

Time-Varying Market Leverage and the Market Risk Premium in New Zealand

by

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Abstract

This paper applies the Ibbotson and Sinquefeld (1976) method and the Lally (2002) method to New Zealand data over the period 1960–2005 in order to estimate the market risk premium (MRP) in two versions of the capital asset pricing model (CAPM). With respect to the standard CAPM, the resulting Ibbotson estimate of the MRP for New Zealand was 6.11%. The resulting Lally estimate of the MRP ranged from 5.52% (in 1970) to 18.40% (in 1990), with an average of 7.95%, and was 6.40% for 2005. With respect to the simplified Brennan-Lally CAPM, the resulting Ibbotson estimate of the MRP for New Zealand was 8.49%. The resulting Lally estimate of the MRP ranged from 7.91% (in 1970) to 20.79% (in 1990), with an average of 10.33%, and was 8.78% for 2005. The Lally and the Ibbotson estimates of the MRP are similar in general. However, when market leverage is unusually high or low, they diverge significantly. In future, practitioners may need to choose between the estimates from the two methods when market leverage goes beyond the normal level.

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Chapter 1

Introduction

Equity investment is very risky, in the sense that equity returns are highly volatile and equity holders do not have priority over a company's assets in the event of bankruptcy. The reward for bearing this risk from holding equities, rather than the risk free asset, is called the market risk premium (MRP). In the standard Capital Asset Pricing Model (Sharpe, 1964; Lintner, 1965; Mossin, 1966), it is defined as the expected return on the market portfolio in excess of the risk free rate of return, and is a forward-looking concept.

The MRP has attracted considerable attention in the field of modern corporate finance. It is a key factor in determining the cost of equity in any version of the Capital Asset Pricing Model (CAPM). A good estimate of the MRP enables better investment decision making, more efficient portfolio management, and more reasonable setting of target returns for companies or government organisations.

The MRP cannot be observed and has to be estimated. Various approaches to estimating the MRP have been developed, including historical averaging approaches, forward-looking approaches, and time-varying approaches. The two principal historical averaging approaches are the Ibbotson and Sinquefeld (1976) method and the Siegel (1992) method. While the former estimates the MRP by averaging the market return in

excess of the risk free rate over a long period, the latter averages the real market return and then deducts the expected real risk free rate. Forward-looking approaches are different from historical averaging approaches in that they estimate the MRP from future expectations rather than from historical data. Two principal such approaches are the dividend discount model (DDM) and the residual income model (RIM). The DDM treats the expected market return as the discount rate and values the market portfolio by discounting future expected dividends. The RIM is derived from the DDM. It values the equity as the sum of its current book value and the present value of its expected future abnormal earnings (beyond a fair rate of return on equity). Time-varying approaches associate the MRP with a market factor that varies over time. Merton (1980) introduces the method by modelling the MRP as proportional to market variance (or standard deviation). Although previous studies have shown evidence of a positive relationship between the MRP and market variance, the form of the relationship remains unclear.

Lally (2002) develops a time-varying MRP estimator, which overcomes some problems with the Merton estimator. The Lally method is based on the work of Modigliani and Miller (1958, 1963), whose proposition II specifies the relationship between a company's cost of equity and its leverage. When the market portfolio is proxied by an equity portfolio (as usual), market leverage (the aggregate debt of companies comprising the market portfolio divided by their aggregate value) should therefore affect the expected return on the "market" portfolio and hence the MRP. The variation over time in market leverage can be substantial. For example, the 1987 stock market crash caused large reductions in equity values, and consequently raised market leverage. Accordingly, the MRP should have risen. Therefore, the MRP should be sensitive to market leverage if the market portfolio contains only equities.

The motivation for this paper is to apply Lally's leverage-sensitive MRP estimator to New Zealand data and to examine how the estimated MRP

varies with market leverage over time. As the Lally MRP estimator has not yet been applied to New Zealand data, the results may be of interest to both academics and practitioners.

Chapter 2 reviews the current literature on three major approaches to estimating the MRP: historical averaging approaches, forward-looking approaches, and time-varying approaches. Their benefits and limitations are discussed. Chapter 3 describes the application of the Lally MRP estimator and the Ibbotson MRP estimator to New Zealand data over the period 1960–2005. It describes the methods involved in estimating the MRPs in both the standard CAPM and the simplified Brennan-Lally CAPM (Cliffe and Marsden, 1992; Lally, 1992). It also discusses the collection processes for the five required data sets under the standard CAPM: market returns, risk free rates of return, market debt values, market equity values, and the returns on corporate bonds. Chapter 4 provides the results from applying the two MRP estimators. With respect to the standard CAPM, the Lally MRP estimate ranged from 5.52% to 18.4% over the period 1960–2005, with an average of 7.95% and a value of 6.40% for 2005, whereas the Ibbotson MRP estimate was 6.11%. With respect to the simplified Brennan-Lally CAPM, the Lally estimate ranged from 7.91% to 20.79%, with an average of 10.33% and a value of 8.78% for 2005, whereas the Ibbotson estimate was 8.49%. Chapter 5 concludes.

Chapter 2

Literature Review

The market risk premium (MRP) is very important in determining the cost of equity. However, it is not observable and has to be estimated. Over the course of many studies, various approaches to estimating the MRP have been suggested. This chapter first introduces two forms of the Capital Asset Pricing Model (CAPM), for which various approaches to estimating their MRPs have been adopted using New Zealand data. It then provides a brief discussion on three major types of approaches to estimating the MRP: historical averaging approaches, forward-looking approaches, and time-varying approaches. Previous applications of these approaches to New Zealand data are also summarised.

2.1 Two Forms of the CAPM

There are two forms of the CAPM that we will consider when estimating the MRP for New Zealand, consistent with their widespread use in New Zealand. One is the standard version of the CAPM, and the other is the Brennan-Lally version of the CAPM.

In the standard CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966), the MRP is defined as $E(R_m) - R_f$, where $E(R_m)$ is the expected rate of return on the market portfolio and R_f is the risk free rate of return. The standard

CAPM has been applied worldwide for many years. However, for New Zealand purposes, this version of the CAPM neglects the local taxation features, such as the dividend imputation system.

The Brennan-Lally version of the CAPM (Cliffe and Marsden, 1992; Lally, 1992) is an extension of the work of Brennan (1970). It defines the MRP as $E(R_m) - D_m T_m - R_f(1 - T_I)$, where D_m is the cash dividend yield on the market portfolio, and T_m and T_I are tax parameters. A simplified version of it assumes that capital gains taxes are zero for all investors, and that imputation credits are attached at the maximum possible rate. Currently, the values for T_m and T_I are generally agreed to be zero and 0.33, respectively, in the simplified version.

The Brennan-Lally CAPM takes into account differential personal taxes on interest income, capital gains, and dividends. It has been favoured by many New Zealand organisations¹ in recent decades. In practice, it is common for the MRP to be estimated under both the standard CAPM and the Brennan-Lally CAPM.

2.2 Approaches to Estimating the MRP

A significant body of literature discusses a variety of approaches to estimating the MRP. Three major types are historical averaging approaches, forward-looking approaches, and time-varying approaches. The following section summarises this literature.

2.2.1 Historical Averaging Approaches

The two principal historical averaging approaches are the Ibbotson and Sinquefeld (1976) method and the Siegel (1992) method. The former method

¹For example, The Treasury, the Commerce Commission, Transpower, Telecom NZ, First New Zealand Capital, Goldman Sachs JBWere Ltd, PricewaterhouseCoopers, and Forsyth Barr.

has been applied to New Zealand data by Chay et al. (1993, 1995), Price-waterhouseCoopers (2002), and Lally and Marsden (2004b), and the latter method has been applied by Lally and Marsden (2004a) and Marsden (2005).

Ibbotson Method

The Ibbotson method, introduced by Ibbotson and Sinquefeld (1976), is the simplest and most widely applied method for estimating the MRP within the standard CAPM. It estimates the MRP by averaging the historical annual excess return (the market return in excess of the risk free rate of return) over a long term. The Ibbotson method is based on the presumption that the true value of the MRP does not change over time. Hence, averaging past data provides an unbiased estimate for the future.

However, changes in various factors call into question the presumption of a constant MRP. Mayfield (2004) indicates that the Ibbotson method can lead to seriously biased MRP estimates in the presence of a structural shift in market volatility. The scaling back of strict government intervention in the New Zealand economy in 1984, the stock market crash in 1987, and the introduction of the dividend imputation system in New Zealand in 1988 could have had an impact on the true value of the MRP. McCulloch and Leonova (2005) list a series of potential changes (e.g. lower costs for investment diversification, reduction in transaction costs, lower risk aversion of investors, etc.) to the New Zealand capital market, which may alter the MRP in the future. All these lead to a major issue with the Ibbotson method: the choice of the time span.

The choice of time span involves a tradeoff between data relevance and statistical precision. Using historical data over a long period raises the possibility of the older data being irrelevant to the estimation of the MRP for the future, when the true MRP shifts over time. However, using a short period can also be problematic. Stock returns are so volatile that averaging over a short period will lead to large statistical errors (i.e. a large

confidence interval for the estimated MRP). Pastor and Stambaugh (2001) demonstrate that using a long sample period improves the MRP estimate even if structural breaks exist in historical equity returns. Siegel (1992) implies that estimation errors can be substantial even using a very long time series of data (US data over nearly 200 years). Hence, although the optimal time period is unclear, a long period would seem to be preferable.

Another major concern with the Ibbotson method relates to the form of averaging. Lally and Marsden (2004b) show that using the arithmetic average of the historical annual excess return generates an MRP estimate of 5.5%, while the geometric average generates an estimate of 2.9%. Hence, the form of averaging can significantly affect the estimate of the MRP.

Consideration must be given not only to the accuracy of this average but also to the use to which this average is put. Blume (1974) shows that the compounded arithmetic mean (A^n) is biased upwards and the compounded geometric mean (G^n) is biased downwards. Hence, for compounding purposes, he proposes a new estimator — the weighted average of the compounded geometric and arithmetic means. This would provide a value somewhere between them. Blume's assessment of biases, by using different forms of averaging, assumes independently distributed equity returns. Where the distribution of equity returns is dependent, Blume suggests that the arithmetic average still introduces the least bias. However, Indro and Lee (1997) show that, with serial correlation in equity returns, Blume's weighted estimator provides the least biased estimate. While both Blume (1974) and Indro and Lee (1997) use the estimator for compounding, Cooper (1996) uses it for discounting, and finds that the arithmetic mean is less biased than the geometric mean as a discount rate. Since the MRP is popularly used to value projects, the accuracy of discounting is more important than compounding. Hence, Cooper's analysis, which is concerned with discounting, is more relevant, and it is therefore reasonable to favour the arithmetic average.

Other issues that arise from use of the Ibbotson method relate to the use

of long-term or short-term government bond yields as a proxy for the risk free rate (Booth, 1999), the use of an equity portfolio as a proxy for the market portfolio (Roll, 1977; Kandel and Stambaugh, 1987; Shanken, 1987; Roll and Ross, 1994), survivorship bias (Brown et al., 1995; Jorion and Goetzmann, 1999; Dimson et al., 2000), and the effects of unexpected inflation on real market returns and bond returns (Siegel, 1992, 1999). Nevertheless, the Ibbotson method still attracts considerable attention, as it is easily applied, the required data sets are usually obtainable, and the results are relatively stable over time.

Siegel Method

Siegel (1992, 1999) argues that the Ibbotson MRP estimate is biased upwards due to unexpected inflation in the period 1926-90, especially 1965-85. As companies can, in general, raise their output prices to maintain their real returns but bond payoffs are fixed, unexpected inflation lowers the real return on government bonds but has almost no effect on real (equity) market returns. Put another way, unexpected inflation does not change nominal bond returns but it raises equity returns. This results in the Ibbotson MRP estimate being biased upwards in the presence of unexpectedly high inflation.

In view of this, Siegel (1992) uses historical averaging of the real market return, and then deducts an estimate of the expected real risk free return (rather than the historical average of the real risk free return), to estimate the MRP. Siegel's MRP estimate is much smaller than the Ibbotson estimate. Over the sample period 1802-1990, it is about half of the corresponding Ibbotson estimate for the US. Lally and Marsden (2004a,b) show a much smaller difference (within 1.7%) between the Siegel and the Ibbotson estimates in New Zealand. Hence, the Ibbotson MRP estimate for New Zealand has not been affected by unexpected inflation as much as for the US.

2.2.2 Forward-Looking Approaches

Unlike historical averaging approaches, which estimate the MRP from historical data, forward-looking approaches estimate the MRP from expectations of the future. Hence, forward-looking approaches avoid most limitations of the historical averaging approach. They are consistent with the MRP being a forward-looking concept. Two principal forward-looking approaches are the dividend discount model (DDM) and the residual income model (RIM). Lally (2001) has applied the DDM to New Zealand data. To my knowledge, the RIM has not yet been applied in New Zealand.

Dividend Discount Model

The DDM values the market portfolio (which is usually proxied by an equity portfolio) through discounting future expected dividends by the expected market return:

$$P_m = \frac{DIV_m(1 + g_1)}{1 + E(R_m)} + \frac{DIV_m(1 + g_1)(1 + g_2)}{[1 + E(R_m)]^2} + \dots \quad (2.1)$$

where

$$\begin{aligned} DIV_m &= \text{current market dividends} \\ g_1, g_2, \dots &= \text{expected dividend growth rates for year 1, 2, ...} \\ E(R_m) &= \text{expected market return} \\ P_m &= \text{current value of the market portfolio.} \end{aligned}$$

Dividing both sides by P_m gives:

$$1 = \frac{DY_m(1 + g_1)}{1 + E(R_m)} + \frac{DY_m(1 + g_1)(1 + g_2)}{[1 + E(R_m)]^2} + \dots \quad (2.2)$$

where DY_m represents the current market dividend yield and is observable. By inputting the value for DY_m and the estimates for the expected dividend growth rate (g_1, g_2, \dots), the expected market return $E(R_m)$ can be estimated through equation 2.2. Given the risk free return (R_f), the MRP can then be estimated through $MRP = E(R_m) - R_f$ in the standard

CAPM. Alternatively, the DDM can be applied at the individual company level first. The resulting estimates of each company's expected equity return are then value weighted, to yield an estimate for the expected market return and hence the estimate of the MRP.

Different assumptions have been made about the expected dividend growth rates, resulting in three versions of the DDM: the one-stage version, the two-stage version, and the three-stage version.

The one-stage version of the DDM refers to the Gordon (1962) dividend growth model, where the expected dividend growth rate is assumed to be constant in perpetuity. Hence, equation 2.2 can be simplified to:

$$1 = \frac{DY_m(1 + g)}{E(R_m) - g} \quad (2.3)$$

where $g = g_1 = g_2 = \dots$. Consequently,

$$E(R_m) = DY_m(1 + g) + g. \quad (2.4)$$

Harris and Marston (1992) use the five-year earnings growth rate forecast by equity analysts as a proxy for g , and generate an average of the MRP estimates for the US over the period 1982–91 at 6.47%. However, Claus and Thomas (2001) argue that the Gordon model produces an MRP estimate that is biased upwards; since the five-year earnings growth rate substantially exceeds the expected growth rate in GDP, it is too large to be a reasonable proxy for the expected dividend growth in perpetuity.

Both the two-stage and the three-stage versions of the DDM separate the expected dividend growth rate into a short-run part and a long-run part. While the two-stage version of the DDM requires the short-run rate to converge to the long-run rate immediately, the three-stage version contains a transition period. Damodaran (1999) applies the two-stage version of the DDM to 1997 US data (with a short-run earnings growth rate estimated at around 10% over the first five years and a long-run rate estimated at 5% thereafter), yielding an MRP estimate of 2.95%. Cornell (1999)

applies the three-stage version of the DDM. He uses the five-year forecast earnings growth rate as a proxy for the short-run expected dividend growth rate over the first five years, and the long-run expected nominal growth in GDP as a proxy for the long-run expected dividend growth rate from the twentieth year in perpetuity. The period between the fifth year and the twentieth year is the transition period, which involves a linear convergence from the short-run estimate to the long-run estimate. Cornell's MRP estimate is 4.5%, which is about 3.5% less than the corresponding Ibbotson MRP estimate. As the estimate of the long-run expected dividend growth rate is much smaller than the estimate of the short-run expected dividend growth rate, the resulting MRP estimates from the two-stage and the three-stage versions of the DDM are lower than the one-stage version.

Nevertheless, Bernstein and Arnott (2003) demonstrate that using the long-run nominal growth rate in GDP as a proxy for the long-run expected dividend growth rate is too strong. The current price of equity is the present value of dividends to existing shareholders in existing companies, and g should then be the long-run expected growth rate in these dividends. However, the long-run growth rate in GDP is greater than the long-run expected dividend growth rate to existing shareholders in existing companies, because existing companies will issue new equity capital to new shareholders and new companies will enter the market. Bernstein and Arnott (2003) suggest a 2% deduction from the long-run expected growth rate in GDP to account for these factors. The two methods they use to generate this 2% adjustment are to compare the real dividend growth rate (to existing shareholders in existing companies) with real GDP growth for many countries from 1900 to 2000, and also to compare the market capitalisation growth rate with the growth rate in a value weighted price index for equity. However, the first of these methodologies is exposed to the possibility of the dividend payout rate falling over time. The second is exposed to foreign listings and listing of US companies that already exist.

Residual Income Model

The RIM values equity as the sum of the current book value of the equity and the present value of the expected future abnormal earnings. The RIM is derived from the DDM using the so-called "clean surplus" relation:

$$DIV_t = \Pi_t - (B_t - B_{t-1}) \quad (2.5)$$

where

$$\begin{aligned} DIV_t &= \text{dividends in year } t \\ \Pi_t &= \text{earnings for year } t \\ B_t &= \text{book value of equity at the end of year } t. \end{aligned}$$

The RIM can be expressed as:

$$P_m = B_0 + \frac{E(ae_1)}{1 + E(R_m)} + \frac{E(ae_2)}{[1 + E(R_m)]^2} + \dots \quad (2.6)$$

where

$$\begin{aligned} B_0 &= \text{current book value of equities} \\ ae_t &= \text{abnormal earnings for year } t \\ &= \Pi_t - E(R_m)B_{t-1} \end{aligned}$$

The RIM requires the estimation of expected abnormal earnings. Claus and Thomas (2001) apply a two-stage version of the RIM. They use earnings forecasts for the first five years and assume that expected abnormal earnings grow at a constant rate equal to the expected inflation rate thereafter. The resulting MRP estimates over the period 1985–98 range from 2.5% to 4.0%, with a mean of 3.4% (about 3% lower than the estimates under the Ibbotson method). Due to the evidence of a systematic upward bias in earnings forecasts, Claus and Thomas suggest a further downward adjustment to their results.

To summarise, the one-stage version of the DDM suffers from the problems of determining a reasonable estimate for the expected dividend growth rate in perpetuity and (in the event of using analysts' five-year earnings

per share forecasts as a proxy for the expected dividend growth rate) considerable variation in the estimated MRP over time. The multistage versions of the DDM and the RIM are similar in terms of producing relatively low and stable MRP estimates over time. One significant benefit of using the RIM is that earnings forecasts and current book values of equity are available from analysts and accounting statements. The DDM, however, has to use a proxy for the expected dividend growth rate, which is subject to estimation errors. Schroeder (2005) makes a comprehensive comparison of the DDM and the RIM, and finds that, although the MRP estimates from a two-stage RIM and a three-stage DDM differ the least, the DDM is superior due to the fact that its individual firm risk premia are better explained by individual firm risk parameters, such as beta.

Overall, although forward-looking approaches avoid the data problems of historical averaging approaches, they raise some new issues. First, the MRP estimates are sensitive to assumptions made about underlying parameters, such as the long-run expected dividend growth rate under the DDM and the long-run expected growth rate of abnormal earnings under the RIM. Second, analysts' five-year earnings forecasts and their growth rate, which are commonly used in the DDM and the RIM, are subject to a systematic optimism bias.² Claus and Thomas (2001) indicate that it is hard to determine the magnitude of this bias. Third, the MRP estimates are sensitive to the current price of the market portfolio (or equities). This implies that, if the observed price deviates from the "fundamental value", the resulting MRP estimate will be wrong. Hence, attention needs to be paid to these issues when applying forward-looking approaches.

²Equity analysts can diverge from the market participants who price the equity. There is a presumption that market prices of equity are correctly set.

2.2.3 Time-Varying Approaches

Many studies support the existence of a time-varying MRP (Merton, 1980; Conrad and Kaul, 1988; Fama and French, 1989; Ferson and Harvey, 1991; Evans, 1994). Time-varying approaches associate the MRP with some time-varying market factors. Two such approaches are the Merton (1980) method and the Lally (2002) method.

Merton Method

Merton (1980) investigates the relationship between the MRP and market risk. He builds three models of the relationship. The first assumes that the MRP is proportional to market variance, the second assumes that the MRP is proportional to market standard deviation, and the third assumes that the MRP is constant. As the CAPM implies that the MRP is proportional to market variance, the first model is preferred. Merton's estimation involves two stages. The first stage estimates the coefficients for the model. The second stage estimates market variance (or standard deviation).

The Merton method faces a tradeoff in determining the time span over which market variance (or standard deviation) is estimated. If the time span is long, the estimated variance (or standard deviation) does not fully reflect the variation of volatility over time, which is inconsistent with the presumption of a time-varying MRP. If the time span is short, the estimated variance (or standard deviation) is subject to the potential for large estimation error, resulting in unreliable MRP estimates. Volatility over different time spans, such as a day, a month, or a year, can be very different. Hence, it is difficult to determine an optimal time span, over which the estimated variance (and standard deviation) correctly and accurately reflects the variation of market risk over time.

Although Merton (1980) concludes that there is a positive relationship between the MRP and market variance, some empirical studies show contrary results. French et al. (1987), Baillie and DeGennaro (1990), and Boudo-

ukh et al. (1997) suggest that there is an insignificant relationship between the MRP and market variance. However, Harvey (1989) and Turner et al. (1989) conclude that there is a significant positive relationship, whereas Campbell (1987) and Glosten et al. (1993) find a significant negative relationship. Scruggs (1998) summarises these previous controversial findings and explains that they are due to the use of single-factor models. Some single-factor models neglect the effect of a government bond return factor, leading to finding an insignificant relationship. Some single-factor models include the nominal risk free rate in the estimation for market variance, leading to finding a negative relationship. Scruggs (1998) concludes that there is a significant positive relationship between the MRP and market variance, by using a two-factor model. The more recent study of Goyal and Santa-Clara (2003), however, finds an insignificant relationship between market variance and the MRP. They explain that, because their estimation does not take into account other state variables, the result is compatible with that of Scruggs (1998).

Even where one believes that there is a positive relationship between the MRP and market variance, the form of the relationship remains unresolved. Harvey (1989) shows that this relationship varies over time. It is also possible that, due to the difficulty in estimating market variance, it is hard to quantify the relationship between the MRP and market variance.

The Merton method was first applied by Credit Suisse First Boston (1998) in New Zealand for both the standard and Brennan-Lally versions of the CAPM. Lally (2000) and Boyle (2005) have also estimated the MRP in New Zealand by using the Merton method.

Lally Method

Lally (2002) develops a time-varying MRP estimator, which associates the MRP with market leverage. Leverage is a particular source of risk. A higher level of leverage implies greater variability in shareholders' returns. This is because bondholders have higher priority over the com-

pany's cash flows than shareholders, as well as over the company's assets in the event of bankruptcy. Modigliani and Miller (1958, 1963) proposition II develops the relationship between a company's cost of equity and its leverage. When the market portfolio is proxied by an equity portfolio (as usual), market leverage should therefore affect the expected return on the "market" portfolio and hence the MRP. Since this relationship is theoretically developed, it avoids many estimation problems of the Merton estimator, which is empirically developed.

Lally (2002) applied his method to US data over the period 1952–97 and shows that the resulting estimates of the MRP for the standard version of the CAPM are sometimes significantly different to those from the Ibbotson method. The Lally method has not yet been applied to New Zealand data. This paper applies the Lally (2002) method to New Zealand data over the period 1960–2005.

The Lally method is closest in spirit to the Ibbotson method. Although the former estimates the unlevered MRP first and then corrects it for market leverage, whereas the latter estimates the levered MRP directly, both require the arithmetic average of historical data. If companies that comprise the market portfolio do not have any debt, the unlevered MRP will equal the levered MRP. In other words, for a market without leverage, the Ibbotson and the Lally estimates of the MRP will be identical. Furthermore, even in the presence of debt, the Ibbotson and Lally estimates of the MRP will still be identical if market leverage is constant over time.

In addition, previous applications of various approaches to estimating the MRP in New Zealand (see Table 2.1) show that the results from applying the Ibbotson method are relatively stable, in contrast to those from the DDM and the Merton (1980) methods. The New Zealand estimates of the Ibbotson MRP range from 5.5% to 6.5% in the standard CAPM. Lally (2001) finds that the three-stage version of the DDM yields a range of the estimated MRP from 3.8% to 5.9%. Boyle (2005) applies the Merton method to New Zealand data, and yields a range from 0.9% to 33.6%. The results

from applying the Siegel method vary within the range of 1% over time, and do not differ substantially from the Ibbotson estimates. This implies that New Zealand estimates of the Ibbotson MRP are not seriously biased due to inflation.³

In view of these points, we seek to compare results from the time-varying approach of Lally (2002) with those from the historical averaging approach of Ibbotson and Sinquefeld (1976). Chapter 3 discusses the application of both the Ibbotson and the Lally (2002) methods to New Zealand data over the period 1960-2005. Chapter 4 presents the results.

Table 2.1: Previous Estimates of the MRP in New Zealand

Author	CAPM	Method	MRP Estimate	Period
Chay et al. (1993)	Standard	Ibbotson	6.2%	1931–92
Chay et al. (1995)	Standard	Ibbotson	6.5%	1931–94
Lally (2001)	Standard	Three-stage version of the DDM	3.8%-5.9%	2001
Lally and Marsden (2004b)	Standard	Ibbotson	5.5%	1931–2002
Lally and Marsden (2004b)	Brennan-Lally	Ibbotson	7.2%	1931–2002
Lally and Marsden (2004a)	Brennan-Lally	Siegel	5.5%-6.2%	1931–2002
Boyle (2005)	Standard	Merton	0.9%-33.6%	1970–2003
Marsden (2005)	Brennan-Lally	Siegel	6%-6.8%	1931–2004

³Table 2.1 does not include the results from applying the survey evidence approach, nor unpublished work (e.g. CSFB, 1998; PwC, 2002).

Chapter 3

Method and Data

The previous chapter has introduced various approaches to estimating the market risk premium. This chapter applies the historical averaging approach of Ibbotson and Sinquefeld (1976) and the time-varying approach of Lally (2002) to New Zealand data over the period 1960–2005. In the standard CAPM, the application of the Ibbotson MRP estimator requires two data sets: market returns and risk free rates of return. The application of the Lally MRP estimator requires an additional three data sets: market debt, market equity, and the returns on corporate bonds. In the simplified Brennan-Lally version of the CAPM, the application of the two estimators requires another five data sets: cash dividend yields, the market value weights of investors who hold shares directly (as opposed to via superannuation funds and unit trusts), the market value weighted averages of the marginal ordinary tax rates faced by individual investors in shares, the proportion of dividends that were not generally tax-free, and company tax rates. These five data sets are available from Lally and Marsden (2004b). This chapter first describes the methods to estimate the two MRP estimators in both the standard CAPM and the simplified Brennan-Lally version of the CAPM. It then discusses the collection processes for the five data sets required under the standard CAPM. This chapter also discusses data issues and how they were addressed. A Miller (1977) tax world, where

debt policy has no effect on a company's value but an equilibrium level of corporate debt still exists in the economy, is assumed to prevail throughout this paper.

3.1 The Ibbotson MRP Estimator

The Ibbotson MRP estimator presumes that the true MRP does not change over time. In the standard version of the CAPM, it estimates the MRP by arithmetically averaging the historical annual excess return over the sample period:

$$\begin{aligned} M\hat{R}P_I &= \overline{R_m - R_f} \\ &= \overline{R_m} - \overline{R_f} \end{aligned}$$

where

$$\begin{aligned} M\hat{R}P_I &= \text{Ibbotson estimate of the MRP} \\ R_m &= \text{return on the market portfolio} \\ R_f &= \text{risk free rate of return.} \end{aligned}$$

Since previous studies, such as Chay et al. (1993, 1995) and Lally and Marsden (2004b), have used the Ibbotson method to estimate the MRP for New Zealand in the standard CAPM, the data sets for R_m and R_f were easily obtained. With the market portfolio being proxied by an equity portfolio (as usual), the market return was therefore the return on this equity portfolio. The risk free rate was proxied by the yield on long-term government bonds.

In the Brennan-Lally version of the CAPM, the Ibbotson estimate of the MRP is generated as follows:

$$\begin{aligned} M\hat{R}P_I &= \overline{R_m - D_m T_m - R_f(1 - T_I)} \\ &= \overline{R_m} - \overline{D_m T_m} - \overline{R_f(1 - T_I)} \end{aligned}$$

where

$$\begin{aligned}
D_m &= \text{cash dividend yield (excluding imputation credits) on the market portfolio} \\
T_m &= \text{weighted average over investors of } \frac{t_{di}-t_{gi}}{1-t_{gi}} \text{ with weights } x_i, \text{ where } t_{di} = \text{investor } i\text{'s tax rate on cash dividends from the market portfolio, and } t_{gi} = \text{investor } i\text{'s tax rate on capital gains} \\
T_I &= \text{weighted average over investors of } \frac{t_i-t_{gi}}{1-t_{gi}} \text{ with weights } x_i, \text{ where } t_i = \text{investor } i\text{'s tax rate on interest} \\
x_i &= \frac{w_i}{(1-t_{gi})} \div \sum \frac{w_i}{(1-t_{gi})} \\
w_i &= \text{market value weight of investor } i.
\end{aligned}$$

The time series data for D_m are observable. Those for T_m and T_I have to be estimated. Due to tax changes in 1988, the estimates of T_m and T_I are generated in a different way from 1988. So, we broke down the study period into two sub periods: 1960–87 and 1988–2005.

Following Lally and Marsden (2004b), T_m and T_I for each year in the period 1960–87 are as follows¹:

$$\begin{aligned}
T_{mt} &= w_{At}T_{0t}p_t \\
T_{It} &= w_{At}T_{0t},
\end{aligned}$$

where

¹Lally and Marsden (2004b) classify New Zealand investors into two groups, with type A investors being defined as those who own equities directly and type B investors being defined as those who own equities via superannuation funds and unit trusts.

- w_{At} = year t market value weight of type A investors
 (who hold shares directly as opposed to via superannuation funds and unit trusts)
 T_{0t} = year t market value weighted average of the
 marginal ordinary tax rates faced by individual
 investors in shares
 p_t = proportion of dividends that were not generally
 tax-free in year t .

Following Lally and Marsden (2004b), T_m and T_I for each year in the period 1988–2005 are as follows:

$$\begin{aligned}
 T_{mt} &= T_{It} - (1 - T_{It})Q_{mt} \\
 T_{It} &= \text{year } t \text{ weighted average over investors of } \frac{t_i - t_{gi}}{1 - t_{gi}} \\
 &\quad \text{with weights } x_i,
 \end{aligned}$$

where Q_{mt} is the ratio of imputation credits to cash dividends for year t .

The simplified Brennan-Lally version of the CAPM assumes that capital gains taxes are zero for all investors ($t_{gi} = 0$). So, $x_i = w_i$. Consequently, for 1988–2005:

$$\begin{aligned}
 T_{It} &= \sum w_{it} t_{it} \\
 &= T_{0t}.
 \end{aligned}$$

The simplified Brennan-Lally version also assumes that imputation credits are attached at the maximum possible rate. That means, $Q_{mt} = \frac{T_{ct}}{1 - T_{ct}}$, where T_{ct} is the company tax rate in year t . Consequently, for 1988–2005:

$$\begin{aligned}
 T_{mt} &= T_{It} - (1 - T_{It}) \frac{T_{ct}}{1 - T_{ct}} \\
 &= T_{0t} - (1 - T_{0t}) \frac{T_{ct}}{1 - T_{ct}}.
 \end{aligned}$$

3.2 The Lally MRP Estimator

Lally (2002) theoretically derives the relation between the MRP and market leverage from Modigliani and Miller (MM) proposition II. The ex-post counterpart to a generalisation of MM proposition II is:²

$$R_{mt} = R_{mt}^u \left[1 + \frac{B_{mt}}{S_{mt}} (1 - \alpha) \right] - R_{dt} \frac{B_{mt}}{S_{mt}} \quad (3.1)$$

where

- R_{mt} = return on the market portfolio in year t
- R_{mt}^u = unlevered return on the market portfolio in year t
- B_{mt} = market debt (aggregate debt of companies comprising the market portfolio) in year t
- S_{mt} = market equity (aggregate equity of companies comprising the market portfolio) in year t
- α = parameter reflecting tax and debt policy
- R_{dt} = return on corporate bonds in year t .

In a Miller (1977) tax world (i.e. $\alpha = 0$), equation 3.1 can be simplified to:

$$R_{mt} = R_{mt}^u \left(1 + \frac{B_{mt}}{S_{mt}} \right) - R_{dt} \frac{B_{mt}}{S_{mt}}. \quad (3.2)$$

Subtracting the risk free rate from both sides gives:

$$\begin{aligned} R_{mt} - R_{ft} &= R_{mt}^u \left(1 + \frac{B_{mt}}{S_{mt}} \right) - R_{dt} \frac{B_{mt}}{S_{mt}} - R_{ft} \\ &= R_{mt}^u \left(1 + \frac{B_{mt}}{S_{mt}} \right) - R_{dt} \frac{B_{mt}}{S_{mt}} - R_{ft} \left(1 + \frac{B_{mt}}{S_{mt}} - \frac{B_{mt}}{S_{mt}} \right) \\ &= (R_{mt}^u - R_{ft}) \left(1 + \frac{B_{mt}}{S_{mt}} \right) - (R_{dt} - R_{ft}) \frac{B_{mt}}{S_{mt}}. \end{aligned}$$

As R_{mt} , R_{mt}^u , and R_{dt} are random variables and R_{ft} , B_{mt} , and S_{mt} are set at the beginning of each sample year, taking the expected value of both sides

² $\alpha = T_c$ under a Modigliani and Miller (1958, 1963) world; $\alpha = 0$ under a Miller (1977) world; $\alpha = \frac{R_f T_c}{1 + R_f}$ under a Miles and Ezzell (1985) world, where T_c represents the corporate tax rate.

of the above equation gives:

$$\begin{aligned} E(R_{mt} - R_{ft}) &= E(R_{mt}^u - R_{ft})(1 + \frac{B_{mt}}{S_{mt}}) - E(R_{dt} - R_{ft})\frac{B_{mt}}{S_{mt}} \\ &= MRP^u(1 + \frac{B_{mt}}{S_{mt}}) - DRP\frac{B_{mt}}{S_{mt}}. \end{aligned}$$

This represents the Lally MRP in the standard version of the CAPM. The unlevered Market Risk Premium (MRP^u) is estimated as the arithmetic mean of the annual unlevered market return in excess of the risk free rate ($\overline{R_m^u - R_f}$), and the Debt Risk Premium (DRP) is estimated as the arithmetic mean of the annual corporate bond return in excess of the risk free rate ($\overline{R_d - R_f}$). Although R_{mt}^u is unobservable, it can be estimated through restructuring equation 3.2 to:

$$R_{mt}^u = \frac{R_{mt} + R_{dt}\frac{B_{mt}}{S_{mt}}}{1 + \frac{B_{mt}}{S_{mt}}}. \quad (3.3)$$

Hence, the Lally estimator for the year T (T represents the last year in the sample period) MRP in the standard version of the CAPM is:

$$MRP_{LT} = (\overline{R_m^u - R_f})(1 + \frac{B_{mT}}{S_{mT}}) - (\overline{R_d - R_f})\frac{B_{mT}}{S_{mT}}.$$

The Lally MRP in the simplified Brennan-Lally version of the CAPM can be estimated by first subtracting $D_{mt}T_{mt} + R_{ft}(1 - T_{It})$ from both sides of equation 3.2:

$$\begin{aligned} R_{mt} - D_{mt}T_{mt} - R_{ft}(1 - T_{It}) &= R_{mt}^u(1 + \frac{B_{mt}}{S_{mt}}) - R_{dt}\frac{B_{mt}}{S_{mt}} - [D_{mt}T_{mt} + R_{ft}(1 - T_{It})] \\ &= [R_{mt}^u - D_{mt}T_{mt} - R_{ft}(1 - T_{It})](1 + \frac{B_{mt}}{S_{mt}}) \\ &\quad - [R_{dt} - D_{mt}T_{mt} - R_{ft}(1 - T_{It})]\frac{B_{mt}}{S_{mt}}, \end{aligned}$$

and then taking the expectations of both sides:

$$\begin{aligned} E[R_{mt} - D_{mt}T_{mt} - R_{ft}(1 - T_{It})] &= E[R_{mt}^u - D_{mt}T_{mt} - R_{ft}(1 - T_{It})](1 + \frac{B_{mt}}{S_{mt}}) \\ &\quad - E[R_{dt} - D_{mt}T_{mt} - R_{ft}(1 - T_{It})]\frac{B_{mt}}{S_{mt}} \\ &= MRP^u(1 + \frac{B_{mt}}{S_{mt}}) - DRP\frac{B_{mt}}{S_{mt}}. \end{aligned}$$

Therefore, the Lally estimator for the year T MRP in the simplified Brennan-Lally CAPM is:

$$M\hat{R}P_{LT} = M\hat{R}P^u(1 + \frac{B_{mT}}{S_{mT}}) - D\hat{R}P\frac{B_{mT}}{S_{mT}}$$

where

$$\begin{aligned} M\hat{R}P^u &= \overline{R_m^u - D_m T_m - R_f(1 - T_I)} \\ D\hat{R}P &= \overline{R_d - D_m T_m - R_f(1 - T_I)} \end{aligned}$$

and the formula for R_{mt}^u is as shown in equation 3.3. Also, for each year in the period 1960–87,

$$\begin{aligned} T_{mt} &= w_{At}T_{0t}p_t \\ T_{It} &= w_{At}T_{0t}. \end{aligned}$$

For each year in the period 1988–2005,

$$\begin{aligned} T_{mt} &= T_{0t} - (1 - T_{0t})\frac{T_{ct}}{1 - T_{ct}} \\ T_{It} &= T_{0t}. \end{aligned}$$

The data sets for D_m , w_A , T_0 , p , and T_c for 1960–2002 were obtained from Lally and Marsden (2004b). As we require data sets for T_0 and T_c up to 2005, we extrapolated their values in 2002 to 2003–05. The following section describes the data collection process for the five required data sets (R_m , R_f , B_m , S_m , and R_d) in the standard CAPM and the corresponding data issues. The data sets for B_m , S_m , and R_d are not as easily obtained as R_m and R_f in New Zealand. Approximations were required.

3.3 Data and Data Issues

To generate the Ibbotson and the Lally MRP estimates over the period 1960–2005, five data sets are required, including market returns (R_m), risk

free rates of return (R_f), market equity (S_m), market debt (B_m), and the returns on corporate bonds (R_d). The following material describes how these data sets were obtained or estimated. In summary, the data sets for R_m and R_f were sourced from Chay et al. (1993), although some modifications were made. Those for S_m and B_m were manually collected. Since the data set for R_d was unavailable, we used the return on government bonds (R_r) as a proxy for R_d .

3.3.1 The Market Return

Chay et al. (1993) provides the source of market return data. They present New Zealand data on equity returns over the period 1931–92. However, Lally and Marsden (2004b) point out that it is inappropriate to use Chay et al.’s (1993) equity return data in the standard CAPM after 1987, because Chay et al. (1993) used the New Zealand Stock Exchange gross share price index after 1987 and this includes imputation credits. Hence, their data are not appropriate to estimate the MRP in the standard CAPM.

Lally and Marsden (2004b, Appendix A) make adjustments to Chay et al.’s (1993) data to remove imputation credits. We used the equity return data suggested by Lally and Marsden (2004b) as our market return data. They are nominal gross equity returns exclusive of imputation credits over the period 1960–2005.³

3.3.2 The Risk Free Rate

The risk free rate of return is necessary to generate both the Ibbotson and the Lally estimates. Two steps are involved to determine the risk free rate: the first is to choose between long-term government bonds and Treasury bills (short-term government bonds) as a proxy for the risk free asset, and the second is to choose between the rate of return and the yield on these bonds.

³Nominal gross equity returns include both capital appreciation and dividend income.

The type of government bonds to use as the risk free asset is arguable. Conceptually, the right choice is that corresponding to the horizon of the common investor which underlies the CAPM, but this is unobservable. More pragmatically, Dimson et al. (2000) argue that Treasury bills are closer to risk free assets, because the values of Treasury bills are less likely to be affected by changes in real interest rates and inflation expectations than long-term government bonds. In addition, investors do not always hold long-term government bonds to maturity. However, Booth (2001) argues that since yields on short-term Treasury bills are often affected by short-term monetary policy, it is not appropriate to use them as a proxy for the risk free asset. Siegel (2005) suggests that long-term inflation-indexed government bonds are closer to risk free assets than short-term government bonds, because they provide a constant real return from a long-term perspective. In practice, the choice of government bonds usually depends on available data sources. As we were unable to obtain reliable data on New Zealand short-term government bonds, long-term (10-year) government bonds were used as a proxy for risk free assets in this paper.

Bond yields are the prospective return per year on the bond until maturity, if there is no default. Bond returns are the realised returns. Since the MRP is a forward-looking concept and bond yields are forward-looking rates, yields on government bonds were chosen rather than returns. Hence, this paper used the yield on 10-year government bonds as a proxy for the risk free rate of return.

3.3.3 Market Leverage

Unlike the data sets for R_m and R_f , which are easily obtained as previous studies have compiled them, we manually collected the data sets for B_m and S_m . We estimated market leverage as the aggregate debt of companies

that comprise the market portfolio divided by their aggregate value:

$$\begin{aligned} L &= \frac{B_m}{B_m + S_m} \\ &= \frac{\sum_{i=1}^N B_i}{\sum_{i=1}^N B_i + \sum_{i=1}^N S_i} \end{aligned}$$

where

- L = market leverage
- B_i = market value of company i 's debt
- S_i = market value of company i 's equity
= market capitalisation of company i
- N = number of companies included in the market portfolio.

We started by selecting an equity index to proxy for the market portfolio, and then deleted companies with relatively small market capitalisation. Only those companies whose aggregate market capitalisation makes up 80% of the total market capitalisation in the equity index were used to proxy for the market portfolio. We then collected the individual debt and equity information on the latter companies ($i = 1, 2, \dots, N$) to estimate the market leverage ratio. This process was conducted every five years over the period 1960–2005.

Data Sources for the Equity Index

The equity index plays a fundamental role in defining the composition of the market portfolio. To be consistent with our data for R_m , which were based on the equity index constructed by Chay et al. (1993), we sought to use the same equity index.

Chay et al. (1993) used four data sources to construct the equity index for New Zealand over the period 1960 to 1990: the Department of Statistics capital index (for the period before 1970), the Reserve Bank of New Zealand (RBNZ) share price index (for 1970–78), the Datex gross share price index (for 1979–86), and the New Zealand Stock Exchange (NZX)

gross share price index (for 1987–90). However, we were unable to obtain data from Statistics New Zealand and Datex, as they have not retained the data from the relevant periods. Thus, we used the RBNZ share price index and the NZX gross share price index to construct the equity index over the period 1960 to 2005.

The RBNZ and the NZX construct their indices in a similar way. Both require listed companies to be large in size and frequently traded. In addition, the RBNZ index emphasises the reasonable representation of listed companies across New Zealand industries, although mining and oil exploration companies are excluded. Unlike the RBNZ index, which only includes New Zealand domiciled companies, the NZX index also includes some overseas companies listed in the New Zealand market.

In addition to the period from 1970–78, the RBNZ share price index was used to replace the missing data from both Statistics New Zealand (for 1960–70) and Datex (for 1979–86). Since the RBNZ share price index was only introduced in January 1968, the composition of the equity index before 1968 was based on the composition of the RBNZ index in 1968. After 1968, changes in the RBNZ index were taken into account each year.

As this paper estimated market leverage every five years, the RBNZ share price index was used in 1960, 1965, 1970, 1975, 1980, and 1985. In addition, the NZX 40 index was used in 1990, 1995, and 2000, and the NZX 50 index in 2005.⁴

The Construction of the Market Portfolio

Reducing the number of companies to a manageable level means that a longer time series is possible within time constraints. Instead of using all the companies in the equity index, we used a subset of all the companies included in the equity index. These companies comprise 80% of the total market capitalisation in the equity index. They were selected according to

⁴The NZX 50 index was launched in 2003 to replace the NZX 40 index.

their weights in the equity index:

$$W_i = \frac{S_i}{\sum_{i=1}^M S_i} \quad (3.4)$$

where

- W_i = index weight of company i
- S_i = market capitalisation of company i
- M = number of companies included in the equity index,
and $M > N$.

Table 3.1 shows the results from our selection process. The number of companies that comprise the market portfolio proxy as a proportion of the number included in the equity index ($\frac{N}{M}$) is smallest in 1995 and 2005: 30% and 32% respectively. Hence, we chose the 1995 and the 2005 cases to test whether the use of a subset of the equity index has materially affected the accuracy of the results.

Table 3.1: Number of Companies in the Market Portfolio Proxy and the Equity Index

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
N	16	23	20	22	19	24	23	12	20	16
M	40	51	58	57	53	56	40	40	40	50
$\frac{N}{M}$	40%	45%	34%	39%	36%	43%	58%	30%	50%	32%

Notes: the RBNZ Share Price Index included 57 companies at the beginning of 1968. Among these 57 companies, 51 companies were listed on the New Zealand Stock Exchange in 1965 and 40 companies were listed in 1960.

Table 3.2 shows the sensitivity of the estimates of market leverage in 1995 and 2005 to increasing the percentage of index value captured to 90% and 100%. In 1995, if we were to use companies with a cumulative index weight of 100% rather than 80% to determine the market portfolio,

estimated market leverage would fall by 2%. If we were to use companies with a cumulative index weight of 90%, estimated market leverage would decrease by 1%. In 2005, a cumulative index weight of 100% results in an increase in estimated market leverage by 1% and a cumulative index weight of 90% results in an increase in estimated market leverage by 2%. These differences do not significantly affect the results in this paper. Hence, a cumulative index weight of 80% is reasonable for the construction of market portfolios in this paper.

Table 3.2: Estimated Market Leverage and Cumulative Index Weights

Year	$\sum_{i=1}^N W_i = 80\%$	$\sum_{i=1}^N W_i = 90\%$	$\sum_{i=1}^N W_i = 100\%$
1995	0.39	0.38	0.37
2005	0.34	0.36	0.35

Estimation of Market Leverage

After specifying the composition of the market portfolio every five years, we estimated market equity (S_m) by adding up the market capitalisation of companies that comprise the market portfolio proxy. The market capitalisation data for individual companies are indicated in *National Business Review* for 1985 and the NZX equity indices for 1990, 1995, 2000, and 2005. The remaining market capitalisation data were obtained from the *Official Record of New Zealand Stock Exchange* for 1960, 1965, 1970, 1975 and 1980. As the *Official Record* does not give the market capitalisation data directly, we calculated market capitalisation by multiplying the number of a company's shares on issue by their last trading price.

We estimated market debt (B_m) by adding up the market values of the debt of companies comprising the market portfolio. As debt is not in general traded, the book value of debt was used as a proxy for its market

value (see Appendix A). Information on the book value of a company's debt was obtained from its consolidated balance sheet, which is included in the company's Annual Report. Only interest-bearing debt was taken into account. Examples include bank overdrafts, loans, advances, debentures, commercial paper, etc. Other liabilities, such as trade or short-term creditors, represent deferred payments for goods or services and were not included in our calculation. Provisions and contingent liabilities are also not interest bearing, and were also excluded from the calculation.

After obtaining the values of market equity and market debt, we were able to estimate market leverage through $L = \frac{B_m}{B_m + S_m}$. The results are shown in Table 3.3. The following section discusses various data issues that arise from the estimation of market leverage.

Table 3.3: Market Equity, Market Debt and Market Leverage

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
S_m										
(\$m)	209	469	875	919	1953	7884	13401	43369	34731	38790
B_m										
(\$m)	70	146	268	825	1688	5552	39976	24386	21511	18932
L	0.25	0.24	0.23	0.47	0.46	0.42	0.75	0.37	0.38	0.33

3.3.4 Data Issues for Market Leverage

Missing Data

Where the essential information of a company was unavailable, this company could not be used. The annual reports of some companies were missing. Consequently, we could not obtain the debt information for these companies, and were forced to remove them from the market portfolio proxy. To ensure that the cumulative index weight of companies com-

prising the market portfolio proxy remained at 80%, substitute companies were added to the market portfolio proxy. These substitute companies were those which were deleted earlier in the process due to their low index weight; companies with a relatively high market value took priority.

The problem of missing data was not significant, except in 1990. In 1990, the top 13 companies in the equity index had a cumulative weight of 84.83%. However, five of them had missing annual reports. Removing these five companies reduced the cumulative weight to 68.72%. To raise the cumulative weight to 80%, 15 substitute companies were added. However, among these 15 companies, the annual reports of two companies could not be found. This reduced the cumulative index weight to 78.94%. Therefore, another three companies were added in substitution. As a result, 24 companies were selected from the NZX 40 index to proxy for the market portfolio in 1990.

Time Differences between Debt and Equity Valuations

As the estimation of market leverage requires both debt and equity data, they must be consistent in terms of time. However, there were significant time gaps between debt and equity values for some companies. This is because the equity data was collected at the same point in time for all companies for a given year whereas the debt data was obtained from companies' annual reports, and it is common for different companies to have different balance dates. Hence, it is necessary to adjust the date of debt data towards the date of equity data, whenever the time gap is significant.

One possibility to reduce the time gap for some companies is to look at their half year reports. When the balance date in the annual report is substantially different to the equity valuation date, there will be a half year report that is closer to it. However, most half year reports did not provide enough detail for us to estimate the debt level of the company. Hence, the only data sources for debt were companies' annual reports.

We therefore sought to minimise the time gap by averaging over two

balance dates. As it is impossible to exactly align the debt and the equity dates for all the companies, a time gap of no more than three months was accepted. Table 3.4 displays the dates for equity values and the corresponding ranges of balance dates within which debt values were used.

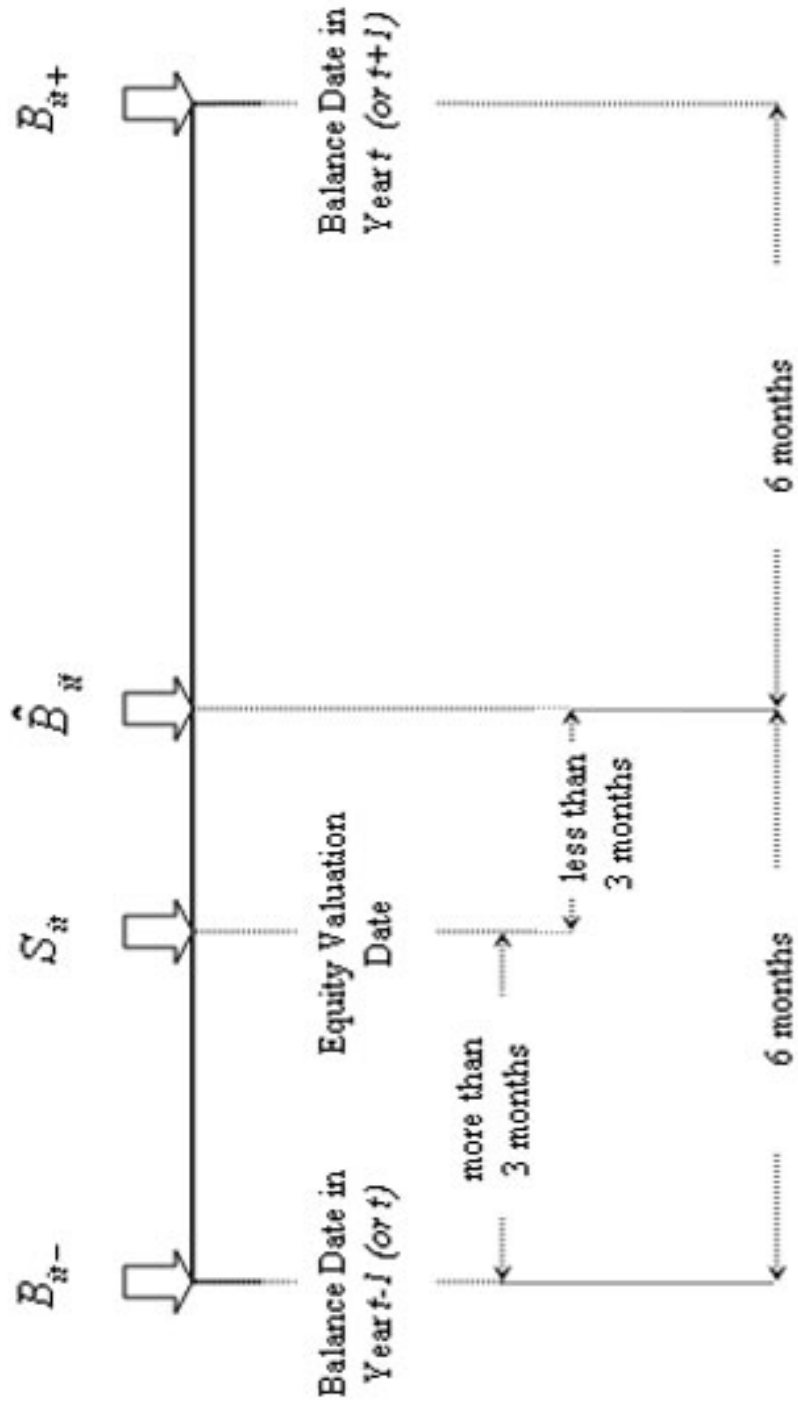
Table 3.4: Equity Valuation Dates and Acceptable Balance Dates

Sample Period	Period before 1985	1985	Period after 1985
Equity Valuation Dates	1 Feb	6 May	28, 29, 30 December
Balance Dates	1 Nov (previous year) —1 May	1 Feb —1 Aug	30 Sep—31 Mar (following year)

Our equity values were obtained as at the 1st of February for the period before 1985, the 6th of May for 1985, and the end of December for the period after 1985. Hence, for the period before 1985, any consolidated balance sheet with a balance date between the 1st of November in the previous year and the 1st of May in the current year was used to obtain the debt level of the company; in 1985 any consolidated balance sheet with a balance date between early February and early August was used; for the period after 1985, any consolidated balance sheet with a date between the end of September in the current year and the end of March in the following year was used.

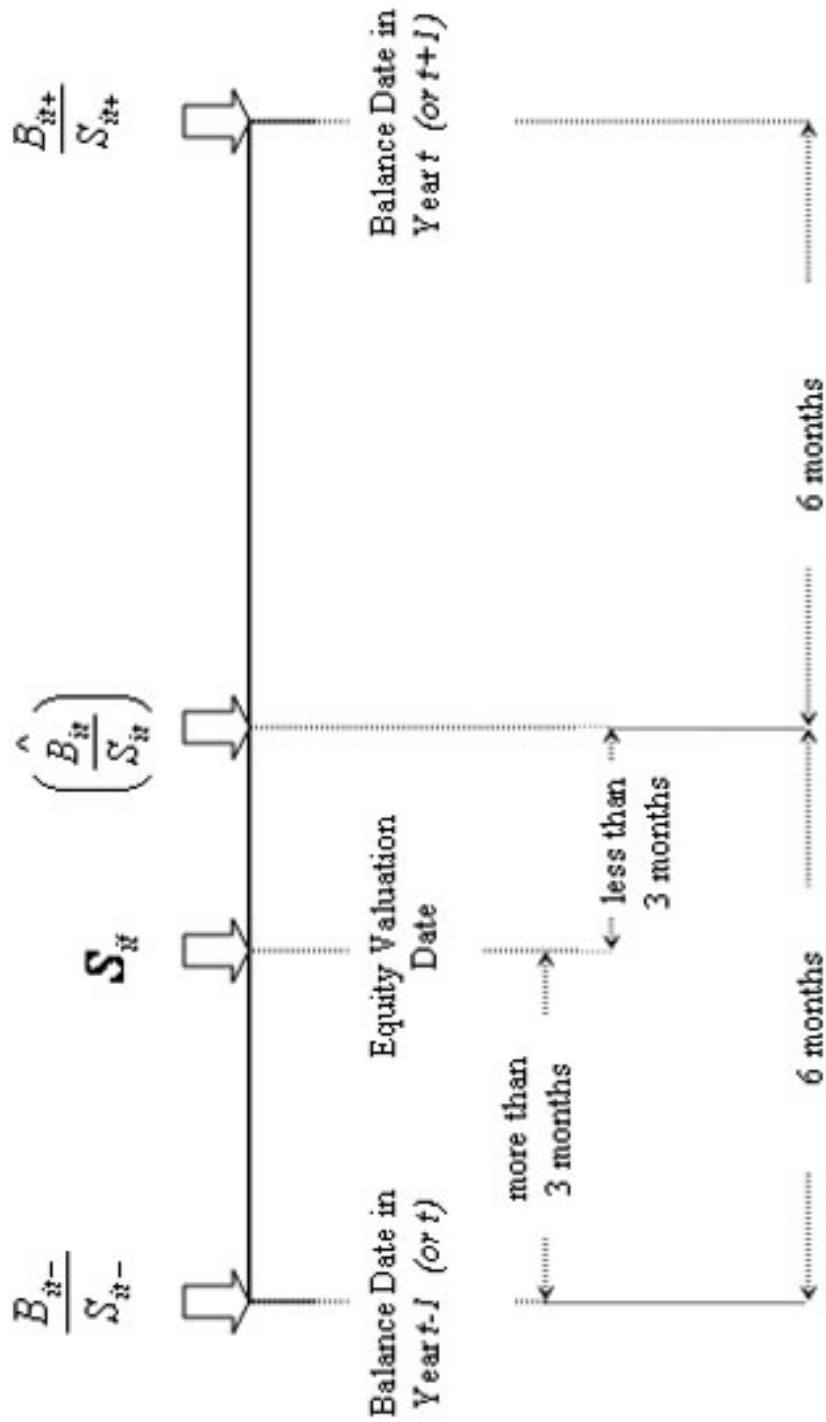
For balance dates outside the ranges stated in Table 3.4, adjustments were made to the raw debt data. Figure 3.1 displays the adjustment under *Method One*, which averages over the debt levels. Whenever the time difference between the equity valuation date and the balance date is more than three months, debt levels for a company are averaged over two adjoining balance dates. Figure 3.2 displays the adjustment under *Method Two*, which averages over the individual debt to equity ratios, i.e., whenever the time difference is more than three months, individual debt to equity ratios are averaged over two balance dates.

Figure 3.1: Method One with Proper Time Adjustments



Notes: B_{it-} refers to a balance date earlier than the equity valuation date and B_{it+} refers to a balance date later than the equity valuation date. $\hat{B}_{it} = \frac{B_{it-} + B_{it+}}{2}$ whenever the time gap between the balance date and the equity valuation date is more than three months. If the time gap is no more than three months, \hat{B}_{it} will be either B_{it-} or B_{it+} , depending on which of them is closer to S_{it} in terms of time.

Figure 3.2: Method Two with Proper Time Adjustments



Notes: $\left(\frac{\hat{B}_{it}}{S_{it}}\right)$ is the estimated debt to equity ratio of company i . $\left(\frac{\hat{B}_{it}}{S_{it}}\right) = \frac{\frac{B_{it-}}{S_{it-}} + \frac{B_{it+}}{S_{it+}}}{2}$ whenever the time gap between the balance date and the equity valuation date is more than three months. If the time gap is no more than three months, $\left(\frac{\hat{B}_{it}}{S_{it}}\right)$ will be the debt to equity ratio at the balance date closer to the equity valuation date.

For example, if a company has a balance date on the 30th of June every year, averaging its debt levels (the adjustment under *Method One*) or debt to equity ratios (the adjustment under *Method Two*) over 30th June 1990 and 30th of June 1991 gives an estimated debt level or debt to equity ratio on 30th December 1990, which matches the equity valuation date in 1990.

These two methods are mathematically identical whenever debt and equity are valued on the same date. *Method One* estimates market leverage as:

$$\hat{L}_1 = \frac{\sum_{i=1}^N B_i}{\sum_{i=1}^N B_i + \sum_{i=1}^N S_i}. \quad (3.5)$$

Method Two estimates market leverage as:

$$\begin{aligned} \frac{\hat{L}_2}{1 - \hat{L}_2} &= \sum_{i=1}^N \left(\frac{B_i}{S_i} \times W_i \right) \\ &= \sum_{i=1}^N \left(\frac{B_i}{S_i} \times \frac{S_i}{\sum_{i=1}^N S_i} \right) \\ &= \frac{\sum_{i=1}^N B_i}{\sum_{i=1}^N S_i} \\ &= \frac{\hat{L}_1}{1 - \hat{L}_1}. \end{aligned}$$

Table 3.5 compares the estimates of market leverage under these two methods for 2005, with and without time adjustments. It shows that making proper time adjustments under *Method One* or *Method Two* leads to very similar estimates of market leverage. With time adjustments, the difference between the estimates of market leverage under *Method One* and under *Method Two* is 0.0003. Without time adjustments, the difference is 0.0185.⁵ Thus, time adjustments are desirable but the choice of *Method One* or *Method Two* is immaterial. This paper used the results from *Method One*.

⁵The term "Without Adjustments" means we did not average individual debt levels or debt to equity levels over two balance dates even when the time gap was more than three months. We simply used the debt data from the consolidated balance sheet with

Table 3.5: Estimates of Market Leverage in 2005 with and without Adjustments

Time Adjustments		No Time Adjustment	
Method One	Method Two	Method One	Method Two
0.3358	0.3361	0.3260	0.3075

Minority Interests

Minority interests usually exist in a company's consolidated balance sheet. They represent the shares owned by outsiders (rather than the parent company) in a company's subsidiaries. For example, the consolidated balance sheet of Alex Harvey Industries in 1985 showed minority interests of \$49 million. This means that \$49 million of the net assets of its subsidiaries are owned by outside shareholdings of the subsidiary companies. The issue of minority interests arises because the consolidated balance sheets were used to determine the debt levels, so as to avoid situations in which the leverage changes purely through a company forming a subsidiary.

We estimated market equity value by adding up the market capitalisation of companies comprising the market portfolio, and market capitalisation relates to the ordinary shares on issue for the parent company. So the resulting market equity is for all the parent companies in the market portfolio. However, market debt was estimated from companies' consolidated balance sheets and hence is for all the consolidated companies. This incon-

the date closest to the equity valuation date. For example, if a company's balance date is 30th August and the equity valuation date is 30th December, the consolidated balance sheet in the current year will be used rather than the one in the following year. Whenever the consolidated balance sheets surrounding the equity valuation date were equidistant, we used the first of these two balance dates.

sistency will result in an overestimation of market leverage. If the value of minority interests is significant, the overestimation of leverage will be significant. So, we need to estimate the market value of the minority interests' equity and consider adding it to that of the parent company.

To estimate the market value of the minority interests' equity, we proceed as follows. For a given consolidated company i , let:

$$\begin{aligned}
 S_{Mi}^b &= \text{book value of minority interests} \\
 S_{Pi}^b &= \text{book value of the parent company's equity} \\
 S_{Mi}^b + S_{Pi}^b &= \text{book value of total shareholders' funds} \\
 S_{Mi}^m &= \text{market value of minority interests} \\
 S_{Pi}^m &= \text{market value of the parent company's equity} \\
 S_{Mi}^m + S_{Pi}^m &= \text{market value of total shareholders' funds.}
 \end{aligned}$$

Table 3.6: Consolidated Balance Sheet of Fletcher Challenge Ordinary Division in December 1995

	NZ \$m		NZ \$m
Equity		Assets	11,799
Ordinary Division Attributed			
Equity and Capital Funds	3,889		
Minority Equity	<u>1,950</u>		
Total Ordinary Division Attributed			
Equity and Capital Funds	5,839		
Liability	<u>5,960</u>		—
Total Ordinary Division Attributed		Total Ordinary Division	
Liabilities and Equity	<u><u>11,799</u></u>	Attributed Assets	<u><u>11,799</u></u>

Table 3.6 provides an example of a company's consolidated balance sheet. The ratio of the book value of minority interests to the book value of total shareholders' funds for Fletcher Challenge Ordinary Division in December 1995 was:

$$S_{Mi}^b : (S_{Mi}^b + S_{Pi}^b) = \$1,950\text{m} : \$5,839\text{m} \approx 1 : 3.$$

The equity index in 1995 showed that the market capitalisation of Fletcher Challenge Ordinary Division was:

$$S_{Pi}^m = \$5,209\text{m}.$$

Assuming that:

$$S_{Mi}^m : (S_{Mi}^m + S_{Pi}^m) = S_{Mi}^b : (S_{Mi}^b + S_{Pi}^b) \approx 1 : 3,$$

the market value of total minority interests was therefore estimated as:

$$S_{Mi}^m = \$2605 \text{ million},$$

and the market value of equity was estimated as:

$$S_{Mi}^m + S_{Pi}^m = \$7814 \text{ million}.$$

In this study, the proportion of the aggregate book value of minority interests to the aggregate book value of total shareholders' funds ranges from 1.01% (in 2000) to 13.76% (in 1990), as shown in table 3.7.

Table 3.7: The Aggregate Book Value of Minority Interests to the Aggregate Book Value of Total Shareholders' Funds from 1960 to 2005

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
$\sum_{i=1}^N S_{Mi}^b$ (\$m)	1.98	4.61	12.7	36.4	139	413	2477	3262	216	636
$\sum_{i=1}^N (S_{Mi}^b + S_{Pi}^b)$ (\$m)	157	325	525	1113	2331	5981	18003	25679	21425	18433
$\frac{\sum_{i=1}^N S_{Mi}^b}{\sum_{i=1}^N (S_{Mi}^b + S_{Pi}^b)} (\%)$	1.26	1.24	2.42	3.27	5.96	6.90	13.76	12.70	1.01	3.45

As the value of $\frac{\sum_{i=1}^N S_{Mi}^b}{\sum_{i=1}^N (S_{Mi}^b + S_{Pi}^b)}$ is significant, especially in 1990 and 1995, we included the aggregate value of minority interests in the aggregate market value of companies. Let:

$$a = \frac{\sum_{i=1}^N S_{Mi}^b}{\sum_{i=1}^N (S_{Mi}^b + S_{Pi}^b)} = \frac{\sum_{i=1}^N S_{Mi}^b}{\sum_{i=1}^N S_{Mi}^b + \sum_{i=1}^N S_{Pi}^b}$$

$$b = \frac{\sum_{i=1}^N S_{Mi}^m}{\sum_{i=1}^N (S_{Mi}^m + S_{Pi}^m)} = \frac{\sum_{i=1}^N S_{Mi}^m}{\sum_{i=1}^N S_{Mi}^m + \sum_{i=1}^N S_{Pi}^m}.$$

Assuming that a is always equal to b :

$$b = \frac{\sum_{i=1}^N S_{Mi}^m}{\sum_{i=1}^N S_{Mi}^m + \sum_{i=1}^N S_{Pi}^m} = a,$$

therefore,

$$\sum_{i=1}^N S_{Mi}^m = \sum_{i=1}^N S_{Mi}^m a + \sum_{i=1}^N S_{Pi}^m a$$

$$\sum_{i=1}^N S_{Mi}^m (1 - a) = \sum_{i=1}^N S_{Pi}^m a$$

$$\sum_{i=1}^N S_{Mi}^m = \frac{a}{1-a} \sum_{i=1}^N S_{Pi}^m.$$

The aggregate market value of equity, including the aggregate market value of minority interest, is therefore:

$$\begin{aligned} S_m^* &= \sum_{i=1}^N S_{Pi}^m + \sum_{i=1}^N S_{Mi}^m \\ &= \sum_{i=1}^N S_{Pi}^m + \frac{a}{1-a} \sum_{i=1}^N S_{Pi}^m \\ &= \left(1 + \frac{a}{1-a}\right) \sum_{i=1}^N S_{Pi}^m \\ &= \left(1 + \frac{a}{1-a}\right) S_m. \end{aligned}$$

This adjustment increased the value of market equity from S_m to S_m^* , which correspondingly reduced the market leverage estimate from \hat{L} to \hat{L}^* . The equation for market leverage becomes:

$$\hat{L}^* = \frac{B_m}{B_m + S_m^*} = \frac{B_m}{B_m + \left(1 + \frac{a}{1-a}\right) S_m} = \frac{B_m}{V_m + \frac{a}{1-a} S_m}.$$

Table 3.8 shows the estimates of market leverage with and without consideration of minority interests. The adjustments made to the estimated market equity overcome the problem of an upward bias to market leverage.

Table 3.8: Estimated Market Leverage With and Without Consideration of Minority Interests

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
\hat{L}	0.25	0.24	0.24	0.48	0.48	0.44	0.78	0.39	0.38	0.34
\hat{L}^*	0.25	0.24	0.23	0.47	0.46	0.42	0.75	0.37	0.38	0.33
a (%)	1.26	1.42	2.42	3.27	5.96	6.90	13.76	12.70	1.01	3.45

Notes: \hat{L}^* is the market leverage estimate that considers minority interests.

Convertible Notes

Convertible notes have the attributes of both equity and debt. Convertible notes are interest-bearing debt prior to maturity. At maturity, they may be converted into ordinary shares, and hence become equity. If convertible notes are counted as debt instead of equity for all companies, the market debt level will be overestimated and the market equity level underestimated, and vice versa. Some studies, such as Brigham (1966), focus on how to break down the value of convertible notes into equity and debt.

This paper faced the issue of convertible notes at two levels. The first level refers to the convertible notes held by companies that comprise the market portfolio (see Table 3.9). The second level refers to the convertible notes included in the equity index (see Table 3.10).

Table 3.9: The Aggregate Book Value of Convertible Notes Held by Companies in the Market Portfolio and the Aggregate Debt Value of these Companies

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
$\sum V_{CN}(\text{\$m})$	1.45	1.42	4.04	11.8	17.4	107	602	690	159	198
$\sum_{i=1}^N B_i(\text{\$m})$	70	146	268	825	1688	5552	39976	24386	21511	18932
$\frac{\sum V_{CN}}{\sum_{i=1}^N B_i}$	2.07%	0.98%	1.51%	1.43%	1.03%	1.93%	1.51%	2.8%	0.74%	1.04%

Notes: $\sum V_{CN}$ is the aggregate book value of convertible notes (in \$NZ million), and $\sum_{i=1}^N B_i$ is the aggregate debt value (in \$NZ million).

Table 3.10: The Aggregate Market Value of Convertible Notes Included in the Equity Index and the Aggregate Market Capitalisation of the Equity Index

Year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Indexed Convertible Notes (\$m)	0	0	0	0	0	0	281	1644	397	0
Indexed Market Capitalisation (\$m)	254	579	1017	1110	2290	8716	14594	46833	42729	46869
$\frac{\text{Indexed Convertible Notes}}{\text{Indexed Market Capitalisation}}$	0	0	0	0	0	0	1.93%	3.51%	0.93%	0

In Table 3.9, we calculated the ratio of the convertible notes held by companies in the market portfolio to their aggregate debt. It shows that the aggregate value of these convertible notes is a tiny fraction of the aggregate debt. Thus, classifying all convertible notes as debt would not substantially alter the estimate of market leverage.

Table 3.10 shows the convertible notes in the equity index as a proportion of the aggregate market capitalisation of the index. Although the recently published *NZX Equity Indices Methodology Overview* indicates that convertible notes are no longer eligible for inclusion in its equity indices, the NZX 40 index in 1990, 1995 and 2000 contained some convertible notes, due to changes in the NZX index criteria over time. In these three years, the aggregate value of convertible notes in the index was a small fraction of the market equity. Thus, classifying these convertible notes as equity would not substantially alter the results.

Since the aggregate value of convertible notes is insignificant both at the individual company level and at the equity index level, the existence of convertible notes is not a material issue in this paper.

Inconsistencies in Shares on Issue

The NZX equity index sometimes shows the number of ordinary shares on issue different to the figure indicated in a company's annual report. This apparent inconsistency is significant for the data in 2000 and 2005, although data in earlier sample years do not seem to have this issue. The main reason for the apparent inconsistency is the listing status of companies in the index, which is one of the elements in deciding the number of shares to be included in the NZX index.⁶ The NZX classifies issuers

⁶The Modified Free Float Methodology is another element. Indexed shares can be either NZ Shares Issued or NZ Free Float Shares depending on the thresholds for an issuer's NZ Free Float Market Capitalisation ($[\text{NZ Free Float Shares (latest)}] \times [\text{Average Daily Adjusted Closing Price (6 months)}]$). There are three thresholds in terms of NZ free float market capitalisation (upper, middle and lower). As we selected companies with a

into three groups according to their listing status: New Zealand listed issuers, dual listed issuers, and overseas listed issuers. New Zealand listed issuers are those who treat the NZX as their Home Exchange. They are mainly New Zealand companies. Dual and overseas listed issuers are those who treat a recognised overseas Exchange as their Home Exchange and are listed on both the NZX and their Home Exchange. Foreign issuers can choose to be listed as a dual or an overseas listed issuer on the NZX. A significant difference between a dual listed issuer and an overseas listed issuer is that the former has to comply with the listing rules of both exchanges (although some exemptions have been made due to equivalent listing rules), but the latter does not (with some exceptions). Besides that, being a dual listed issuer or an overseas listed issuer affects the index weighting of its shares.

For New Zealand listed issuers, the number of indexed shares equals the number of shares on issue at that time. Examples include Telecom Corporation of NZ Limited and Contact Energy Limited. Of course, there could still be slight difference between the number of shares included in the index and the number of shares on issue as shown in the annual report closest to the date on which the market capitalisation was observed. For example, the annual report of Donaghys Ltd shows 31.5 million ordinary shares on issue on 30 June 1990 and 32.6 million ordinary shares on issue on 30 June 1991. The NZX index in December 1990 shows 32.2 million indexed shares. Thus, for New Zealand listed issuers, the apparent inconsistency in shares on issue is mainly due to the time difference and is generally insignificant.

For dual listed issuers, the number of indexed shares equals:

cumulative index weight of 80% to constitute the market portfolio, all of them are above the middle threshold and more than half are above the upper threshold. That implies that most of the companies in this research were included at full NZ Market Capitalisation in the index while the rest were at least close to their full NZ Market Capitalisation. Hence, NZ Shares Issued were used instead of NZ Free Float Shares as the indexed shares.

$$\text{the number of shares on issue} \times \frac{\text{revenue generated in New Zealand}}{\text{total revenue generated}}.$$

Examples of dual listed issuers include Promina Group Limited, and APN News and Media Limited. They are jointly listed on the NZ and Australian Stock Exchanges. The balance sheet of APN News and Media Limited on 31st December 2005 shows 478 million shares on issue. However, only 151 million shares issued are treated as indexed shares. The latter is 31.7% of the total shares on issue, representing the proportion of APN News and Media Limited's revenue generated in New Zealand. Hence, for dual listed issuers, the apparent inconsistency in shares on issue is mainly due to the difference between the revenue generated in New Zealand and the revenue generated elsewhere.

For overseas listed issuers, the number of indexed shares equals the number of shares on the New Zealand register. Overseas companies must register on the New Zealand register, if they want to operate in New Zealand through their New Zealand subsidiaries. Examples of overseas listed issuers include Guinness Peat Group, Westpac Banking Corporation, AMP, and Lion Nathan. Westpac Banking Corporation is listed on the ASX, NZX, NYSE, Tokyo Stock Exchange Inc., and other exchanges. Its consolidated balance sheet shows 1869 million shares on issue on 30th September 2005. As the balance date is within three months of the date of the NZX index, the number of shares on issue at 30th December 2005 was estimated to be 1869 million. However, the NZX index shows only 40 million shares of Westpac Banking Corporation on 30th December 2005, which is 2% of the estimated number of shares on issue. This percentage represents the proportion of Westpac Banking Corporation's shares on the New Zealand register.

As dual listed companies and overseas listed companies have some of their shares listed in a different market, if the debt level from the annual report is used in combination with the market capitalisation from the NZX index, the resulting market leverage will be overestimated. Thus, we calculated the ratio of the number of indexed shares to the number of shares

on issue in the annual report, and applied this ratio to the debt level:

$$\text{the modified debt level} = \frac{\text{the number of indexed shares}}{\text{the number of shares on issue}} \times \text{debt level}.$$

The modified debt level is then consistent with the number of shares to which the market capitalisation relates.

Currency Differences

For those overseas companies listed in the New Zealand market, their financial figures must be converted into New Zealand dollars. For example, Lion Nathan migrated to Australia on 2nd June 2000. Its financial details are therefore stated in Australia dollars in its annual report. We converted these figures to New Zealand dollars, using the appropriate exchange rate from the Reserve Bank of New Zealand. The date of the exchange rate is the one to which the NZX index relates. In the example of Lion Nathan, the exchange rate on 29th December 2000 was used.

3.3.5 Corporate Bond Returns

The application of the Lally MRP estimator requires the rate of return on New Zealand corporate bonds (R_d). However, returns data on corporate bonds have not been formally maintained by organisations until recently. We obtained corporate bond return data from the NZX Corporate Bond Indices only for the period 1994–2005, and attempted to obtain data for the remaining study period from historical newspapers. This was unsuccessful. An alternative method was then adopted: using the rate of return on government bonds as a proxy for the return on corporate bonds. We tested the accuracy of this approximation with Ibbotson US data and the NZX Corporate Bond Indices.

Corporate Bond Returns from the NZX Corporate Bond Indices

The NZX Corporate Bond Indices provide gross returns of highly rated corporate bonds, capturing both the capital movement of these bonds and the interest received from holding them. There are two types of corporate bond indices: the A Grade Corporate Bond Index and the AB Grade Corporate Bond Index. The difference between these two indices is mainly due to the credit quality of the component bonds. The A Grade requires its debt securities to have a credit rating of at least A- (if rated by Standard and Poor's) or at least A3 (if rated by Moody's). The AB Grade includes more debt securities by lowering the boundary to a credit rating of BBB- or Baa3 (if rated by Standard and Poor's or Moody's respectively). Since the AB Grade Corporate Bond Index covers a wider range of high credit quality debt securities, it was chosen over the A Grade Corporate Bond Index for this study.

However, neither of the bond indices covers a period that is comparable to our study period: the A Grade Corporate Bond Index only covers the period from 1994, and the AB Grade Corporate Bond Index only covers the period from 2001. Hence, we used the A Grade Corporate Bond Index to estimate R_d over the period 1994 to 2001 and the AB Grade Corporate Bond Index over the period 2001 to 2005.

Corporate Bond Returns from Newspapers

Since NZX Corporate Bond Indices only cover the period from 1994 to 2005, we attempted to retrieve the remaining (1960–93) historical data on NZ corporate bond returns from the local newspaper—the *Dominion Post*, whose copies are kept in the National Library in the form of microfilm. We expected them to contain sufficient information on corporate bonds, such as coupon rates, maturity dates, and market prices (or bond yields).

However, information on corporate bonds could only rarely be found. Only the years 1960, 1961, 1969, and 1970 contained sufficient information

for us to estimate the corporate bond return. The remaining years, however, contained very little information on corporate bonds.

Since NZ corporate bond returns could not in general be obtained from newspapers for the years 1960–93, data from the NZX Corporate Bond Indices for the years 1994–2005 could not be used for the estimation of the MRP. Instead, they were used to test the accuracy of our approximation for the NZ corporate bond return.

Approximation for NZ Corporate Bond Returns

In view of the above data difficulties, we considered using the return on government bonds as a proxy for the return on corporate bonds.

We first tested this proxy with Ibbotson US data because the US capital market has comprehensive historical data sets available. Ibbotson Associates, now owned by Morningstar Corporation, produce comprehensive historical data sets. Their *Stocks, Bonds, Bills and Inflation (SBBI) Yearbook* provides various types of US financial data. The data sets we selected are long-term corporate bond returns (R_d), long-term government bond returns (R_r), long-term government yields (R_f), and equity returns of large company stocks (R_m). Long-term data sets were chosen instead of intermediate-term sets in order to be consistent with our NZ sample study. The only required data that the *SBBI Yearbook* does not include is market leverage. Nevertheless, Lally (2002) contains this data. As the sample period of Lally (2002) is from 1952 to 1997, we selected the same sample period for the Ibbotson data.

We start by using the return on US government bonds (R_r) as a proxy for the return on US corporate bonds (R_d). We then calculated the unlevered market return for each US sample year by:

$$R_m^u = \frac{R_m + R_r \frac{B_m}{S_m}}{1 + \frac{B_m}{S_m}}. \quad (3.6)$$

Subtracting R_f from R_m^u for each year over the period 1952 to 1997, and arithmetically averaging the result over the period, gave the estimate of

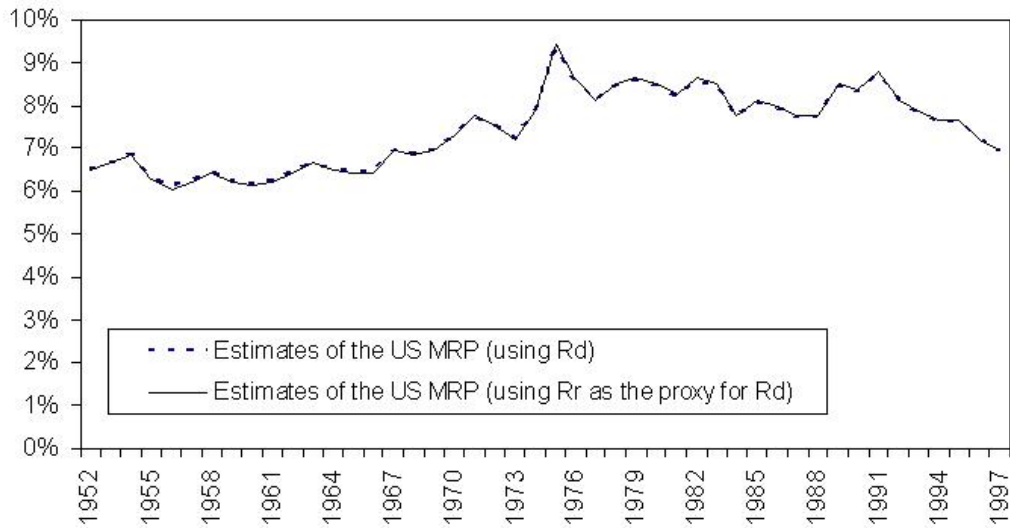
the unlevered MRP ($M\hat{R}P^u$). We used market leverage for year T ($T = 1952, 1953, \dots, 1997$) to estimate MRP_L in the standard CAPM for year T as follows:

$$M\hat{R}P_{LT} = M\hat{R}P^u \left(1 + \frac{B_{mT}}{S_{mT}}\right) - (\overline{R_r - R_f}) \frac{B_{mT}}{S_{mT}}. \quad (3.7)$$

This generated a time series of MRP_L estimates over the period 1952–97.

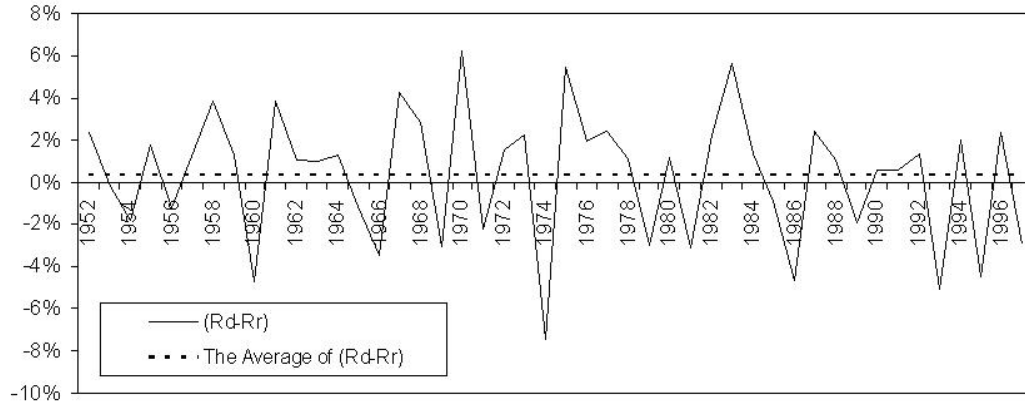
We then repeated these calculations, using the actual value of R_d rather than R_r . This generated another time series of MRP_L estimates. The results from using actual R_d and from using R_r as a proxy for R_d are displayed in Figure 3.3.

Figure 3.3: US MRP Estimates from Using R_d and from Using R_r as a Proxy for R_d



It is extremely hard to distinguish between the two lines. This could be explained by the fact that, although the rate of return on corporate bonds (R_d) and the rate of return on government bonds (R_r) are not identical in any particular year, their averages are very close. Figure 3.4 shows the difference between the return on US corporate bonds and the return on US government bonds from 1952 to 1997. It is clear that R_d and R_r for the US capital market are different over time. However, the arithmetic means

Figure 3.4: The Difference between US Corporate Bond Returns and US Government Bond Returns from 1952 to 1997



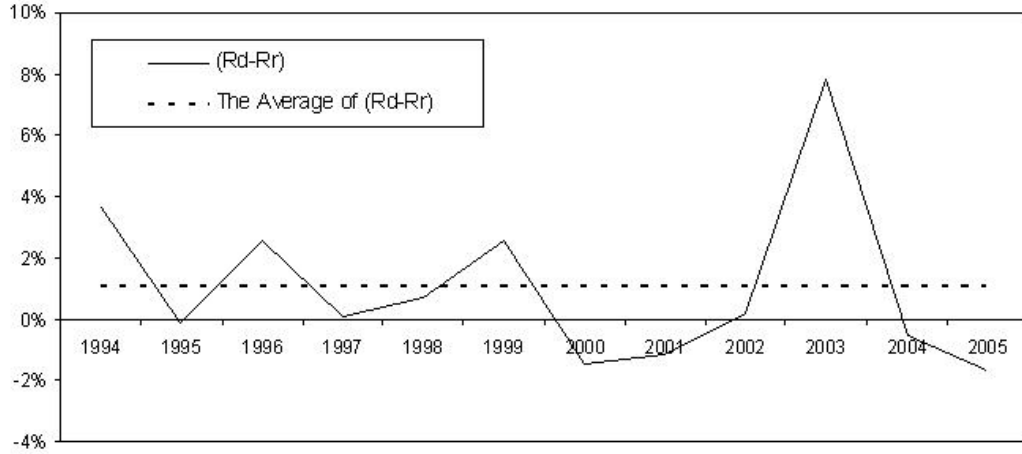
of R_d and R_r are very close: 6.92% and 6.59% respectively. The arithmetic mean of their difference is only 0.33%. Therefore, using the government bond return as a proxy for the corporate bond return makes almost no difference to the Lally estimate of the US MRP in the standard CAPM. This supports our use of the government bond return as a good proxy for the corporate bond return.

We then tested the suitability of using the government bond return as a proxy for the corporate bond return with the NZX Corporate Bond Indices data. The NZX Corporate Bond Indices provide daily index levels over the period 1994–2005. The A Grade Corporate Bond Index was used from 1994 to 2000 and the AB Grade Corporate Bond Index was used from 2001 to 2005. The annual rate of return on corporate bonds was calculated as:

$$R_d = \frac{\text{Index Level at the Beginning of Year } t+1}{\text{Index Level at the Beginning of Year } t} - 1. \quad (3.8)$$

Figure 3.5 shows that the rate of return on corporate bonds differs from the rate of return on government bonds over time. Their average difference is 1.04% ($\overline{R_d - R_r}$). Although this may suggest that $(R_r + 1.04\%)$ is a good proxy for R_d in New Zealand, we consider that using R_r as a proxy for R_d is more appropriate. As the Ibbotson data cover a period of 46 years,

Figure 3.5: The Difference between NZX Corporate Bond Returns and NZ Government Bond Returns from 1994 to 2005



which is 34 years more than the period that the NZX Corporate Bond Indices cover, the Ibbotson US evidence is more reliable than the NZX evidence. Thus, we used the return on 10-year NZ government bonds as a proxy for the return on NZ corporate bonds.

To summarise, by assuming that a Miller (1977) tax world prevails throughout this paper, five data sets, including market returns (R_m), risk free rates of return (R_f), market debt (B_m), market equity (S_m), and the returns on corporate bonds (R_d) were required for the estimation of the MRP under the Lally (2002) method. Only the first two data sets are required under the Ibbotson and Sinquefeld (1976) method. The data collection for R_m and R_f was straight forward, as previous studies had compiled them.

The data sets for B_m and S_m were manually collected. They form the data set for market leverage (L). Market leverage is estimated as the aggregate debt of companies comprising the market portfolio divided by their aggregate value. The estimation process was conducted every five years over the period 1960–2005. An equity portfolio was used as a proxy for the market portfolio (as usual), and its composition was determined by the equity index that we selected: the RBNZ share price index for 1960–85,

the NZX 40 index for 1990–2000, and the NZX 50 index for 2005. Companies with large market capitalisation making up 80% of the total market capitalisation in the equity index were used to proxy for the market portfolio. The individual debt information on these companies was collected from the consolidated balance sheets in their annual reports. The individual equity information was obtained from the *Official Record of New Zealand Stock Exchange* for 1960–1980, *National Business Review* for 1985, and the NZX equity indices for 1990–2005. The resulting estimates of market leverage were adjusted, mainly due to time differences between debt and equity valuations, minority interests, and inconsistencies in shares on issue. Other data issues, such as missing data and convertible notes were generally insignificant.

The data set for R_d was unavailable, and was therefore proxied by the return on long-term government bonds. The suitability of using this proxy was tested with both the Ibbotson US data and the NZX Corporate Bond Indices data.

Chapter 4

Results and Analysis

This chapter presents the results from applying the Ibbotson and the Lally estimators for the MRP in the standard and the simplified Brennan-Lally versions of the CAPM to New Zealand data over the period 1960–2005. The results are compared and analysed. This chapter also discusses the application of the two estimators in three cases and their implications.

4.1 Results for the Standard CAPM

Table B.1 shows the time series of values for R_m , R_f , R_r , R_m^u , and $\frac{B_m}{S_m}$. Over the period 1960–2005, the average yield on government bonds (\bar{R}_f) was 8.37%. The average return on the market portfolio (\bar{R}_m) was 14.48%. Hence, the Ibbotson estimate of the MRP in the standard CAPM was 6.11% for 2005, as follows:

$$\begin{aligned}MRP_I &= \bar{R}_m - \bar{R}_f \\&= 0.1448 - 0.0837 \\&= 0.0611.\end{aligned}$$

Using equation 3.3 to determine the unlevered market return (R_m^u), the average value was 12.42%. The estimate of the unlevered MRP (MRP^u)

was then $\bar{R}_m^u - \bar{R}_f = 4.05\%$ in the standard CAPM. The average corporate bond return (\bar{R}_d) was proxied by the average government bond return (\bar{R}_r) of 7.61%, and hence the estimate of the debt risk premium ($D\hat{R}P$) was $\bar{R}_r - \bar{R}_f = -0.76\%$. Using the estimated market leverage for 2005 of 0.33 (i.e. $\frac{B_{mT}}{S_{mT}} = 0.49$ with $T = 2005$), the Lally estimate of the MRP in the standard CAPM was 6.40% for 2005, as follows:

$$\begin{aligned} M\hat{R}P_{L2005} &= M\hat{R}P^u \left(1 + \frac{B_{m2005}}{S_{m2005}}\right) - D\hat{R}P \frac{B_{m2005}}{S_{m2005}} \\ &= 0.0405 \times (1 + 0.49) - (-0.0076) \times 0.49 \\ &= 0.0640. \end{aligned}$$

The Ibbotson and Lally MRP estimates were very similar for 2005; they differed by 0.29%. However, when we consider the estimates of market leverage for years prior to 2005, the resulting Lally MRP estimates for some years were significantly different to the Ibbotson MRP estimate. Table 4.1 shows the Ibbotson and the Lally estimates of the MRP in the

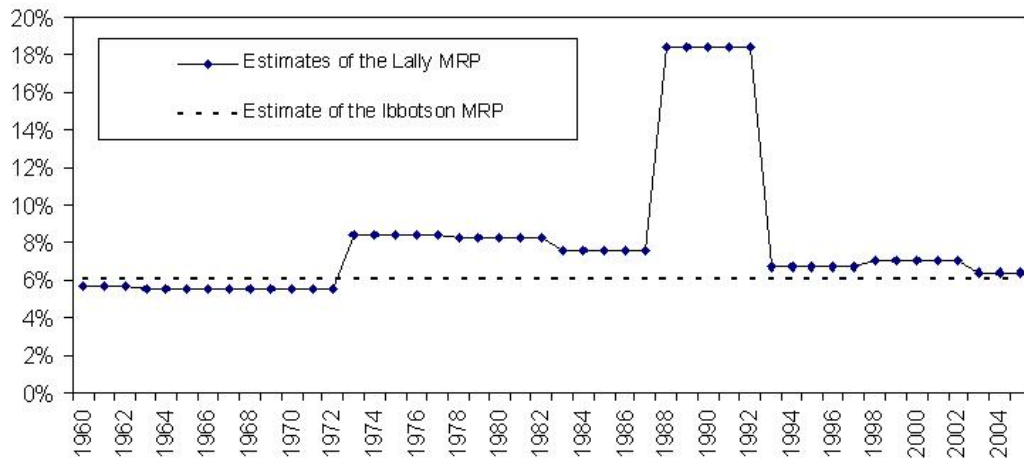
Table 4.1: Estimates of the Ibbotson MRP and the Lally MRP in the Standard CAPM

Year	$\frac{B_m}{S_m}$	Lally Estimates	Ibbotson Estimates	Absolute Difference
1960	0.3366	5.67%	6.11%	0.44%
1965	0.3097	5.54%	6.11%	0.57%
1970	0.3069	5.52%	6.11%	0.59%
1975	0.8979	8.37%	6.11%	2.26%
1980	0.8644	8.21%	6.11%	2.10%
1985	0.7349	7.58%	6.11%	1.47%
1990	2.983	18.40%	6.11%	12.29%
1995	0.5623	6.75%	6.11%	0.64%
2000	0.6194	7.03%	6.11%	0.92%
2005	0.4881	6.40%	6.11%	0.29%
Mean	0.8103	7.95%	6.11%	2.16%

standard CAPM over the period 1960–2005. The Lally MRP estimate ranged from 5.52% (in 1970) to 18.4% (in 1990), with an average of 7.95%. The Lally estimates of the MRP were similar to the Ibbotson estimate of the MRP at the beginning and the end of the study period. However, the two estimates showed considerable divergence from 1975 to 1990, with 1990 showing the greatest difference of 12.29%.

The Lally MRP was estimated every five years because market leverage was estimated every five years from 1960 to 2005. So, each estimate of the Lally MRP was used to cover a five-year period, from two years before the leverage estimate to two year after it. This results in some dramatic shifts in the estimate (see Figure 4.1).

Figure 4.1: Estimates of the Ibbotson MRP and the Lally MRP in the Standard CAPM



4.2 Results for the Simplified Brennan-Lally CAPM

Table B.1 shows the time series of values for R_m , R_f , R_r , R_m^u , $\frac{B_m}{S_m}$, D_m , T_m , and T_I along with data required to estimate T_m and T_I in accordance with

the equations in section 3.1. The Ibbotson estimator for the MRP in the simplified Brennan-Lally CAPM is:

$$\begin{aligned} M\hat{R}P_I &= \overline{R_m - D_m T_m - R_f(1 - T_I)} \\ &= \overline{R_m} - \overline{D_m T_m} - \overline{R_f(1 - T_I)}. \end{aligned}$$

Over the period 1960–2005, the average of $(D_m T_m)$ was 0.0056. The average of $R_f(1 - T_I)$ was 0.0543. Hence, the Ibbotson estimate of the MRP in the simplified Brennan-Lally version of the CAPM was 8.49% for 2005, as follows:

$$\begin{aligned} M\hat{R}P_I &= \overline{R_m} - \overline{D_m T_m} - \overline{R_f(1 - T_I)} \\ &= 0.1448 - 0.0056 - 0.0543 \\ &= 0.0849. \end{aligned}$$

Similarly, the estimate of the unlevered MRP is as follows:

$$\begin{aligned} M\hat{R}P^u &= \overline{R_m^u} - \overline{D_m T_m} - \overline{R_f(1 - T_I)} \\ &= 0.1242 - 0.0056 - 0.0543 \\ &= 0.0643. \end{aligned}$$

With $\overline{R_d}$ being proxied by $\overline{R_r}$, the estimate of DRP is:

$$\begin{aligned} DRP &= \overline{R_r} - \overline{D_m T_m} - \overline{R_f(1 - T_I)} \\ &= 0.0761 - 0.0056 - 0.0543 \\ &= 0.0162. \end{aligned}$$

Hence, the Lally estimate of the MRP in the simplified Brennan-Lally CAPM was 8.78% for 2005, as follows:

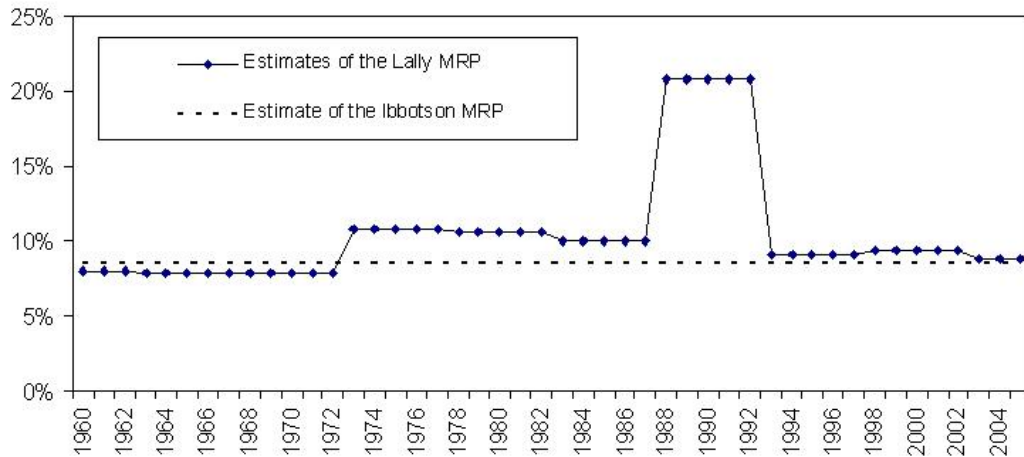
$$\begin{aligned} M\hat{R}P_{L2005} &= M\hat{R}P^u \left(1 + \frac{B_{m2005}}{S_{m2005}}\right) - DRP \frac{B_{m2005}}{S_{m2005}} \\ &= 0.0643 \times (1 + 0.49) - 0.0162 \times 0.49 \\ &= 0.0878. \end{aligned}$$

Table 4.2: Estimates of the Ibbotson MRP and the Lally MRP in the Simplified Brennan-Lally Version of the CAPM

Year	$\frac{B_m}{S_m}$	Lally Estimates	Ibbotson Estimates	Absolute Difference
1960	0.3366	8.05%	8.49%	0.44%
1965	0.3097	7.92%	8.49%	0.57%
1970	0.3069	7.91%	8.49%	0.58%
1975	0.8979	10.75%	8.49%	2.26%
1980	0.8644	10.59%	8.49%	2.10%
1985	0.7349	9.97%	8.49%	1.48%
1990	2.983	20.79%	8.49%	12.30%
1995	0.5623	9.14%	8.49%	0.65%
2000	0.6194	9.41%	8.49%	0.92%
2005	0.4881	8.78%	8.49%	0.29%
Mean	0.8103	10.33%	8.49%	2.16%

Table 4.2 shows the Ibbotson and the Lally estimates of the MRP in the simplified Brennan-Lally version of the CAPM over the period 1960–2005. The differences between them over time were almost the same as those in the standard CAPM. The Lally MRP estimate ranged from 7.91% (in 1970) to 20.79% (in 1990), with an average of 10.33%. Again, the year 1990 showed the greatest difference of 12.30% between the Ibbotson and the Lally MRP estimates. With each Lally MRP estimate being used to cover a five-year period, the variation in the Lally estimate over time in the simplified Brennan-Lally version of the CAPM is shown in Figure 4.2.

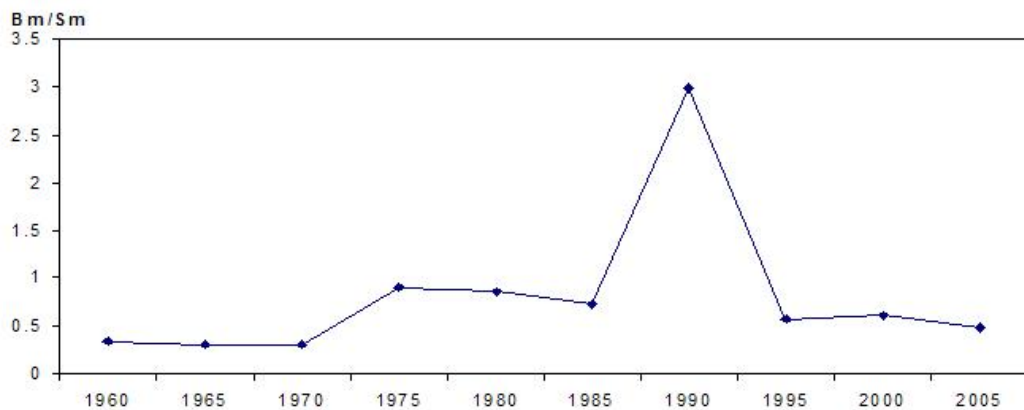
Figure 4.2: Estimates of the Ibbotson MRP and the Lally MRP in the Simplified Brennan-Lally Version of the CAPM



4.3 Intertemporal Variation in the Lally MRP

The variation in the Lally MRP over time is due to shifts in market leverage over time, and this in turn to shifts in the values for market capitalisation and market debt. Figure 4.3 shows the variation in the ratio of market debt to market capitalisation from 1960 to 2005. The ratio was low for the

Figure 4.3: Ratio of Market Debt to Market Capitalisation

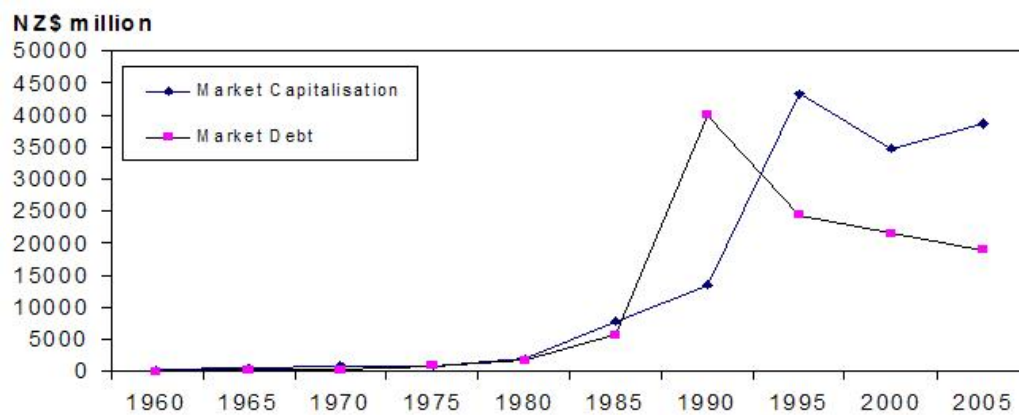


period prior to 1970. It almost tripled in the 1970s and then rose again

even more dramatically in the late 1980s to its peak, which was almost four times the average ratio over the period 1960–2005. It then declined sharply in the early 1990s, to a point somewhere between the levels for the periods 1960–70 and 1975–85.

Figure 4.4 shows the variation over time in market capitalisation and market debt. Both market capitalisation and market debt rose steadily

Figure 4.4: Market Capitalisation and Market Debt



from 1975. In 1990, market debt reached to its peak, which was about three times market capitalisation. After 1990, market debt dropped dramatically and was below market capitalisation from 1995. In contrast, market capitalisation reached its peak in 1995, and has essentially remained at that level since.

The spike in leverage in 1990 is therefore due to a spike in debt, for which a possible explanation is an increase up to the 1987 stock market crash, which was only slowly reversed. Compounding this downtrend would be the dividend imputation system introduced in 1988, which effectively removed the tax advantage of debt.

4.4 Further Results

It may be argued that the time series of estimates for the Lally MRP prior to 2005 are unrealistic, as we estimated the unlevered MRP by using data over the entire 1960–2005 period. To investigate the Lally MRP estimator in a more realistic context, we considered three situations: estimating the MRP in the standard CAPM for 1985, 1990, and 2000. In each case, we only used historical data up to that year for estimating the MRP. The results are shown in Table 4.3.

In case I, we estimated both the Ibbotson and the Lally MRP for 1985 (shortly before the 1987 stock market crash). Using data from 1960–85, the Ibbotson MRP was estimated at 9.50% and the Lally MRP was estimated at 10.23% for 1985. They differed by 0.73%.

In case II, we estimated the MRP for 1990 (shortly after the stock market crash). Using data over the period 1960–90, the Ibbotson MRP was estimated at 6.45% and the Lally MRP was estimated at 21.66%. While the Ibbotson MRP estimate does not reflect the high volatility of the market at that time (arising from high leverage), the Lally MRP estimator explicitly takes this into account and this leads to the much higher estimate of the MRP.

In case III, we estimated the MRP for 2000, after the market recovered from the 1987 stock market crash. Using data from 1960–2000, the Ibbotson MRP estimate was 5.81%, and the Lally MRP estimate was 6.75%. Again, the Ibbotson and the Lally MRP estimates were very similar, with a difference of 0.94%.

Therefore, under most conditions, the estimates from the two methods are similar and only diverge significantly when market leverage is unusually high or low (as it was in 1990).

Table 4.3: Estimates of the Ibbotson and the Lally MRP in the standard CAPM by Using Data over the Periods 1960–1985, 1960–1990, 1960–2000, and 1960–2005

Estimation Year	Ibbotson MRP Estimate		Lally MRP Estimate	
	using data up to the estimation year	using data over the period 1960–2005	using data up to the estimation year	using data over the period 1960–2005
1985	9.50%	6.11%	10.23%	7.58%
1990	6.45%	6.11%	21.66%	18.40%
2000	5.81%	6.11%	6.75%	7.03%

Chapter 5

Conclusion

This paper applied two methods to estimate the MRP in both the standard and the simplified Brennan-Lally versions of the CAPM to New Zealand data over the period 1960–2005. The first is the Lally (2002) method. It is derived from Modigliani and Miller (1958, 1963) proposition II, which relates a company's cost of equity to its leverage. When using an equity portfolio as a proxy for the market portfolio, which is general practice, "market" leverage should therefore affect the expected return on the "market" portfolio and consequently the MRP. The Lally method first estimates the unlevered MRP by averaging excess unlevered returns and then adjusts it for market leverage to generate an estimate of the levered MRP. The resulting MRP estimate varies over time with market leverage. The second method is the Ibbotson and Sinquefeld (1976) method. This simply averages the annual excess return over a long period and hence directly estimates the levered MRP. The results from applying the Lally method are compared to those from the Ibbotson method, due to the similarity in the two methodologies. Both arithmetically average historical data, and they will generate the same result if market leverage does not change over time

In respect of the standard CAPM, the resulting Ibbotson MRP estimate was 6.11% and the Lally estimate was 6.40% for 2005. In respect of the sim-

simplified Brennan-Lally version of the CAPM, the estimates were 8.49% and 8.78% respectively. By using estimates of market leverage for years prior to 2005, the resulting Lally MRP estimates ranged from 5.52% to 18.40% in the standard CAPM and from 7.91% to 20.79% in the simplified Brennan-Lally version. The year 1990 gave rise to an extremely large estimate for the MRP in both versions of the CAPM using the Lally method, due to the very high level of market leverage, which in turn was caused by a spike in debt. We also estimated the MRPs for 1985, 1990, and 2000 in the standard CAPM by only using historical data up to each year. Again, the estimate for 1990 using the Lally methodology was very high. In general, the Ibbotson and Lally estimators produced similar results except when market leverage was very high or low.

The Lally estimator is superior to the Ibbotson estimator because it better reflects changes in market leverage. In addition, and relative to the Merton method, because the Lally MRP estimator is theoretically based rather than empirically developed, it is not exposed to unrepresentative statistical data. However, the Lally MRP estimator may be exposed to the risk of model error. Furthermore, as the Lally MRP estimator presumes the use of an equity portfolio as the proxy for the market portfolio, the method will be irrelevant if the market portfolio contains both equity and debt at market values.

Appendix A

Estimation of the Market Value of Debt

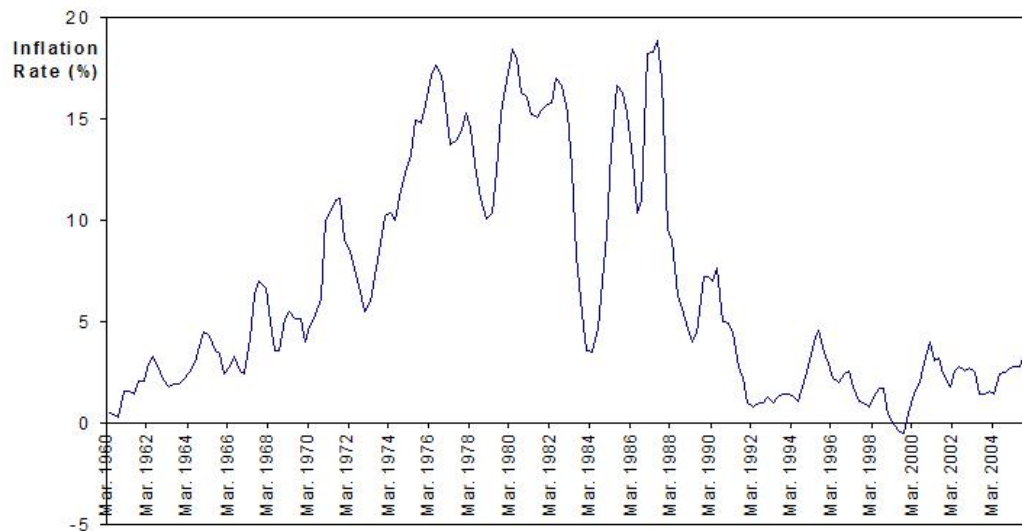
Previous studies, such as Hirschey (1985) and Fama and French (1999), use the book value of debt as a proxy for its market value because it is difficult to obtain historical data on the market value of debt. If the interest rate on debt is generally stable over time, the market value of debt will be generally very close to its book (face) value. Therefore, the book value of debt is generally a good proxy for its market value. However, the market value of debt may diverge from its book value when market conditions change rapidly. The following analysis aims to assess the magnitude of this divergence. It also discusses the implications for the MRP estimate.

There are two main reasons for a potential divergence between the market value of debt and its book value: a change in the level of inflation and a change in the level of default risk. Both will lead to a different required rate of return on debt. Floating interest rates, such as those on bank overdrafts and some subordinate notes, are affected by changes in the inflation rate and default risk. Hence, the market value of such debt will remain close to the book value. However, most corporate debt has fixed coupon interest rates, including corporate bonds, term loans, and mortgages. Their rates are determined at the time of issue, and therefore

do not reflect changes in inflation or default risk. As debt with fixed interest rates is generally the major part of a company's debt, rapid changes in market interest rates could cause a divergence between the book value and the market value of a company's debt.

The market portfolio in 1990 was chosen for examination as the period it covers in this paper (1988–92) involved significant changes in both inflation and default risk. Figure A.1 shows that the inflation rate was unstable, especially in the period 1984–92. The inflation rate reached its peak

Figure A.1: Fourth-Quarter-Ended Inflation Rates from 1960 to 2005



Source: Statistics NZ

of 18.9% in 1987 and dropped rapidly to 0.8% in 1992. Figure A.2 shows that the government bond yield was very high in 1987 at 18.86% and decreased to 6.14% in 1992. The nominal rate of return on government bonds fell so that real rates of return were roughly constant.

Taking only the decreased level of inflation into account, the nominal yield on corporate bonds should have dropped in accordance with that on government bonds. That is, the market interest rate on corporate bonds

Figure A.2: Monthly Average Yield on One-Year Secondary Market Government Bonds over the Period 1987 to 2005



Notes: Pre-1987 yield data of one-year secondary market government bonds are unavailable.

in 1990 should be lower than the coupon rate on fixed rate corporate debt issued prior to 1990. Consequently, corporate debt issued prior to 1990 should have a market value in 1990 higher than its book value.

Default risk is likely to have sharply increased after the stock market crash in 1987, when many NZ companies went bankrupt. The increased market interest rate should reduce the market value of fixed rate corporate debt that was issued prior to 1990. Hence, corporate debt should have had a market value in 1990 lower than its book value if we account for the increased level of default risk.

To determine the market value of debt with fixed interest rates, we require data on three parameters: the coupon rate of debt (which was determined before 1990), the maturity date, and the market interest rate in 1990. Assuming that coupons were paid half-yearly, the market value of

debt is as follows:

$$MV = \frac{\frac{C}{2}}{(1+Y)^{\frac{m}{12}}} + \frac{\frac{C}{2}}{(1+Y)^{\frac{m+6}{12}}} + \cdots + \frac{\frac{C}{2}}{(1+Y)^{\frac{n-6}{12}}} + \frac{\frac{C}{2} + BV}{(1+Y)^{\frac{n}{12}}} \quad (\text{A.1})$$

where C is the annual coupon payment ($C = BV \times r$, where r is the coupon interest rate of debt); BV is the book value of debt; MV is the market value of debt; Y is the market interest rate for corporate debt in 1990; m is the number of months left from the balance date of a company's annual report to the date of the next coupon payment; n is the number of months left from the balance date to the maturity date.

Although the formula for the market value of debt is straightforward, we do not know the market interest rate for corporate debt in 1990 (Y). In section 3.3.5, we used the rate of return on government bonds as a proxy for the return on corporate bonds, and showed that it was a good approximation using Ibbotson US data over the period 1952–97. However, since the New Zealand market experienced much higher default risk in 1990, the yield on corporate bonds is likely to have significantly exceeded the yield on government bonds. Hence, we approximated the value for Y by adding a debt premium to the government bond yield. The government bond yield we used for the calculation is the monthly average one-year secondary market government bond yield (in figure A.2). The month it refers to must be the same as on the balance sheet. *The 2006 New Zealand Company Beta Book* shows that the debt premiums for 37 New Zealand listed companies relative to the three-year government bond yield were within a range of 1.08%–2.20%. Thus, we set the yield on government bonds (R_f) plus 1% to be the lower bound for the yield on corporate bonds. The resulting market value from using ($R_f + 1\%$) as the proxy for the interest rate of corporate debt in 1990 gives rise to the upper bound on the potential market value of corporate debt. As the range of the debt premiums in *the 2006 New Zealand Company Beta Book* were obtained when market leverage was relatively low, we used an upper bound of 4% for the debt premium, in consideration of the extremely large market leverage ra-

tio (and hence default risk) in 1990. Thus, by applying debt premiums of 1% and 4% to the government bond yield in 1990, we obtained upper and lower bounds on the market values of corporate debt with fixed interest rates.

Another problem we encountered was that six out of 23 companies that comprise the 1990 market portfolio do not provide any information on the coupon interest rate and the maturity date of debt. The remaining 17 companies provide a range of coupon interest rates and/or a range of maturity dates. We averaged the coupon interest rates and/or maturity dates of debt for these companies. As a result, we were able to estimate the market value of debt for 17 companies in the 1990 market portfolio.

Table A.1 shows the results. Fletcher Challenge Ltd shows the greatest divergence between the market value of debt and its book value. If the debt premium is 4%, the market value is less than the book value by 15.1%.

Although we were unable to estimate the market value of debt for six companies, we could approximate them by treating the other 17 companies as representative. For these 17 companies, we calculated their aggregate book value and market values under two debt premiums (1% and 4%). We divided each aggregate market value by the aggregate book value, which gave us two market to book ratios corresponding to debt premiums of 1% and 4%: 98.2% and 95.5% respectively. Applying these ratios to the book value of debt for the other six companies gave an approximation of their market values. Table A.2 shows the book value and market value of each company's total debt (those with fixed interest rates and floating interest rates). It also displays the resulting market leverage ratios and the MRP estimates.

Table A.2 shows that the estimated MRP is hardly affected by the use of book or market value for debt or the estimate for the debt risk premium. If the book value is used as a proxy for the market value of debt, the estimate of the MRP in 1990 is 18.26%. If market value is used with a debt risk premium of 1%, the MRP estimate drops by only 0.28%. If the market

value is used with a debt risk premium of 4%, the MRP estimate drops by only a further 0.41%. Therefore, approximating the market value of debt by its book value would seem to be satisfactory for the purposes of this study.

Table A.1: Comparison between the Book Value and the Market Value of Debt with Fixed Interest Rates in the 1990 Market Portfolio

Companies	Book values of debt with fixed interest rates (in \$m)	Estimated market values (as a proportion of book values) by using the following discount rates:	
		Rf+1% (in \$m)	Rf+4% (in \$m)
Fletcher Challenge Ltd	7,867	7,239(92.02%)	6,679(84.90%)
BIL International Ltd	2,890	2,942(101.8%)	2,770(95.84%)
Carter Holt Harvey Ltd	2,193	2,094(95.47%)	1,930(87.99%)
Lion Nathan Ltd	605.8	627.0(103.5%)	598.2(98.74%)
Bank of New Zealand	908.3	910.2(100.2%)	885.2(97.46%)
Wilson&Horton Ltd	43.68	45.68(104.6%)	43.23(98.96%)
Independent Newspapers Ltd	160.6	158.0(98.38%)	147.8(92.01%)
Air New Zealand ltd	446.7	425.9(95.34%)	398.9(89.29%)
Fisher&Paykel Healthcare Corp. Ltd.	110.7	106.4(96.15%)	98.86(89.32%)
Fay Richwhite & Company Ltd	238.4	239.0(100.2%)	230.2(96.55%)
The NZ Refining Company Ltd		Insufficient Information	
Wilson Neil Ltd		Insufficient Information	
BNZ Finance	822.9	817.3(99.33%)	796.5(96.79%)
Sanford ltd	34.87	33.39(95.75%)	31.08(89.11%)
Countrywide		Insufficient Information	
Fortex Group Ltd	35.48	34.91(98.40%)	32.54(91.72%)
Asian Properties Ltd	78.02	71.26(91.34%)	66.81(85.62%)
Jarden Morgan Ltd		Insufficient Information	
Shortland Properties Ltd	15.00	15.06(100.42%)	14.1(93.99%)
Steel&Tube Holdings Ltd		Insufficient Information	
Donaghys Ltd	26.61	27.10(101.8%)	25.63(96.32%)
Milburn NZ Ltd	62.57	63.57(101.6%)	59.60(95.26%)
Waste Management NZ Ltd		Insufficient Information	

Notes: R_f is the monthly average of the one-year secondary market government bond yield in 1990.

Table A.2: The Book and Market Values of Aggregate Debt, Market Leverage, and MRP Estimates in the 1990 Market Portfolio

Companies	Market Value of equity (in\$m)	Book value of debt (in \$m)	Market value of debt when the discount rate equals:	
			Rf+1% (in \$m)	Rf+4% (in \$m)
Fletcher Challenge Ltd	3,986	8,527	7,899	7,339
BIL International Ltd	1,901	4,723	4,775	4,603
Carter Holt Harvey Ltd	1,666	4,190	4,090	3,926
Lion Nathan Ltd	1,065	795.3	816.4	787.6
Bank of New Zealand	600.6	17,773	17,775	17,750
Wilson&Horton Ltd	398.0	56.75	58.75	56.30
Independent Newspapers Ltd	359.9	158.3	155.9	146.5
Air New Zealand Ltd	187.5	381.3	367.8	350.2
Fisher & Paykel Healthcare Corp. Ltd	171.3	126.9	122.6	115.0
Fay Richwhite & Company Ltd	156.7	342.4	342.9	334.1
The NZ Refining Company Ltd	145.2	0.801	0.787	0.765
Wilson Neil Ltd	131.5	188.3	184.9	179.8
BNZ Finance	128.7	824.5	819.0	798.1
Sanford ltd	123.8	41.57	40.09	37.77
Countrywide	110.1	1,522	1,495	1,454
Fortex Group Ltd	85.00	58.78	58.21	55.84
Asian Properties Ltd	74.76	78.49	71.73	67.28
Jarden Morgan Ltd	64.58	9.670	9.497	9.236
Shortland Properties Ltd	56.88	17.35	17.41	16.45
Steel&Tube Holdings Ltd	52.11	49.66	48.77	47.43
Donaghys Ltd	51.57	32.96	33.45	31.98
Milburn NZ Ltd	50.01	69.70	70.69	66.73
Waste Management NZ Ltd	41.95	9.697	9.524	9.262
<i>Aggregate Value</i>	11,667	39,976	39,262	38,182
<i>Market Leverage</i>		77.41%	77.09%	76.59%
<i>Market Leverage (adjusted for the effect of minority interests)</i>		74.71%	74.37%	73.84%
<i>Resulting Estimate of the MRP</i>		18.26%	17.98%	17.57%

Appendix B

Summary of Data

Table B.1: Total Data Sets for this Paper

End Year	R_m	R_f	R_r	$\frac{B_m}{S_m}$	R_m^u	D_m	w_A	T_0	p	T_c	T_m	T_I
1960	0.151	0.048	0.042	0.337	0.123	0.041	0.810	0.387	0.42		0.132	0.313
1961	-0.060	0.051	0.016	0.337	-0.041	0.047	0.810	0.387	0.42		0.132	0.313
1962	0.128	0.053	0.060	0.337	0.111	0.050	0.810	0.387	0.42		0.132	0.313
1963	0.252	0.052	0.058	0.310	0.206	0.047	0.810	0.400	0.42		0.136	0.324
1964	0.146	0.051	0.057	0.310	0.125	0.044	0.810	0.412	0.42		0.140	0.334
1965	-0.059	0.051	0.044	0.310	-0.035	0.046	0.810	0.412	0.42		0.140	0.334
1966	0.008	0.053	0.034	0.310	0.014	0.051	0.810	0.412	0.42		0.140	0.334
1967	-0.049	0.055	0.041	0.310	-0.028	0.059	0.810	0.425	0.42		0.145	0.344
1968	0.482	0.055	0.056	0.307	0.382	0.052	0.810	0.437	0.42		0.149	0.354
1969	0.211	0.055	0.056	0.307	0.174	0.044	0.810	0.490	0.42		0.167	0.397
1970	-0.051	0.055	0.058	0.307	-0.025	0.047	0.810	0.620	0.42		0.211	0.502
1971	0.003	0.055	0.052	0.307	0.015	0.055	0.810	0.475	0.42		0.162	0.385
1972	0.245	0.055	0.055	0.307	0.020	0.051	0.810	0.435	0.42		0.148	0.352
1973	0.003	0.058	0.016	0.898	0.009	0.049	0.810	0.423	0.42		0.144	0.343
1974	-0.178	0.061	0.058	0.898	-0.066	0.071	0.810	0.450	0.42		0.153	0.365
1975	0.218	0.063	0.022	0.898	0.125	0.077	0.810	0.480	0.42		0.163	0.389

Table B.1 (continued)

End Year	R_m	R_f	R_r	$\frac{B_m}{S_m}$	R_m^u	D_m	w_A	T_0	p	T_c	T_m	T_I
1976	0.101	0.083	-0.062	0.898	0.024	0.072	0.810	0.483	0.42		0.164	0.391
1977	-0.073	0.093	0.014	0.898	-0.032	0.085	0.810	0.486	0.40		0.158	0.394
1978	0.212	0.100	0.099	0.864	0.160	0.085	0.810	0.473	0.44		0.169	0.383
1979	0.226	0.120	-0.055	0.864	0.096	0.090	0.810	0.480	0.43		0.167	0.389
1980	0.578	0.133	0.132	0.864	0.371	0.080	0.810	0.480	0.30		0.117	0.389
1981	0.341	0.128	0.156	0.864	0.255	0.058	0.810	0.550	0.36		0.160	0.446
1982	-0.079	0.129	0.112	0.864	0.009	0.077	0.810	0.310	0.24		0.060	0.251
1983	1.194	0.122	0.271	0.735	0.803	0.087	0.810	0.312	0.31		0.078	0.253
1984	0.264	0.126	-0.192	0.735	0.071	0.056	0.810	0.320	0.21		0.054	0.259
1985	0.337	0.177	0.177	0.735	0.269	0.047	0.810	0.451	0.66		0.241	0.365
1986	1.014	0.164	0.168	0.735	0.655	0.031	0.810	0.520	1.00		0.421	0.421
1987	-0.486	0.157	0.239	0.735	-0.179	0.033	0.810	0.480	1.00		0.389	0.389
1988	-0.080	0.131	0.177	2.983	0.113	0.041		0.400		0.28	0.167	0.400
1989	0.159	0.128	0.159	2.983	0.159	0.048		0.330		0.33	0	0.330
1990	-0.371	0.125	0.144	2.983	0.015	0.047		0.330		0.33	0	0.330
1991	0.283	0.101	0.204	2.983	0.224	0.047		0.330		0.33	0	0.330
1992	0.115	0.084	0.120	2.983	0.119	0.044		0.330		0.33	0	0.330
1993	0.494	0.068	0.135	0.562	0.365	0.040		0.330		0.33	0	0.330
1994	-0.084	0.078	-0.028	0.562	-0.064	0.041		0.330		0.33	0	0.330
1995	0.173	0.079	0.132	0.562	0.159	0.050		0.330		0.33	0	0.330
1996	0.164	0.081	0.086	0.562	0.136	0.049		0.330		0.33	0	0.330
1997	0.011	0.073	0.070	0.562	0.032	0.045		0.330		0.33	0	0.330
1998	-0.053	0.063	0.136	0.619	0.020	0.053		0.330		0.33	0	0.330
1999	0.149	0.066	0.005	0.619	0.094	0.046		0.330		0.33	0	0.330
2000	-0.110	0.069	0.111	0.619	-0.025	0.054		0.330		0.33	0	0.330
2001	0.148	0.062	0.049	0.619	0.110	0.044		0.330		0.33	0	0.330
2002	0.022	0.064	0.084	0.619	0.046	0.049		0.330		0.33	0	0.330
2003	0.241	0.056	-0.009	0.488	0.159	0.051		0.330		0.33	0	0.330
2004	0.253	0.061	0.062	0.488	0.190	0.058		0.330		0.33	0	0.330
2005	0.067	0.061	0.082	0.488	0.072	0.054		0.330		0.33	0	0.330

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