.29084*** (0.0416)	1.02057*** (0.1041)
-2 Log L	3081.66	2939.81	6338.76	1519.12
LR	293.52 [<0.0001]	274.70 [<0.0001]	320.56 [<0.0001]	330.60 [<0.0001]

(Standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean.

Table 4-8. Duration of Local Currency Debt Default as a Function of Macroeconomic and/or Balance Sheet Variables

Period No. of Countries Independent Variables	1975-2001 15 Macroeconomic	1982-2001 14 Macroeconomic	1983-2002 23 Balance Sheet	1983-2001 14 Macroeconomic & Balance Sheet
	Model 5	Model 6	Model 7	Model 8
DEBT SERVICE	0.05339*** (0.0089)	0.05449*** (0.0110)		-0.03062* (0.0226)
EXPORT/GDP	-0.01895* (0.0099)	-0.01783* (0.0113)		-0.05346* (0.0444)
EXPORTS	0.00010*** (2.940x10^{-5})	0.00012*** (3.010x10^{-5})		0.00020* (0.0001)
EXPORTS GROWTH RATE	-0.46808 (1.6177)	0.70124 (2.1379)		5.30487* (4.6130)
IMPORTS	-0.00021*** (4.560x10^{-5})	-0.00021*** (4.450x10^{-5})		-0.00021* (0.0001)
FISCAL BAL	0.03572* (0.0303)	0.06780* (0.0399)		0.11984* (0.0691)
INFLATION	-0.00895** (0.0039)	-0.01048** (0.0051)		-0.01361* (0.0108)
REAL GDP GROWTH	0.34147*** (0.0874)	0.38829*** (0.0852)		0.18264* (0.1388)
IMPORTS/RESERVES	-0.01213 (0.0127)	-0.00726 (0.0092)		-0.02060* (0.0127)
EXTERNAL DEBT/EXPORTS		-0.02142 (0.0152)		-0.14564* (0.1138)
GDP PER CAPITA		-0.00028* (1.607x10^{-4})		-0.00053 (0.0006)
SHORT-TERM DEBT/TOTAL BANK DEBT			-0.00841 (0.0101)	0.71957*** (0.1466)
MEDIUM-TERM DEBT/ TOTAL BANK DEBT			0.26647* (0.1483)	2.76907*** (0.5415)
LONG-TERM DEBT/ TOTAL BANK DEBT			0.05058* (0.0325)	-0.39735*** (0.1230)
COUNTRY DEBT/SAMPLE BANK DEBT			0.92300* (0.6552)	1.07650 (2.4222)
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT			-0.21051* (0.1651)	-3.73358*** (0.6595)
FOREX RESERVES/IMF QUOTA			-0.21644*** (0.0531)	-0.45126** (0.2052)
USE IMF CREDIT/IMF QUOTA			0.44050*** (0.1042)	3.33833*** (0.4600)
-2 Log L	625.86	585.01	1242.30	184.69
LR	55.07 [<0.0001]	63.94 [<0.0001]	89.34 [<0.0001]	131.03 [<0.0001]

(Standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean.

Table 4-9. Duration of Foreign Currency Bond Debt Default as a Function of Macroeconomic and/or Balance Sheet Variables

Period No. of Countries Independent Variables	1975-2001 11 Macroeconomic	1982-2001 11 Macroeconomic	1983-2002 15 Balance Sheet	1983-2001 11 Macroeconomic & Balance Sheet
	Model 9	Model 10	Model 11	Model 12
DEBT SERVICE	0.04154** (0.0175)	0.04867*** (0.01791)		0.00517 (0.0261)
EXPORT/GDP	0.07866*** (0.0217)	0.08349*** (0.0241)		-0.07297** (0.0366)
EXPORTS	-1.59920x10^{-6} (0.0001)	-0.00002 (0.0001)		0.00048*** (0.0001)
EXPORTS GROWTH RATE	-0.96313 (4.0149)	-2.77175 (3.9754)		15.11933*** (4.5105)
IMPORTS	-0.00025 (0.0003)	-0.00018 (0.0003)		-0.00147*** (0.0003)
FISCAL BAL	0.00300 (0.0177)	-0.00357 (0.0169)		-0.07029*** (0.0232)
INFLATION	-0.01482*** (0.0042)	-0.01543*** (0.0043)		0.00435 (0.0109)
REAL GDP GROWTH	0.00797* (0.0060)	0.00595 (0.0068)		0.03141*** (0.0119)
IMPORTS/RESERVES	-0.15469** (0.0694)	-0.20972*** (0.0777)		-0.09633* (0.0713)
EXTERNAL DEBT/EXPORTS		0.00320** (0.0159)		-0.17444 * (0.0917)
GDP PER CAPITA		-0.00007 (0.0001)		-0.00098*** (0.0002)
SHORT-TERM DEBT/TOTAL BANK DEBT			0.05674 (0.1723)	0.22098 (0.4590)
MEDIUM-TERM DEBT/ TOTAL BANK DEBT			14.22211*** (2.6527)	5.41388* (4.0230)
LONG-TERM DEBT/ TOTAL BANK DEBT			-0.73591** (0.3023)	0.09206 (0.3653)
COUNTRY DEBT/SAMPLE BANK DEBT			-0.67808* (0.5096)	13.52737*** (3.8278)
UNDISBURSED CREDIT COMMITMENTS/ TOTAL BANK DEBT			-3.93447*** (1.1205)	-3.41093** (1.6069)
FOREX RESERVES/IMF QUOTA			-0.05240 (0.0605)	0.05155 (0.1439)
USE IMF CREDIT/IMF QUOTA			0.41572*** (0.1506)	1.91210*** (0.4113)
-2 Log L	534.56	500.16	940.50	262.49
LR	91.76 [<0.0001]	94.91 [<0.0001]	100.48 [<0.0001]	164.43 [<0.0001]

(Standard error in parentheses); [P-values in square brackets]; * indicates one standard deviation from mean; ** indicate two standard deviations from mean; *** indicate three standard deviations from mean.

5. Conclusion

This thesis has presented three empirical studies that have provided insight into new methodological techniques and have addressed areas in the literature that were still not well researched.

Whereas there has been a long history of discussing the payout ratio at the firm level in corporate finance, its role in investment strategy and equilibrium asset pricing had been relatively neglected until Arnott and Asness (2003) offered interesting empirical insights into the US experience since 1871 regarding the payout ratio and aggregate real earnings. Surprisingly, the US payout ratio was positively related to real earnings growth. In extending that analysis to a further ten countries, we report that their findings are generally supported by international evidence. Hence, despite very different institutional, tax and legal environments, leading to highly variable degrees of minority shareholder protection between countries (see La Porta *et al.*, 2000), we still find that substantial reinvestment of retained earnings will not lead to faster future real earnings growth, though it will lead to faster real dividend growth. It is also observed that investing in countries with higher payout ratios results in higher earnings growth compared to low payout markets. Unfortunately, these findings do not translate to returns predictability in a persuasive fashion: the results are mixed for different countries and time periods, thus suggesting that the payout ratio is a poor predictor of returns. The positive relation between the payout ratio and subsequent real earnings growth may be due to mean reversion. If the mean-reversion hypothesis is true, then adding prior earnings growth as an additional right-hand-side variable could explicitly show the mean reversion we are testing for through a negative coefficient as poor prior 10-year real growth forecasts superior subsequent growth and vice versa. Japan is the only country with a positive lagged earnings growth variable suggesting that, for all other countries, scaling earnings by dividends produces an effective and consistent measure of mean reversion in earnings. Moreover, the US, UK, France, Germany, Netherlands and Japan all show a very marked increase in predictive power compared to when a model with only payout ratio is used as independent variable over a 5-yr horizon. This would mean that adding the lagged variable does increase the predictive power of the model, and so the efficacy of the payout ratio might be compromised. However, the 10-year results seem more consistent with the findings of Arnott and Asness (2003), who note that whilst LEG has the anticipated negative sign in their results, the predictive ability of the variable is poor and it fails to materially diminish the role of the payout ratio.

There is also good reason to believe that the ability to explain future earnings growth may be improved by considering the overall valuation of the aggregate stock market as well. For all countries, when the EY variable is added in the model, the explanatory power increases considerably indicating that the model for predicting 5-yr earnings growth is improved by including EY. The same observation can be made for regressions over the 1-yr horizon. However, the payout ratio retains its positive coefficient, indicating that the inclusion of the earnings yield variable does not detract in any meaningful way from the positive relationship observed between the payout ratio and subsequent real earnings growth.

Predicting real earnings and dividend growth is the easier part: valuing them is quite another matter! Currently the components of the S&P 500 are paying out around one-third of their earnings as dividends, well below the post-World War II average of 50-60%: given our findings this suggests an ominous outlook for earnings growth over the next few years.

In our second empirical study, we used bull and bear markets which are a common way of describing cycles in equity prices to become better acquainted with one application of survival analysis. Research, in the past decades, has focused a great deal on characterizing the dynamics returns in equity markets. In our first empirical study, one aspect that we focused on was whether the payout ratio could predict returns. In the second empirical study, we chose to study one feature of equity returns, periods of rise and fall in stock prices, that had been paid much less attention over the years but that was nonetheless one of considerable importance. We made use of this emerging statistical technique called survival analysis to study duration dependence in bull and bear markets of the eleven international markets mentioned in the first empirical study. Our models showed negative duration dependence in the bull market indicating that the probability of a bull market ending at any given duration, given that it had reached that duration, decreased with duration in the market cycle. For the bear market, the lognormal, the loglogistic and Weibull models revealed negative duration dependence. Negative duration dependence implied that more mature bull and bear markets were more robust to failure than younger bull and bear markets. The finding of duration dependence in bull and bear markets implies that stock market prices do not follow a random walk during these phases but rather possess a predictable component. Two explanations for predictable price behaviour have been offered in the literature, temporary 'fads' (Poterba and Summers, 1988; Shiller, 1989; and Delong *et al.*, 1990) and time-varying required returns (Fama and French, 1988a, 1988b). The existence of 'fads' implies the possibility of earnings excess profits while the presence of time-varying required returns is consistent with rational pricing in an efficient market. Factors such as the emergence of a regulated financial system, the widespread availability of financial information, greater trading activity in the financial markets and more activist monetary and fiscal policies on the part of government may suggest time-varying require returns as an explanation for predictable price behaviour during stock market conditions. An avenue for future research would be investigating those factors mentioned above to improve the understanding of predictability of stock prices. In addition, tests of technical trading rules can be carried out using hazard models. Importantly, if predictable behaviour in stock prices is due to 'fads', these latter tests should permit forecasting (using the hazard probabilities) of turning points in the stock market, with the potential for earning abnormal returns. One explanation for decreasing hazards could be irrational investors such as noise traders who could become more optimistic about the future when a bull market keeps up and who would therefore want to invest more in the stock market. This translated into a decreasing probability of switching out of the bull market. Conversely, length of a bear market could be related to the amount of pessimism about future returns by investors. This would lead to a substitution from equity into other expected high-return instruments such as treasury bills.

Taking the opportunity to investigate survival analysis further, we devised third empirical study to understand how survival analysis could be applied to a completely different field, more specifically how it could be used to model sovereign debt default. In this study, we provided a much more comprehensive examination of survival analysis and its related applications as the main aim of this chapter was to understand the use of this emerging statistical technique in empirical finance. Empirical work, so far, had been concentrated on investigating the importance of various economic factors in establishing the debt servicing capacity of borrowers. This study added a new dimension to the existing literature in that it focused on the length, or more specifically, the duration of a default period. We investigated the effect of certain macroeconomic and balance sheet variables on the duration of three types of debt, namely foreign currency bank debt, local currency debt and foreign currency bond debt. This was mostly done through the use of the Cox Proportional Hazards model with which we assessed the relation between the distribution of the survival time and the independent variables. The findings suggested that both macroeconomic and balance sheet variables contributed to some extent in predicting the length of default of the three types of debt. The fit of the model was improved by combining macroeconomic and balance sheet variables in one model for all types of debt. In a model that included both macroeconomic and balance sheet variables, our results showed that the level of imports, inflation, real GDP growth and long-term debt relative to total bank debt were good predictors of the length of the default period for foreign currency bank debt. Looking at local currency debt, however, we found that the medium-term debt relative to total bank debt variable was the only significant variable showing the proper sign. The only variables good at explaining duration of foreign currency bond debt default were the level of imports, exports, the exports growth rate and real GDP growth.

In order to illustrate our findings, we use the model which has been found to be the best one, from the likelihood ratio statistic, that is, the model for foreign currency bank debt featuring both macroeconomic and balance sheet variables. Those variables that are found to be significant and to have the correct sign are the level of imports, inflation, real GDP growth, and long-term debt relative to total bank debt. From the estimates of those four variables, we find that a one-unit increase in the level of imports is associated with a 0.03% increase, (e^{β}-1), in the expected time to leaving the state of default, holding all other variables constant, while a one percent increase in the level of inflation is associated with a 1.75% increase in the survival of default. On the other hand, a one percent increase in real GDP growth is associated with a 1.44% decrease in the expected time to leaving the state of default, holding all other covariates constant. Similarly, a one-unit increase in long-term debt relative to total bank debt will have the effect of reducing expected survival time in the state of default by 6.34%. Thus a country wishing to leave the state of default faster should follow the above strategies, that is, reducing the level of imports (especially if foreign exchange reserves are not up to par), level of inflation and should try to increase their real GDP growth and encourage banks to offer long-term loans since longer loan maturities are viewed as an indication of financial stability.

The explanatory power of an improved model, containing both macroeconomic and balance sheet variables, as illustrated by the likelihood ratio statistic, was best for foreign currency bank debt default. The model tried to find those variables that were significant at explaining the length of the debt default. For example, the higher the level of imports was, the lower the hazard of leaving default would be, hence a longer default. In other words, as the level of imports moved from year to year, the probability that a country left default (provided that it had already been in default at the beginning of the interval) in the next year became lower, thus indicating persistence in the default state. The model is in fact explanatory and not predictive. Predicting when default would end is beyond the scope of this study but could be investigated in future research where the hazard probabilities could be applied to determine how default in subsequent years would be modelled. In addition, the model could be refined with the inclusion of other variables such as, for example, variables measuring political risk.

Appendix I. Literature and Background on Survival Analysis

This sub-section is included to provide some insight and a better understanding about the various estimation and modelling details associated with survival analysis in general. It is provided only for the sake of thoroughness to explain how survival analysis works. The background research on survival analysis has been collected from numerous papers and books, for example, Lee (1980), Miller (1981), Parmar and Machin (1995), Singer and Willett (2003), Cox (1972). Survival analysis is a collection of statistical procedures for data analysis for which the outcome variable of interest is time until an event occurs. The problem of analysing time to event data arises in a number of applied fields, such as medicine, biology, public health, epidemiology, engineering, economics, and demography. In survival analysis, interest is focused on a group or groups of individuals for each of whom (or which) there is defined an event, often called failure, occurring after a length of time called the survival time. The survival time represents the time that an individual has "survived" over some period. The event is called a failure because the kind of event of interest usually is death, disease, incidence of some other negative individual experience. However, in our paper survival time is the time to a country getting out of default, in which case, failure is a positive event. Examples of some failure times include the lifetimes of machine components in industrial reliability, the duration of strikes or periods of unemployment in economics, the times taken by subjects to complete specified tasks in psychological experimentation, and the survival times of patients in a clinical trial. To determine whether a research question lends itself to survival analysis, we must examine the study's methodological features:

1. Target event whose occurrence is being studied
2. A time origin must be defined
3. A metric for clocking time, a meaningful scale in which event occurrence is recorded.

Event occurrence represents an individual's transition from one "state" to another "state." Event occurrence in this study is the transition from a 'default' state to a ‘non-default’ state. The time of origin is a moment when everyone in the population occupies one, and only one, of the possible states. The time of origin should be precisely defined for each individual. It need not be and is usually not at the same calendar time for each individual. The distance from the origin of time until event occurrence is referred to as the event time or survival time and each individual’s survival time is usually measured from his own date of entry. Thus, survival time is the time that a country spends in default. The metric used for measuring the passage of time should be the smallest possible unit relevant to the process under study. However much care is taken in measuring time as precisely as possible, researchers find themselves with discrete data.

Making the distinction between continuous- and discrete-time data is a very important methodological detail. Almost every feature of survival analysis from parameter definition to model construction to estimation and testing depends on the metric for time. The earliest descriptive methods for event occurrence, life-table methods, were developed for discrete-time data. However, modern methods of analysis, the Cox regression can be applied to continuous-time data. With continuous-time data there is a very low probability that two or more individuals will share an identical event time. Therefore, when that happens the ties can be eliminated from the data set.

However, when using discrete data, ties are much more likely to occur. We first review the theoretical background behind survival analysis for discrete-time. The main disadvantage with using discrete-time methods is that the survival analysis programs widely available in statistical packages cannot be used to their fullest extent. However, all steps of survival analysis, that is, parameter definition, model structure, statistical analysis, and interpretation of results are simpler and easier to understand in discrete time. Once the concepts have been explained in the simple framework, they can be extended to continuous time. The literature is therefore divided in two parts; the initial stage deals with discrete time while the later stage deals with continuous time.

I.1 Censoring

Censoring is a nearly universal feature of survival data. It occurs whenever a researcher does not know an individual's event time. There are two major reasons for censoring:

1. Some individuals will never experience the target event, and
2. Others will experience the event, but not during the study's data collection. Some of these individuals will experience the event shortly after data collection ends while others will do so at a much later time.

There are several forms of censoring. The most common distinction is between left and right censoring. Right-censoring arises when an event time is unknown because event occurrence has not yet been observed. Left-censoring arises when an event time is unknown because the origin of time is not observed. This is usually due to lapse of concentration or forgetfulness as the researcher has not specified the origin of time. Right-censoring is the most common type of censoring observed in survival analysis and, assuming that censoring occurs in this study, right-censoring is the one that is exhibited here.

I.2 Discrete-time Framework

All of the standard approaches to survival analysis are probabilistic or stochastic. This means that the times at which events occur are assumed to be realisations of some random process. It follows that T, the event time for some particular individual, is a random variable having a probability distribution. There are many different models for survival data and what often distinguishes one model from another is the probability distribution for T.

One way of describing probability distributions is the cumulative distribution function (c.d.f). The c.d.f of a variable T, denoted by F(t) is a function that tells us the probability that the variable will be less than or equal to any chosen value t. Thus,

$$F(t) = \Pr[T \leq t]$$

If we know the value of F for every value of t, then we know everything there is to know about the distribution of T. In survival analysis, one function used to describe the probability distribution of T is the survivor function, S(t).

$$S(t) = \Pr[\ T > t] = 1 - F(t)$$

The survival function gives the probability that a randomly selected individual will survive beyond t. At the beginning of time, when everyone is "surviving," the value of the survivor function is 1. Over time, as events occur, the survivor function declines towards 0.

The fundamental quantity used to assess the risk of event occurrence in each discrete-time period is known as the hazard, $h(t_{ij})$. It is the conditional probability that individual i will experience the event in time period j, given that he or she did not experience the event in any earlier time period. Because hazard represents the risk of event occurrence in each discrete-time period among people eligible to experience the event, the hazard tells us whether and when events occur.

Let T represent a discrete random variable whose value T_i indicates the time period j when individual i experiences the target event. For example, for a country that leaves the state of default in year 5, $T_i = 5$; for a country that leaves the state of default in year 3, $T_i = 3$. Usually the distribution of a random variable like T is described by:

1. Its probability density function, $\Pr[T_i = j]$, which is the probability that individual i will experience the event in time period j or
2. Its cumulative density function, $\Pr[T_i < j]$, which is the probability that individual i will experience the event before time period j.

However, the hazard function is a conditional one, and therefore can be described as:

$$h(t_{ij}) = \Pr[T_i = j \mid T_i \geq j]$$

As people experience events, they drop out of the risk set (all those people eligible to experience the event) and are ineligible to experience the event in a later period. The estimate of the discrete-time hazard is given by:

$$\hat{h}(t_j) = \frac{\text{number of events}_j}{\text{number at risk}_j}$$

The magnitude of the hazard in each time interval indicates the risk of event occurrence in that interval. When examining estimated values of discrete-time hazard, we need to remember that:

1. As a probability, the discrete-time hazard always lies between 0 and 1.
2. Within these limits, the hazard can vary widely. The greater the hazard, the greater the risk; the lower the hazard, the lower the risk.

The survivor function provides another way of describing the distribution of event occurrence over time. The estimated survivor function provides maximum likelihood estimates of the probability that an individual randomly selected from the population will "survive" or not experience the event through each successive time period. The estimate of the survivor function can be calculated as:

$$\hat{S}(t_j) = \frac{\text{number who have not experienced the event by the end of time period j}}{\text{number in the data set}}$$

Another way of formulating the estimated survival probability for year j is simply the estimated survival probability for the previous year multiplied by one minus the estimated hazard probability for that year:

$$\hat{S}(t_j) = \hat{S}(t_{j-1})[1 - \hat{h}(t_j)]$$

This equation can be re-written as:

$$\hat{S}(t_j) = [1 - \hat{h}(t_j)]\,[1 - \hat{h}(t_{j-1})]\,[1 - \hat{h}(t_{j-2})]\ldots[1 - \hat{h}(t_1)]$$

I.3 Discrete-time Hazard Models

By fitting statistical models of hazard to the data, we try to understand how the risk of event occurrence is systematically related to predictors. The type of statistical model used to represent the relationship between the hazard and the predictors depends on whether time is being measured continuously or discretely. This section deals with models for discrete-time data.

The basic discrete-time hazard model assumes that the shape of the hazard function is similar across groups but that its relative level differs. We can transform the estimated hazard probability on the y-axis into an estimated logit (hazard) probability or an estimated odds probability. Transformation can improve distributional behaviour as variables with skewed distribution can be transformed to symmetry. Odds compare the relative magnitude of two complementary probabilities: the probability that an event will occur and the probability that it will not occur.

$$\text{Odds} = \frac{\text{Probability}}{1\text{-Probability}}$$

The logit transformation represents a natural choice because it allows us to:

1. Specify the model using familiar terminology
2. Use widely available software for estimation
3. Exploit intermediate strategies with which many empirical researchers are comfortable.

Assumptions of discrete-time models

1. For each value of the predictor, there is a postulated logit hazard function. If the predictor is continuous, the population comprises as many hazard functions as there are predictor values.
2. Each of these logit hazard functions has an identical shape, although there is great flexibility in the specification of that shape.
3. The distance between each of these logit hazard functions is identical in every time period.

I.4 Observed Heterogeneity

In observed heterogeneity, the population is heterogeneous. This means that individuals will have different hazard functions if they have different values for observed predictors. Observed heterogeneity is introduced into the definition of hazard by first identifying predictors hypothesized to be associated with event occurrence. Some predictors will be time-invariant while others will be time-varying. Time-varying predictors will take on different values in each time period.

Let X_{1ij}, X_{2ij}, …., X_{Pij} represent the P predictors for individual i in each time period. Therefore, the hazard function can be written as

$$h(t_{ij}) = \Pr[T_i = j \mid T_i \geq j \text{ and } X_{1ij} = x_{1ij}, X_{2ij} = x_{2ij}, \ldots, X_{Pij} = x_{Pij}]$$

where x_{Pij} represents individual i's values for the p^{th} predictor in time period j. The above equation shows that the population value of hazard which is the probability that an individual will experience the target event in that time period conditional on no prior event occurrence depends on the values for the P predictors. However, the functional form of that dependence is not specified. If we use the logit form of the hazard, we can write the population discrete-time hazard model as being:

$$\text{logit } h(t_{ij}) = \alpha_j + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \ldots + \beta_P X_{Pij}$$

When all P predictors are 0, the equation represents the baseline logit hazard function. The β's multiplied by their respective predictors represent the shift in the baseline logit hazard function corresponding to unit differences in the associated predictors. The maximum likelihood function for the discrete-time hazard model is given by:

$$\text{Likelihood} = \prod_{i=1}^{n} \prod_{j=1}^{J_i} h(t_{ij})^{EVENT_{ij}} (1 - h(t_{ij}))^{(1-EVENT_{ij})}$$

Censored individuals contribute terms of the second type only. The likelihood equation can also be expanded to:

$$\text{Likelihood} = \prod_{i=1}^{n} \prod_{j=1}^{J_i} [1/(1 + e^{-\{ \alpha j + \beta 1 X1ij + \beta 2\ X2ij + \ldots + \beta P\ XPij \}})]^{EVENTij}$$

$$X\ [1- 1/(1 + e^{-\{ \alpha j + \beta 1 X1ij + \beta 2\ X2ij + \ldots + \beta P\ XPij \}})]^{(1-EVENTij)}$$

Taking logarithm on both sides:

$$LL = \sum_{i=1}^{n} \sum_{j=1}^{J_i} EVENT_{ij} \log h(t_{ij}) + (1-EVENT_{ij}) \log(1- h(t_{ij}))$$

The aim is to find those values of α and β to calculate the values of $h(t_{ij})$ that maximise the log likelihood function.

I.5 Deviance Statistics – How to determine goodness-of-fit.

The larger the log likelihood (LL) statistics, the better the fit. The LL statistics is used to compute a deviance statistic, which for a given set of data, quantifies how much worse the current model is in comparison to the best possible model.

$$\text{Deviance} = -2^{*}\text{loglikelihood}_{\text{current model}}$$

The deviance statistic for a discrete-time hazard model will always be greater than 0, unless it is computed for the full model in which case it will be exactly 0. The better the fit of the current model, the smaller its deviance.

If the aim is to choose between models that include different predictors, then it is a good idea to compare non-nested models using AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) as long as the focal models are fit to the same data set. Both the AIC and the BIC are based on the log-likelihood statistic. Each decreases the LL according to pre-specified criteria. The AIC penalty is based upon the number of parameters. This is because adding parameters – even if they have no effect- will increase the LL statistic thereby decreasing the deviance statistic. In addition to the number of parameters, the BIC's penalty is based also on the sample size. In larger samples, a larger improvement is needed before we choose a more complex model.

Information Criterion = -2[LL – (scale factor)(number of model parameters)]

= Deviance + 2(scale factor)(number of model parameters)

For AIC, the scale factor is 1 while for BIC it is half the log of the sample size (number of individuals under study). The model with the smaller information criterion (either AIC or BIC) is the better one.

I.6 Statistical Inference using asymptotic standard errors

An alternative strategy for testing hypotheses about predictors' effects is to compare a parameter estimate to its asymptotic standard error (*ase*). The *ase* measures the precision of an estimate; the smaller the *ase*, the more precise the estimate. The sampling distribution of a maximum likelihood parameter estimate is asymptotically normal, which means that we can use *ase*'s to test hypotheses about population values of model parameters and construct confidence intervals around their associated estimates. A Wald chi-square statistic compares a maximum likelihood parameter estimate to its asymptotic standard error in much the same way as a t-statistic in regression analysis compares least-squares parameter estimate to its standard error. But unlike the t-statistic, which, under the null hypothesis that a parameter is 0, is simply the ratio of these two quantities, the Wald chi-square statistic squares this ratio yielding a test statistic that has a χ^2 distribution on one degree of freedom. When the Wald chi-square statistic is large relative to critical value of the χ^2 distribution, we reject the null hypothesis.

I.7 Insertion of time-varying predictors in a discrete-time hazard model

A time-varying predictor can take on different values in different time periods. However, no special procedure is necessary to include time-varying predictors into a discrete-time hazard model. We can specify a logit link model that includes a time-varying (X_{2ij}) and a time-invariant variable (X_{1i}) as follows:

$$\text{logit}\, h(t_{ij}) = \alpha_j + \beta_1 X_{1i} + \beta_2 X_{2ij}$$

The model states that for individual i, the value of logit hazard in time period j depends on the value of X_1 which is constant across all time periods and on the value of X_2 in time period j. A logistic regression is then used to regress the event indicator on variables representing the desired predictors. In some contexts, it might be more logical to use lagged predictors to link prior predictor status with current outcome status.

I.8 Continuous-Time Event Occurrence Data

In order to get the maximum information possible, it is recommended to use the finest metric system to record event occurrence. Continuous-time data has the following two properties:

1. The probability of observing any particular event time is infinitesimally small. In continuous time, the probability that an event will occur at any specific instant approaches 0. The probability may not reach 0, but as time's divisions become finer and finer, it becomes smaller and smaller.
2. The probability that two or more individuals will share the same event time is also infinitesimally small. If the probability of event occurrence at each instant is infinitesimally small, the probability of co-occurrence (a "tie") must be smaller still.

Survivor Function

Let T be a continuous random variable where values T_i indicate the precise instant when individual i experiences the target event. The survival probability for individual i at time t_j is the probability that his event time T_i will exceed t_j.

$$S(t_{ij}) = \Pr[T_i > t_j]$$

The initial value for the continuous-time survivor function is 1. As can be seen, there is no difference in the survivor function in either discrete-time or continuous-time.

Hazard Function

The hazard function assesses the risk at a particular moment that an individual who has not yet done so will experience the target event. In discrete time, the hazard is expressed as a conditional probability as the moments are time periods. In continuous time, this definition of hazard no longer applies as the moments are infinite number of infinitesimally small instants of time that exist within any finite time period. If there are an infinite number of instants when an event can occur, the probability that an event does occur at any particular instant must approach 0 as the units of time get fine. At the limit, in truly continuous time, the probability that T takes in any specific value t_j has to be equal to 0. Therefore, the hazard would no longer be described as a conditional probability as it would be 0 at all values of t_j. Singer and Willet (2003) advance that hazard should quantify risk at particular instants, but mathematically, risk can be quantified only by cumulating together instants to form intervals. They further go on to say that statisticians resolve this dilemma by recognizing that instants and intervals can be thought of as one and the same if the intervals are so small that they can be thought of as instants. This argument relies in the simple basis that when a finite period of time is divided into smaller and smaller units, a corresponding series of intervals is created.

Singer and Willet look at an example to test this argument. They state that if we divide a finite time period, for example a year, into increasingly smaller units we get 365 one-day intervals. But if we divide each day into hours, we have 365*24 = 8,760 one-hour intervals. Dividing each of these into minutes, we have 365*24*60 = 525,600 one-minute intervals which ultimately lead to 365*24*60*60 = 31,536,000 one-second interval. As we use finer and finer units, we eventually find that this finite time period includes an infinite number of intervals, each so narrow that it appears to be an instant. In essence, then, instants and intervals are one and the same if the width of the interval approaches but never quite reaches 0.

Mathematicians codify this argument by letting the symbol Δt represent the vanishing width of each of these infinitesimally small intervals. This allows us to write the j^{th} time interval as $[t_j, t_j + \Delta t)$, where the opening bracket indicates that the instant t_j falls just inside the interval and the closing parenthesis indicates that the next instant, $t_j + \Delta t$, falls just outside. In defining the hazard function, we have to account for the width of the interval as the probability in a one-second interval is different from the probability in a one-nanosecond interval. Therefore, individual i's continuous-time hazard at time t_j can be defined to be:

$$h(tij) = \text{limit as } \Delta t \rightarrow 0 \ \left\{ \frac{\Pr [T_i \text{ is in the interval}[t_j, t_j + \Delta t) \mid T_i \geq t_j}{\Delta t} \right\}$$

The continuous-time hazard is not a probability, but rather it is a rate assessing the conditional probability of event occurrence per unit time. One important difference between continuous-time hazard rates and discrete-time hazard probabilities is that rates are not bounded from above. Although neither can be negative, rates can easily exceed 1.0. The possibility that continuous-time hazard rates can exceed 1 has serious consequences because it requires that we revise the statistical models that incorporate the effects of predictors. We cannot hypothesize a model in terms of logit hazard because that transformation is only defined for values of hazard between 0 and 1. As a result, when we specify continuous-time hazard models, our specification will focus in the logarithm of hazard, a transformation that is defined for all values of hazard greater than 0.

Our aim is to estimate a value for the survivor and hazard functions at every possible instant when an event could occur. We can do so only if we are willing to adopt constraining parametric assumptions about the distribution of event times. Statisticians have identified many different distributions, for example, Weibull, Gompertz, gamma and log-logistic, that event times might follow. Nonparametric methods are also popular in estimating values for the survivor as well as the hazard functions and this is mainly because there is no need to make constraining assumptions about the distribution of event times. For a long time, statisticians have calculated nonparametric estimates of the continuous-time survivor and hazard functions by grouping event times into a small number of intervals, constructing life tables and applying discrete-time strategies. One such method of constructing a grouped life table is described here.

I.9 Grouped Life Table

When choosing an interval, we have to choose one that is substantively meaningful, is coarse enough to yield stable estimates and is fine enough to reveal discernible patterns. All intervals need not be of the same width but it might be better to use wider intervals at later times to obtain risk sets of adequate size. Then the discrete-time estimator of the continuous-time survivor function is obtained by applying discrete-time principles to the data in the grouped life table. A new quantity, $P(t_j)$ is introduced and is the conditional probability that a member of the risk set at the beginning of interval j will experience the target event during that interval. Let *n at risk*$_j$ represent the number of individuals at risk at the beginning of interval j and *n events*$_j$ indicate the number of individuals who experience the event during that interval. $P(t_j)$ is estimated to be:

$$p(tj) = \frac{n\ events_j}{n\ at\ risk_j}$$

The survivor function at time t_j is obtained by multiplying the successive probabilities of surviving through each interval from the 1st to the jth. Each of these probabilities in turn is just the complement of the conditional probability of event occurrence during the interval.

$$\hat{S}(t_j) = (1-p(t_1))(1-p(t_2))\ldots(1-p(t_j))$$

The hazard equation defines the hazard rate as the limit of the conditional probability of event occurrence in a vanishingly small interval divided by the interval's width. A logical estimator is therefore the ratio of the conditional probability of event occurrence in an interval to the interval's width.

$$\hat{h}(t_j) = \frac{p(t_j)}{width_j}$$

One problem with the discrete-time method is that grouped estimation methods artificially categorise a continuous variable. Different categorisations will give different estimates and for truly continuous data, categorisation makes little sense. It should be possible to use the actual event times to describe the distribution of event occurrence. This idea forms the basis of the Kaplan-Meier method, also known as the product-limit method.

The Kaplan-Meier method is a simple extension of the discrete-time method with a fundamental change: instead of rounding event times to construct the intervals, it capitalises on the raw event times and constructs intervals so that each contains just one observed event time. Each Kaplan-Meier interval begins at one observed event time and ends just before the next. By convention, we also construct an initial interval which begins at t_0 and ends immediately before the first event. If an individual is censored at an observed event time, we "break the tie" by assuming that the event preceded the censoring. The same equation that is used in the grouped life table is also used here to calculate the survivor function. Although there is no Kaplan-Meier estimate for the hazard, we apply the discrete-time estimator of hazard to the data in the Kaplan-Meier intervals.

$$\hat{h}_{KM}(t_j) = \frac{p_{KM}(t_j)}{\text{width}_j}$$

However, because the risk set decreases while the number of events in each interval remains constant, the numerator of this equation rises. Dividing by the interval width is just a means of averaging these increasing values across their respective intervals. When the interval width varies, the resulting estimates vary from one interval to the next. This causes the estimated values to be so erratic that pattern identification is almost impossible.

As Kaplan-Meier estimates of hazard are too erratic to be meaningful, we use the cumulative hazard function, $H(t_{ij})$. The cumulative hazard function assesses at each point in time the total amount of accumulated risk that an individual i has faced from the beginning of time until the present. At time t_j, individual i's value of cumulative hazard is defined as:

$$H(t_{ij}) = \underset{\text{between } t_0 \text{ and } t_j}{\text{cumulation}} [h(t_{ij})]$$

Because $H(t_{ij})$ literally cumulates hazard, examination of its changing level over time tells us about the shape of the underlying hazard function. Although cumulation prevents it from describing the unique risk at each particular instant – that, after all, is what the hazard function assesses – comparison of its changing levels allows us to deduce this information.

There are two ways to estimate the cumulative hazard function:

1. Nelson-Aalen method which is based on Kaplan-Meier type hazard estimates.
2. The negative log survivor function method which is based on Kaplan-Meier survivor function estimates.

Nelson-Aalen Method

If $H(t_{ij})$ cumulates together all the "hazard" that exists at all possible instants between t_0 and t_j, a reasonable estimate would total all estimated hazard that exists between theses points in time. Each estimates the value of hazard at an "average instant" during its associated interval. To compute the total amount of hazard that exists during all instants in interval j, simply multiply the hazard estimate by its interval's width:

$$\text{Total hazard during interval } j = \hat{h}_{KM}(t_j)\ \text{width}_j$$

The Nelson-Aalen estimator simply sums up these interval-specific estimates:

$$\hat{H}_{NA}(t_j) = \hat{h}_{KM}(t_1)\ \text{width}_1 + \hat{h}_{KM}(t_2)\ \text{width}_2 + \ldots + \hat{h}_{KM}(t_j)\ \text{width}_j$$

Negative log survivor function method

This method uses the relationship between the cumulative hazard and the survivor function where

$$H(t_{ij}) = -\ln S(t_{ij})$$

Hence,

$$\hat{H}_{LS}(t_j) = -\ln \hat{S}_{KM}(t_{ij})$$

This equation can also be expressed in terms of rate of change where, rate of change in $H(t_{ij})$ must be equal to the rate of change in $-\ln S(t_{ij})$. However, the rate of change in cumulative hazard is simply the hazard function itself, which means that

$$h(t_{ij}) = \text{rate of change in } \{-\ln S(t_{ij})\}$$

I.10 Statistical Modelling of Continuous-Time Hazard

We represent the population relationship between continuous-time hazard and predictors in much the same way as we represent the population relationship between discrete-time hazard and predictors. However, as continuous-time hazard is a rate and not a probability, we treat its logarithm, not its logit, as the dependent variable. The new continuous-time model expresses log hazard as the sum of two components:

1. A baseline function, the value of log hazard when the values of all predictors are 0.
2. A weighted linear combination of predictors, whose parameters assess the shift in log hazard associated with unit differences in the corresponding predictor.

This representation is known as the Cox regression model (1972), also often called the proportional hazards model. The Cox model formula says that the log cumulative hazard function is the product of the general baseline log cumulative hazard function and the predictor (X_i).

$$\text{Log } H(t_{ij}) = \log H_0(t_j) + \beta_1 X_i$$

$$\text{When } X = 0, \text{ Log } H(t_{ij}) = \log H_0(t_j)$$

$$\text{When } X = 1, \text{ Log } H(t_{ij}) = \log H_0(t_j) + \beta_1$$

This second function is just a vertically shifted version of the first, where β_1, the parameter associated with the predictor, measures the size of the vertical displacement. We can also re-express the model as

$$H(t_{ij}) = H_0(t_j).e^{\beta 1 Xi}$$

With this transformation, the right-hand side of the model becomes non-linear.

$$\text{When } X = 0, H(t_{ij}) = H_0(t_j)$$

$$\text{When } X = 1, H(t_{ij}) = H_0(t_j).e^{\beta 1}$$

The fundamental difference between the two representations of the Cox model surrounds the metric in which we interpret the time-constant effect:

1. $e^{\beta 1}$ measures the effect of the predictor on raw (not log) cumulative hazard.
2. β_1 measures the effect of the predictor on log cumulative hazard.

In both cases, the effect of the predictor is assumed to be time-invariant. If we let X_1 through X_p represent P predictors, we may formulate the general Cox regression model as follows:

$$H(t_{ij}) = H_0(t_j).e^{[\beta 1X1ij \ + \ \beta 2X2ij + \ldots + \beta pXpij]} \quad \text{or,}$$

$$\text{Log } H(t_{ij}) = \log H_0(t_j) + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \ldots + \beta_p X_{pij}$$

We can also substitute $h(t_{ij})$ for $H(t_{ij})$ and re-write the Cox model as follows:

$$h(t_{ij}) = h_0(t_j).e^{[\beta 1X1ij \ + \ \beta 2X2ij + \ldots + \beta pXpij]} \quad \text{or,}$$

$$\text{Log } h(t_{ij}) = \log h_0(t_j) + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \ldots + \beta_p X_{pij}$$

<u>Assumptions of the Cox model</u>

1. For each value of the predictor, there is a postulated hazard function. If the predictor is dichotomous, we postulate two log hazard functions. If the predictor is continuous, we postulate that there are as many log hazard functions as there are values of the predictor.
2. Each of these log hazard functions has an identical shape, although we don't place any constraints on the specification of that shape. The shape of each log hazard function is constrained to be the same across all predictor values. Within this constraint, the function can take on any form necessary to adequately describe the distribution of event occurrence in the population.
3. The distance between each of these log hazard functions is identical at every possible instant. Regardless of the common shape of the postulated log hazard functions, the difference in their level is constant over time. We do not allow the gap to be smaller during some periods and larger during others. This means that the effect of the predictor on log hazard is constant over time.

Cox's 1972 paper offers a convincing model and an ingenious new method of estimation known as partial maximum likelihood estimation which is used to fit a Cox regression model to data. Although partial maximum likelihood (ML) does not provide direct estimates of the baseline function, its estimates share many asymptotic properties associated with other maximum likelihood estimates: consistency, efficiency and normality. The partial ML estimation uses a two-step:

1. constructing a partial likelihood function – an equation that expresses the probability of observing the sample data as a function of the unknown parameters.
2. numerically examining the relative performance of alternative estimates of the unknown parameters until those values that maximise the partial likelihood are found.

In constructing a full likelihood function, our main question is "What is the probability that individual i experiences his observed event time?" In partial likelihood, however, the main question is "Given that someone experienced an event at time t_j, what is the probability that it was individual i?" The conditional argument means that only those individuals who actually experience the target event will contribute an explicit term. This is different from full ML, in which every person contributes an explicit term, regardless of whether his or her event time is observed or censored.

In order to construct the partial likelihood function, each individual's contribution is evaluated: the conditional probability that individual i experiences the event at time t_j, given that someone still at risk does. Then, we multiply together all individual contributions to obtain the partial likelihood function.

$$\text{Partial likelihood} = \prod_{\substack{\text{noncensored}\\ \text{individuals}}} \frac{h(t^*_{ij})}{\sum_{\text{risk set at } t^*_{ij}} h(t^*_{ij})}$$

where t^*_{ij} is the time t_j when individual i experiences the target event. Someone who faces a high hazard when he experiences the event will contribute a large term and someone who faces a low hazard will contribute a small term. The partial likelihood function can also be re-written more explicitly as:

$$\text{Partial Likelihood} = \prod_{\substack{\text{Noncensored} \\ \text{Individuals}}} \frac{h_0(t_j).e^{[\beta 1X1ij\ +\ \beta 2X2ij + \ldots + \beta pXpij]}}{\sum_{\text{risk set at } t^*_{ij}} h_0(t_j).e^{[\beta 1X1ij\ +\ \beta 2X2ij + \ldots + \beta pXpij]}}$$

The unknown baseline hazard ($h_0(t_j)$) is common in both the numerator and denominator, which means that it cancels out. Invoking the proportionality assumption allows us to use the partial likelihood method to fit the model without specifying anything about the shape of the baseline hazard. Another point to note with the Cox model is that the precise event times are irrelevant; only their rank order matters. To estimate parameters, we compare a weighted linear combination of each person's predictor values to a similar weighted linear combination among everyone still in the risk set when that person experiences the target event.

I.11 Interpreting Parameter Estimates

1. Each raw coefficient (β_1) describes the effect of a one-unit difference in the associated predictor on log hazard.
2. The antilog of each coefficient, $e^{(\text{coefficient})}$, describes the effect of a one-unit difference in the associated predictor on raw hazard.

I.12 Inclusion of Time-varying Predictors in a Cox Regression Model

As an example, we can specify a Cox regression model with one time-invariant (X_1) and one time-varying predictor (X_{2j}) as follows:

$$h(t_{ij}) = h_0(t_j).e^{[\beta 1X1i\ +\ \beta 2X2ij\ ]}$$

Taking logarithms on both sides:

$$\text{Log } h(t_{ij}) = \log h_0(t_j) + \beta_1 X_{1ij} + \beta_2 X_{2ij}$$

One problem that time-varying predictors pose, though, is that for each predictor, we need to know its value for everyone still at risk, at every moment when someone experiences the target event.

I.13 Nonproportional Hazards Models

A Cox regression model involves a proportionality assumption, that the hazard function for each individual in the population is a constant multiple of a common baseline function. If we find that subgroups of individuals have different baseline hazard functions, we have two options

1. Fit a stratified model which posits explicitly the existence of the multiple baseline hazard functions.
2. Fit a model that includes an interaction with time as a predictor to represent the time-varying effect.

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