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# **LIQUIDITY AND STOCK RETURNS IN ORDER DRIVEN MARKETS**

A thesis presented in partial fulfilment of the requirements for the degree  
of Master of Business Studies in Finance at Massey University

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## Abstract

This thesis examines the relationship between liquidity and stock returns in the New Zealand and Australian stock markets, for the periods of 1993 to 1998 and 1994 to 1998 respectively. There is evidence to suggest that investors are compensated for holding less liquid stocks with higher returns. However, this is the first study (that the author is aware of) to test the return-liquidity relationship in pure order driven stock exchanges. The combined use of bid-ask spread, turnover rate, and amortised spread as proxies for liquidity, also makes this study unique. Previous studies have investigated the return-liquidity relationship using only one or two of these proxies. In addition to liquidity, other factors that have been found by previous researchers to influence stock returns, such as beta, size, and book-to-market equity are also considered. Seemingly Unrelated Regressions (SUR) and a variant of the General Pooled Cross-Sectional Time-Series Model, known as the Cross Sectionally Correlated Timewise Autoregressive (CSCTA) Model, form the methodological basis for this research. A small liquidity premium is found in both markets. This premium persists for the entire year in the Australian market, while in the New Zealand market the premium is only evident in the month of January. There is strong evidence of a negative size effect in Australia. In New Zealand, there is weak evidence of a negative size effect in the month of January. The returns of high book-to-market equity (value) firms are found to be larger than those of their low book-to-market equity (growth) firm counterparts in New Zealand.

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## Introduction

Individual investors and fund managers alike are constantly in search of superior performing investments. A considerable amount of finance research has therefore been devoted to determining the factors driving asset returns. Based on Markowitz's (1952) analysis of individuals' investment decisions under conditions of uncertainty using mean-variance analysis, Sharpe (1964), Lintner (1965), and Mossin (1966) derived the Capital Asset Pricing Model (CAPM). The CAPM, which explains asset returns in terms of individual assets' sensitivity to the market, has been universally accepted as the foundation for asset pricing in the literature. However, beginning in the late 1970s, evidence that factors such as size, book-to-market equity, and earnings-price ratios affect returns, began to emerge.

Liquidity emerged as a determinant of stock returns in the mid 1980s, with studies finding that investors were compensated for holding less liquid stocks with higher returns. The debate on how to best measure liquidity continues to this day. Dynamic liquidity measures such as market impact have been theoretically proven superior. However, the large data and computational requirements associated with such measures have largely prevented them from being tested empirically. Instead, the relationship between return and static liquidity measures such as the bid-ask spread, turnover rate, and amortised spread has been tested. These studies have produced mixed results. Some have found a strong positive return-illiquidity relationship; others have found no relationship, while others still have found that the relationship is unique to the month of January.

As with most of the finance literature, the vast majority of asset pricing research has been conducted using data from hybrid quote driven stock markets, namely the NYSE, AMEX, and Nasdaq. In quote driven markets, designated market makers supply liquidity to the market by continuously quoting the bid and ask prices at which they are willing to trade. Since 1997, the quotes of dealers on Nasdaq have

faced effective competition from limit orders submitted from the public.

Competition from limit orders is also part of the NYSE and AMEX trading systems: hence the term “hybrid quote driven market.”

In contrast to the NYSE, AMEX, and Nasdaq, the stock markets of New Zealand (NZSE) and Australia (ASX) operate order driven systems. In an order driven environment, public limit orders provide liquidity to the market and establish the bid-ask spread.

By considering the relationship between liquidity and asset pricing on the NZSE and ASX, this thesis helps fill the void in research with respect to order driven stock markets. The combined use of the bid-ask spread, turnover rate, and amortised spread also makes this thesis unique. Previous research has tended to focus on one, or in some instances two, of these measures, making comparison of these liquidity proxies difficult.

The relationship between return and each liquidity proxy is tested over the periods 1993 to 1998 and 1994 to 1998 for the New Zealand and Australian Stock Exchanges respectively. In keeping with earlier studies, the relationship is investigated separately for the entire year and the month of January. While the relationship between liquidity and stock returns is the primary focus of this study, consideration is also given to the relationship between beta, size, book-to-market equity, and returns.

Zellner’s (1962) Seemingly Unrelated Regression (SUR) Model and a variant of the General Pooled Cross-Sectional Time-Series Model, known as the Cross Sectionally Correlated Timewise Autoregressive (CSCTA) Model, provide the methodological basis for this research. Both of these methodologies allow for contemporaneous (same time period) correlation among cross-sectional units (portfolios) and are therefore ideally suited to finance research.

This thesis is divided into three parts. Part One, which reviews all the relevant literature, comprises three chapters. The first chapter begins with the development of the CAPM, and then looks at the CAPM ‘anomaly’ literature. Chapter Two takes a

general look at the concept of liquidity before outlining the theoretical and empirical developments in the liquidity asset pricing literature. Part One is concluded in Chapter Three with a description of the stock exchange mechanisms of New Zealand, Australia, and the markets on which previous liquidity asset pricing studies have been conducted. A comparison of liquidity in order and quote driven markets is also included. Part Two looks at the data and methodology used in this thesis. Chapter Four describes the data set and portfolio formation procedures used, while Chapter Five outlines the SUR and CSCTA Models, together with the statistical basis for the tests that were carried out to ascertain the applicability of these techniques. The results and analysis are provided in Part Three. Chapters Six and Seven include and analyse the New Zealand and Australian results. The results from these two markets are then compared with each other and those of previous studies in Chapter Eight. This thesis then ends with conclusions and directions for future research.

# PART ONE

## LITERATURE REVIEW

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Although this is the first study (that the author is aware of) to consider the relationship between liquidity and stock returns in pure order driven markets, there is a substantial amount of relevant literature. Chapter One reviews the literature concerned with explaining the factors that have been found to influence stock returns. This description of the general asset pricing framework sets the scene for the discussion on liquidity, which is undertaken in Chapter Two. The chapter begins with an introduction to the concept of liquidity and then outlines the theoretical and empirical evidence of its effects on asset pricing, specifically stock returns. Chapter Three reviews the literature that links this study to previous liquidity asset pricing studies. It begins with a description of the trading mechanisms of the foreign stock exchanges that previous related studies have considered, together with a description of the New Zealand and Australian Stock Exchanges. This is followed by a review of studies that provide an insight into liquidity levels across different exchange mechanisms.

# Chapter One

## Asset Pricing

### 1.1 Introduction

Within the discipline of finance, much attention has been given to asset pricing and in particular, the factors that determine stock returns. While the impact of liquidity on stock returns is the major focus of this research, it is important to understand the general asset pricing framework, and how liquidity asset pricing studies fit into this framework.

The earliest and most significant contribution to this area of study was provided by Sharpe (1964), Lintner (1965), and Mossin (1966) who developed the Capital Asset Pricing Model (CAPM), which remains one of the most significant contributions made to finance theory. The CAPM, which built on Markowitz's (1952) mean-variance analysis, not only formalised the risk-return relationship, but also stated that relative asset returns are determined solely by individual assets' level of non-diversifiable risk. Specifically, an asset's expected return is linearly related to its expected non-diversifiable risk, as measured by its future beta.

Following the introduction of the CAPM, researchers set about testing the model's ability to explain relative asset returns.<sup>1</sup> In support of the CAPM, Black, Jensen, and Scholes (1972) along with Fama and MacBeth (1973)<sup>2</sup> found evidence of a positive

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<sup>1</sup> Since large-scale systematic data on expectations does not exist, almost all tests of the CAPM have been performed using ex-post data. Such testing of an expectational model in terms of realisations has been conducted on the basis that expectations are, on the whole, correct. Therefore, over long periods of time, actual events are said to be good proxies for expectations (Elton and Gruber, 1995).

<sup>2</sup> Fama and MacBeth (1973) developed a cross-sectional regression approach, which has served as the methodological basis for the majority of subsequent CAPM literature.

relationship between average returns and beta during the periods 1926-66 and 1935-68 respectively.<sup>3</sup>

Despite widespread acceptance of the CAPM in finance theory, numerous studies have provided substantial empirical evidence questioning the ability of the CAPM to fully describe asset returns. These studies evaluate the CAPM by testing the ability of beta to explain return, and offer a number of alternative factors as potential influences of equity returns. The predominant factors considered are firm size, the month of January, the earnings-price ratio (E/P), book-to-market equity, leverage, and dividend yield.

## 1.2 Early Empirical Evidence

Banz (1981) provided the first evidence of a size effect. He found that during the period 1936-75, smaller firms had higher risk-adjusted returns, on average, than larger firms.<sup>4</sup>

Rozeff and Kinney (1976) were among the first to find evidence of seasonality. For the period 1904-74, they found a statistically significant (at the 5% level) higher mean return for the month of January. They concluded that the absence of a significant January effect finding in previous studies is due to the failure of these studies to examine stock return distributions by month.<sup>5</sup>

The first discussion of E/P<sup>6</sup> effects is attributed to Basu (1977). He found that for the 1957-71 period, portfolios of firms with high E/P ratios earned, on average, higher absolute and risk-adjusted rates of return than their low E/P ratio counterparts.

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<sup>3</sup> The reader should assume that the empirical studies outlined in Chapter One used NYSE data unless it is stated otherwise.

<sup>4</sup> The size effect was found to be non-linear in market value, with the main effect occurring for very small firms.

<sup>5</sup> Earlier studies such as Granger and Morgenstern (1970), who used spectral analysis, focused on aggregate monthly data.

<sup>6</sup> Basu (1977) actually discussed the earnings-price relationship as P/E ratios but so as to be consistent with subsequent research Basu's findings are explained here in terms of E/P ratios.

Much of the early literature considered the relationship between size, January, and E/P effects. Reinganum (1981) found that portfolios based on firm size or E/P ratios experienced average returns systematically different to those predicted by the CAPM. He also found that the size effect subsumed the E/P effect.

Using a different sample period and a different portfolio formation procedure, Basu (1983) found, in contrast to Reinganum (1981), that the E/P effect was statistically significant (at the 5% level) even after controlling for size, whereas the size effect disappeared after controlling for risk and E/P ratios. Using an ANOVA methodology to test for interaction between size and E/P effects, Cook and Rozeff (1984) got a different set of results. They found that neither the size nor the E/P effect subsumed the other. i.e. both a size and an E/P effect were at work. Using longer time periods and different methodologies, studies that are more recent<sup>7</sup> have also found evidence of both a size and an E/P effect.

Blume and Stambaugh (1983), together with Brown, Kleidon, and Marsh (1983), Keim (1983), and Cook and Rozeff (1984), found that up to half of the annual size effect occurred in the month of January, with up to 25 percent occurring in the first five trading days.<sup>8</sup> Reinganum (1983) and Roll (1983), who found the same January effect in the returns of small firms, proposed a tax-loss selling hypothesis<sup>9</sup> as a partial explanation.<sup>10</sup>

Ritter and Chopra (1989) provided further evidence that the January effect is related to the size effect by showing that inferences about the January effect are sensitive to the procedure used to form portfolios. Using data for the period 1935-86, they found no evidence of the January effect using value-weighted portfolios, while previous

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<sup>7</sup> See Jaffe, Keim and Westerfield (1989) and Keim (1990).

<sup>8</sup> Cook and Rozeff (1984) also found that a large portion of the E/P effect occurred in January.

<sup>9</sup> Brown, Keim, Kleidon, and Marsh (1983, p. 107) explained that the tax-loss selling hypothesis "maintains that tax laws influence investors' portfolio decisions by encouraging the sale of securities that have experienced recent price declines so that the (short-term) capital loss can be offset against taxable income." Both Reinganum (1983) and Roll (1983) conjectured that the tax-loss selling effect is largest for small firms because small firms' stock returns are more volatile, and because tax exempt investors, such as pension funds, have relatively small holdings in small firms' stocks.

<sup>10</sup> Reinganum (1983) accepted that the tax-loss selling effect is not a comprehensive explanation. He found that small firms least likely to be sold for tax reasons (prior year 'winners') also exhibited large average January returns.

studies over a similar time period which used equally weighted portfolios found a January effect.

Lamoureux and Sanger (1989) investigated size and January effects for over-the-counter (OTC) stocks traded on Nasdaq. Consistent with the majority of NYSE studies, they found evidence that small firms earn significant positive abnormal returns in January.

Another major beta alternative is the book-to-market equity factor. Rosenberg, Reid, and Lanstein (1985) found a statistically significant (at the 5% level) positive relationship between book-to-market equity and stock returns over the 1973-85 period. This effect was found to be strongest in the month of January. Chan, Hamao, and Lakonishok (1991) confirmed this relationship with their finding of a strong positive relationship between book-to-market equity and stock returns in the Japanese stock market.

Leverage emerged as a determinant of relative asset returns with Bhandari (1988) providing evidence of a positive relationship between a company's debt-to-equity ratio and stock returns. He found that while leverage is not a substitute for beta and size factors, it could make an important contribution to explaining relative asset returns.

Dividend yield has also been considered as a factor driving relative asset returns. Litzenberger and Ramaswamy (1979, p. 190)<sup>11</sup> found a “strong positive relationship between before tax expected returns and dividend yields of common stocks.”

Other studies through the 1980s tested the ability of beta to explain stock returns. The results were mixed. Tinic and West (1984) found that the positive relationship between risk and return factors found by Fama and MacBeth (1973) is unique to January. Tinic and West (1986), like Gibbons (1982) before them, found that the relationship between risk and return appears to contain important non-linearities. Lakonishok and Shapiro (1986) found that over the 1962-81 period, neither beta nor

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<sup>11</sup> Rozeff (1984), Shiller (1984), Flood, Hodrick, and Kaplan (1986), and Campbell and Shiller (1988) have also provided evidence of a relationship between dividend yield and return.

alternative risk measures such as variance and residual standard deviation could explain the cross-sectional variation in returns.

Although literature throughout the 1980s provided substantial evidence of a number of potential determinants of stock returns, the relative importance of these different factors remained unclear. In what has turned out to be a seminal paper, Fama and French (1992) used 1963-90 NYSE, AMEX, and Nasdaq data to provide a comprehensive analysis of the ability of size, book-to-market equity, beta, leverage, and the E/P ratio to explain stock returns. They found that when used alone, or in combination with other variables, beta had little information about average returns. When used alone, size, E/P, leverage, and book-to-market equity had explanatory power. However, in combinations both size and book-to-market equity were found to “capture the cross-sectional variation in average stock returns associated with size, E/P, book-to-market equity, and leverage” (Fama and French, 1992, p. 450).

### **1.3 Post Fama and French (1992)**

The literature that followed Fama and French (1992) can be classified into three categories:

1. Literature that has provided theoretical justification for the size and book-to-market equity factors.
2. Literature that has criticised the Fama and French conclusions as spurious.
3. Literature that has used new data and methodology to re-test the CAPM.

#### **1.3.1 Theoretical Justification for Size and Book-to-Market Equity Factors**

Fama and French (1992) documented the importance of size and book-to-market equity factors in explaining stock returns but they provided little theoretical justification for their findings. Subsequent literature set about doing this.

Using a “rational pricing” argument, Fama and French (1993, 1996a, b)<sup>12</sup> proposed that the higher returns associated within smaller and higher book-to-market equity firms are compensation for higher systematic risk. Fama and French (1993) suggested that book-to-market equity and size are proxies for distress, and that distressed firms may be more sensitive to certain business cycle factors like changes in credit conditions, than firms that are financially less vulnerable. Fama and French (1993) also showed that prices of high book-to-market equity and small capitalisation stocks tend to move up and down in a way that is suggestive of a common risk factor. Fama and French (1995) strengthened their rational pricing argument by showing that both size and book-to-market equity are related to earnings. For instance, high (low) book-to-market ratios were found to signal persistent poor (strong) earnings.

In an alternative rational pricing argument, Berk (1995) has showed that the market value of equity<sup>13</sup> is negatively correlated to average return because it is theoretically inversely related to the risk of the firm. Pontiff and Schall (1998) have argued that book-to-market equity is a ratio of a cash flow proxy to the current price level.

In what has been termed the “irrational pricing” argument, Lakonishok, Shleifer, and Vishny (1994) and Haugen (1995) proposed that the distress premium identified by Fama and French (1993) is due to investor over-reaction.<sup>14</sup> As an alternative justification for the irrationality of the distress premium, Lakonishok et al. (1994) showed that periods of poor returns on distressed stocks are not typically periods of low GNP growth or low overall market returns. They concluded that the premium arises simply because investors dislike distressed stocks and so cause them to be under priced.

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<sup>12</sup> Using the time-series regression approach of Black, Jensen and Scholes (1972), rather than the Fama and MacBeth (1973) cross-sectional regression approach that they used in their 1992 paper, Fama and French (1993) found that a “three factor model” which includes a market factor, size, and book-to-market equity explains the cross-section of average stock returns.

<sup>13</sup> This is the standard measure of size in the literature.

<sup>14</sup> Specifically, it is argued that investors do not understand that the low earnings growth of high book-to-market equity firms and the high earnings growth of low book-to-market equity firms revert to normal levels after portfolios are formed based on book-to-market equity.

Daniel and Titman (1997) undermined both the rational and irrational pricing arguments by showing that the return premia on small capitalisation and high book-to-market equity stocks does not arise because of the comovements of these stocks with pervasive factors. For instance, they found that although high book-to-market equity stocks do covary strongly with each other, the covariances do not result from there being particular risks associated with the distress.<sup>15</sup> Instead, they reflect the fact that high book-to-market equity firms tend to have similar properties e.g. they might be in related lines of business. The question of theoretical justification for size and book-to-market equity factors is thus far from resolved.

### **1.3.2 Literature that Criticises the Conclusions of Fama and French (1992) as Spurious**

Numerous studies have argued that the CAPM does in fact hold, and that Fama and French (1992) and others have spuriously rejected it. Black (1993, p. 9) claimed that the Fama and French (1992, p. 459) comment that their results “seem to contradict” the evidence that the slope of the line relating expected return and beta is positive, is a misstatement. He concluded that “even in the period they choose to highlight, they cannot rule out the hypothesis that the slope of the line is positive.” Breen and Korajczyk (1994) and Kothari, Shanken, and Sloan (1995a) argued that survivorship bias<sup>16</sup> in COMPUSTAT data is an important factor in the book-to-market equity-return relationship discussed by Fama and French (1992).

Others such as Lo and MacKinlay (1988), Black (1993), and MacKinlay (1995) have argued that CAPM anomalies are the result of data mining (or snooping). This literature concludes that as the finance profession rummages through the same data, patterns in average returns that are inconsistent with the CAPM but sample specific, are likely to emerge.

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<sup>15</sup> Instead, Daniel and Titman (1997) found that the covariances were equally strong before the firms became distressed.

<sup>16</sup> It is argued that the “back-filling-in” procedure COMPUSTAT uses to replace missing data is likely to result in firms with high book-to-market ratios and subsequently higher returns being added, and firms with high book-to-market ratios and subsequently low returns being excluded.

A third view is that the CAPM holds and that return anomalies just expose the shortcomings of empirical proxies for the market portfolio.<sup>17</sup> In other words, the true market portfolio is mean-variance-efficient, but the proxies used in empirical tests are not. Finally, Handa, Kothari, and Wasley (1989) and Kim (1995, 1997) postulated that most of the empirical tests that have found contradictions to the CAPM have an errors-in-variables problem, since true betas are unobservable and estimated betas are used as proxies for the unobservable betas.

### **1.3.3 Literature that Uses New Data and Methodology to Re-test the CAPM**

The survivorship bias explanation of Kothari, Shanken, and Sloan (1995a) has been dismissed in subsequent literature. Chan, Jegadeesh, and Lakonishok (1995) concluded that it could not explain the strong relationship between average return and book-to-market equity. They also showed that almost all of the missing COMPUSTAT data has not resulted in survivorship bias. Further, Cohen and Polk (1995) constructed portfolios in a way that completely eliminated the COMPUSTAT survivorship bias and still found evidence of a book-to-market equity factor. In a very comprehensive study, Kim (1997) collected the missing COMPUSTAT data for the vast majority of companies<sup>18</sup> and found evidence suggesting that the survivorship bias argument is weak. Finally, Davis (1994) found a book-to-market equity effect, similar in magnitude to the one found by Fama and French (1992), in NYSE 1940-63 data that was free of survivorship bias.

Fama and French (1996a) accepted that data mining bias can never be completely ruled out. However, they suggested several counter arguments. They used the Davis (1994) study as evidence that the distress premium is not specific to the post 1962 period studied by Fama and French (1992). Another argument is the fact that tests on international data, which can be regarded as out-of-sample, have produced

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<sup>17</sup> See Roll (1977), Ross (1977), Roll and Ross (1994), Kandel and Stambaugh (1995), Shefrin and Statman (1995), and Grauer (1999).

<sup>18</sup> Chan, Jegadeesh, and Lakonishok (1995) only collected data for the top 20% (by market capitalisation) of NYSE and AMEX domestic primary companies.

relationships between average returns and size and book-to-market equity, similar to those documented by studies of US markets.<sup>19</sup>

Particularly relevant to this research, are studies that have considered the determinants of stock returns in order driven markets such as New Zealand and Australia. Aitken and Ferris (1991) found a size effect on the Australian Stock Exchange (ASX) for the period 1965-85, as did Lawerance (1998) for the later period of 1988-98. Gillian (1991) documented a size effect in the New Zealand market over the 1977-84 period, while Vos and Pepper (1997) and Chin (1998) found a size effect for the periods of 1991-95 and 1988-98 respectively. Chin (1998), Vos and Pepper (1997) together with Bryant and Eleswarapu (1997), who tested the longer time period of 1971-93, all found evidence of a book-to-market equity effect in the New Zealand market. Both Chin (1998) and Gillian (1991) found no statistically significant relationship between return and the earnings-price ratio.<sup>20</sup> Brailsford (1993) and Young and Handa (1993) found weak evidence of a January effect in the New Zealand market.

Fama and French (1996a, b) also refuted what they termed the “bad market proxy” argument. They pointed out that the bad market proxies that are said to produce spurious anomalies in tests of the CAPM are similar to those used in applications (e.g. to estimate the cost of capital). Therefore, “if the common market proxies are not mean variance efficient, applications that use them rely on the same flawed estimates of expected return that undermine tests of the CAPM” (Fama and French, 1996a, p. 81). Jagannathan and Wang (1996) advanced the bad market proxy argument by showing that the addition of human capital to the traditional market proxy of a weighted portfolio of common stocks, resulted in the CAPM<sup>21</sup> explaining over fifty percent of the cross-sectional variation in average returns. In addition, size and book-to-market equity were found to be poor predictors of return.

<sup>19</sup> Chan, Hamao, and Lakonishok (1991) documented size and book-to-market effects in the Tokyo Stock Exchange, while Capaul, Rowley, and Sharpe (1993) documented a book-to-market effect in the stock markets of France, Germany, Switzerland and the U.K. Hawawini and Keim (1998) conduct an extensive review of international “anomaly” evidence.

<sup>20</sup> Gillian (1991) used price-earnings rather than earnings-price.

<sup>21</sup> The CAPM model tested is the unconditional version of the conditional CAPM proposed by Jagannathan and Wang (1996). The conditional CAPM assumes that betas and the market risk premium vary over time.

Studies that have corrected for the errors-in-variables (EIV) problem have also provided support for the CAPM. Handa, Kothari, and Wasley (1989) and Kim (1995, 1997) showed that the EIV problem induces an underestimation of the price of beta risk and an overestimation of the other cross-sectional regression coefficients associated with idiosyncratic variables that are observed without error, such as firm size and book-to-market equity. After correcting for the EIV problem, Kim (1997) found the return-beta and return-book-to-market relationships to be statistically significant (at the 5% level). The return-size relationship was statistically significant (at the 10% level) when monthly returns were used, but was insignificant for quarterly returns. The return-earnings price relationship was not statistically significant.

Lougran (1997) shed further light on the findings of Fama and French (1992). Using an exhaustive sample of all firms listed on NYSE, AMEX, and Nasdaq over the 1963-95 period, he reported that the Fama and French (1992) findings were driven by two features of their data: a January seasonal in the book-to-market equity effect<sup>22</sup> and exceptionally low returns on small, young, growth<sup>23</sup> stocks. In the largest size quintile of all firms (accounting for 73% of the total market value of all publicly traded firms), book-to-market equity had no statistically significant explanatory power on the cross-section of realised returns. Lougran (1997) postulated that this explains why the returns on value and growth funds, as documented by Malkiel (1995), are not materially different.

In two recent, closely related studies, Pontiff and Schall (1998) and Kothari and Shanken (1997) considered the time-series predictive ability of book-to-market equity. Both provided evidence that the book-to-market ratio of the Dow Jones Industrial Average (DJIA) predicted market returns over the periods 1926-94 and 1926-91 respectively.

The determinants of equity returns are still somewhat unresolved. While there appears to be sufficient evidence to question the validity of the CAPM, the model

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<sup>22</sup> This compliments the study of Davis (1994) who found that book-to-market equity had no explanatory power outside of January during the 1940-63 period.

<sup>23</sup> "Growth" is the term given to stocks with relatively high book-to-market ratios.

continues to hold a fundamental place in finance theory, with beta remaining as the major tool for explaining relative asset returns in practice. Asset pricing continues to be the focus of a substantial proportion of finance research, with other determinants of stock returns such as liquidity, gaining credibility in the literature.

## Chapter Two

# Liquidity and Asset Pricing

### 2.1 Liquidity: An Introduction

The scope of this research is restricted to the impact of liquidity on the returns of assets with infinite maturities (stocks).<sup>1</sup> However, this section begins with a general introduction to liquidity and its implications.

Keynes (1930) was among the first to discuss asset liquidity. He proposed that “an asset is more liquid than another if it is more certainly realisable at short notice without loss” (Keynes, 1930, p. 67). Subsequent literature has agreed with Keynes. For example, Engle and Lange (1997, p. 1) stated that “most simply it (liquidity) is the ability to perform a transaction without cost.”

Amihud and Mendelson (1991a) separated asset illiquidity costs into four distinct components: the bid-ask spread (hereafter spread), market-impact costs, delay and search costs, and direct transaction costs. Each of these components is said to be inversely related to liquidity. The spread is the difference between the best sell price and the best buy price for a stock. Market-impact costs relate to the premium the buyer pays or the price concession the seller makes for an immediate purchase. These costs increase in order size. Delay and search costs are incurred when a trader delays the execution of a transaction in an attempt to accomplish better trading terms. These costs include the cost of contacting potential trading partners and the risk borne by the investor while searching and delaying the execution. Direct transaction

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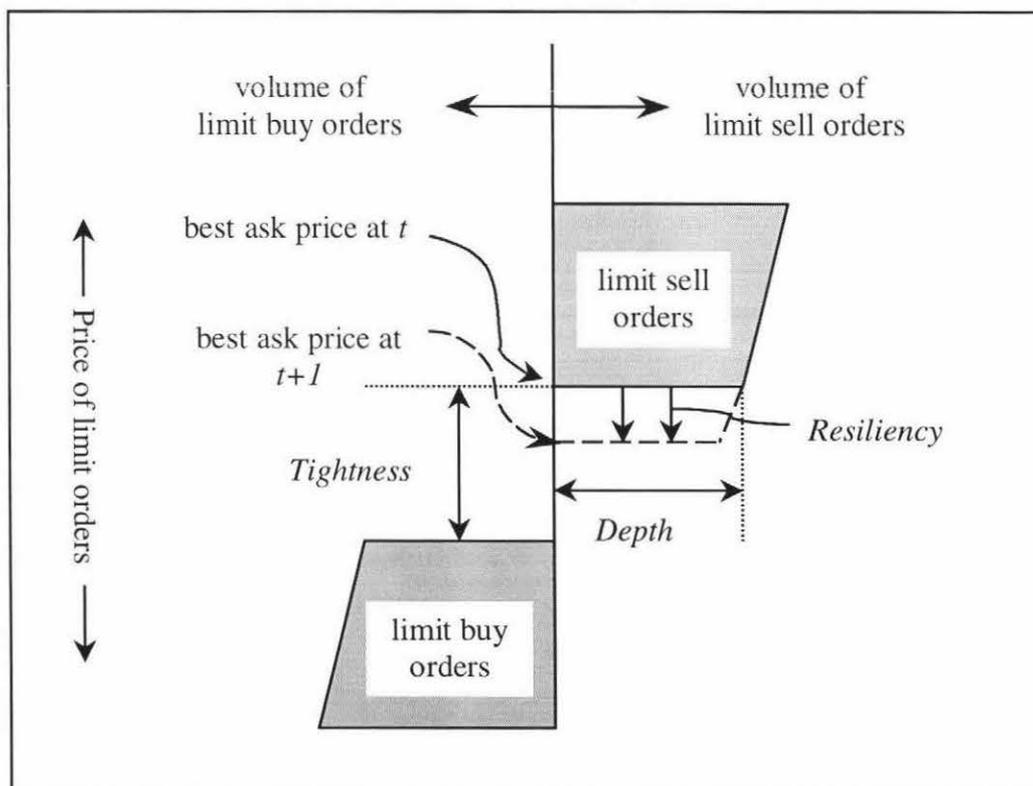
<sup>1</sup> A small number of studies have considered the impact of liquidity on assets with finite maturities (bonds). The interested reader should refer to Garbade (1984), Kamara (1990), Amihud and Mendelson (1991b), and Kamara (1994).

costs include brokerage commissions, exchange fees, and transaction taxes.

Subsequent research into the effects of illiquidity on asset prices has tended to use the term “transactions costs” to describe the asset illiquidity costs referred to by Amihud and Mendelson (1991a).<sup>2</sup> This thesis follows this convention.

In seeking to further clarify the elusive notion of liquidity, others have looked at the characteristics of liquid markets. According to Kyle (1985), market liquidity is represented by the three concepts of tightness, depth, and resiliency.<sup>3</sup> Tightness refers to the divergence of transaction prices from the efficient price and is usually measured by the spread. Depth shows the volume that can be traded at the current price level. Resiliency is shown by the speed of convergence from the current price level, which has been brought about by random price changes, to the efficient price level. These three aspects of market liquidity are depicted in Figure 1.1.

**Figure 1.1 Three Concepts of Market Liquidity<sup>4</sup>**



<sup>2</sup> See for example Vayanos (1998) p. 1.

<sup>3</sup> See Engle and Lange (1997), Muranaga (1999), and Muranaga and Shimizu (1999a, b) for more discussion on these three concepts.

<sup>4</sup> This diagram has been amended from Muranaga (1999). It relates to an order driven market.

In Figure 1.1, the best ask price is assumed to move up by a trade execution at time  $t$ . Since the market has a tendency to restore the condition, the best ask price will come down with a new limit order at time  $t + 1$ .

Others such as Martin and Winn (1996)<sup>5</sup> have concurred with the depth and resiliency concepts, but have proposed breadth, which they defined as the existence of orders in substantial volume, as the third measure of market liquidity in place of tightness.

The implications of liquidity are far reaching. Martin and Winn (1996) pointed out that the contribution of financial markets to economic activity is determined by their efficiency, which in turn is determined by their liquidity. Muranaga and Shimizu (1999a) developed the link between market efficiency and market liquidity. They proposed that market liquidity affects market efficiency through price uncertainty. A lack of liquidity is said to lead to price uncertainty through market prices not revealing all available information and / or market prices temporarily diverging from the equilibrium price.<sup>6</sup>

The liquidity of its stock also has consequences for the operation of a company. Bhidé (1993) theorised that the seemingly unrelated problems of liquidity and manager-stockholder contracting are closely intertwined. He hypothesised that stock liquidity discourages internal monitoring by reducing the costs of 'exit' for unhappy shareholders and therefore increases agency costs. Garvey, McCorry, and Swan (1995) hypothesised that CEO compensation is related to liquidity. Using NYSE data, they found that there is a positive relationship between a CEO's observed pay-for-performance and the spread that prevails in the market for the firm's shares. One explanation for this, based on the work of DeLong, Shleifer, Summers, and Waldmann (1990), is that higher trading costs lead to more informative stock prices.

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<sup>5</sup> See also Garbade (1982), Berstein (1987), and Hasbrouck and Schwartz (1988).

<sup>6</sup> For studies which review market efficiency and market liquidity from the viewpoint of the uncertainty of transaction execution price, and information reflecting process on price, see Brown and Zhang (1997) and Easley and O'Hara (1992).

## 2.2 Transaction Costs and Asset Pricing

Although transaction costs were mentioned in asset pricing debates earlier,<sup>7</sup> it was not until the seminal papers<sup>8</sup> of Amihud and Mendelson (1986) and Constantinides (1986) that the impact of transaction costs on asset pricing models was given detailed consideration.

Constantinides (1986) incorporated proportional transaction costs into an intertemporal portfolio selection model in which there are two assets – a riskless, perfectly liquid bond, and a risky stock that carries a transaction cost. He found that transaction costs had a first-order effect on the asset's demand but only a second-order effect on equilibrium asset returns. Constantinides (1986, p. 843) proposed that “investors accommodate large transaction costs by drastically reducing the frequency and volume of trade.” He went on to say (p. 843) “it turns out that an investor's expected utility of the future consumption stream is insensitive to deviations of the asset proportions from those proportions that are optimal in the absence of transactions costs. Therefore, a small liquidity premium is sufficient to compensate an investor for deviating significantly from the target portfolio proportions.”

Amihud and Mendelson (1986), who employed a model which assumes that assets are identical in all dimensions other than transaction costs<sup>9</sup> with rational traders differing only in their holding periods,<sup>10</sup> agreed with Constantinides (1986) about the relationship between transaction costs and holding periods. Their first proposition says “assets with higher spreads are allocated in equilibrium to portfolios with (the same or) longer expected holding periods” (Amihud and Mendelson, 1986, p. 228). However, unlike Constantinides (1986), they proposed that there is a first order effect between transactions costs and expected returns. Their second proposition

<sup>7</sup> See Brennan (1975), Goldsmith (1976), Levy (1978), Milne and Smith (1980), and Mayshar (1981).

<sup>8</sup> These papers appear to have been developed independently.

<sup>9</sup> Spread as used as the proxy for transaction costs.

<sup>10</sup> Other assumptions of the Amihud and Mendelson (1986) model include the following: Agents enter the market following a Poisson distribution; the duration of their stay in the market follows an exponential distribution; the asset prices are constant over time; and no investor short sells assets.

says “in equilibrium, the observed market (gross<sup>11</sup>) return is an increasing and concave piecewise-linear function of the relative spread”<sup>12</sup> (Amihud and Mendelson, 1986, p. 228).

Chalmers and Kadlec (1998) reconciled this disagreement by pointing out that it is due to differing assumptions regarding the length of investors’ holding periods. “Amihud and Mendelson (1986) assume that individuals trade for liquidity purposes with an average holding period of 1.6 years. Under this assumption, spreads are amortised over relatively short holding periods, and the amortised cost of transacting is large. Alternatively, Constantinides (1986) assumes that individuals trade only to rebalance their portfolios. Under this assumption, spreads are amortised over relatively long holding periods, and thus, the amortised cost of transacting is small” (Chalmers and Kadlec, 1998, p. 160).

Following Amihud and Mendelson (1986) and Constantinides (1986), researchers set about modelling the return-transaction costs relationship using less restrictive assumptions. Kane (1994) found the return premium to be an increasing concave function of transactions costs under a more general specification of the Amihud and Mendelson (1986) model, which allows a closed form solution. However, using a general equilibrium framework, which relaxed several of the Amihud and Mendelson (1986) assumptions,<sup>13</sup> Vayanos (1998) and Vayanos and Vila (1999) showed that the price of an illiquid asset could in fact decrease following an increase in transactions costs if the asset is in short supply.

In an even more general, discrete-time infinite horizon setting,<sup>14</sup> Yu (1998) confirmed that a negative liquidity premium is a theoretical possibility in finance theory based on optimisation and market clearing. In reaching this conclusion, Yu

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<sup>11</sup> It is important that the reader remembers that it is gross returns (returns before transaction costs) rather than net returns (returns after transaction costs) that are being discussed. Amihud and Mendelson (1989, p. 485) explained that “an investor who wishes to take advantage of the excess (gross) return on high spread securities has to pay the spread in the process, thus reducing his or her (net) return.” Thus, it does not follow that an investor who purchases high spread securities will make abnormal net returns.

<sup>12</sup> The relative spread is defined as  $(\text{ask} - \text{bid}) / ((\text{ask} + \text{bid}) / 2)$ .

<sup>13</sup> The assumptions of Vayanos (1998) and Vayanos and Vila (1999) include the following: Agents have identical preferences and endowments; birth and death rates are equal; and birth and death rates are constant over time.

<sup>14</sup> One of the few assumptions in the Yu (1998) setting is finite agent life.

(1998) showed that the convex return-spread relationship of Amihud and Mendelson's (1986) second proposition is the direct result of the constant price assumption of their model.

Amihud and Mendelson's (1986) second proposition became the focus of numerous empirical studies. The results of these have been mixed, with some finding a strong positive relationship between spread and return, others finding no relationship, while others still have found a negative relationship.

The first study was by Amihud and Mendelson (1986) who tested the relationship using OLS and GLS regressions on 1961-80 NYSE data. They found that risk-adjusted returns<sup>15</sup> increased with spread.<sup>16</sup> Further, the spread slope coefficients were not only positive, but they were also generally decreasing with movement to higher spread groups. This is consistent with the hypothesised concavity of the return-spread relation, reflecting the lower sensitivity of long-term portfolios to spread.

In addition, Amihud and Mendelson (1986) found that the coefficient of beta declined when the spread variable was added to the return-beta equation, indicating that part of the effect that could be attributed to beta may, in fact, be due to the spread. The inclusion of a size variable resulted in beta and spread effects prevailing (they remained statistically significant at the 5% level), while size was not statistically significant at the 5% level. Amihud and Mendelson (1986) concluded that transaction costs play an important role in determining asset returns.

Chen and Kan (1989) investigated whether Amihud and Mendelson's (1986) finding of a positive relationship between return and spread is unique to the methodology<sup>17</sup> they used in their study. Using the same spread data, the robustness of the return-spread relationship was estimated using four alternative methodologies. These were

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<sup>15</sup> The reader should assume that empirical studies have calculated excess returns as the actual return less the risk-free rate unless stated otherwise.

<sup>16</sup> The reader should assume that empirical studies have used the relative spread unless it is stated otherwise.

<sup>17</sup> A criticism of the Amihud and Mendelson (1986) methodology is that it constrained the risk premium to be constant over the thirty-year period.

the Fama and MacBeth (1973) approach, the Seeming Unrelated Regression (SUR) framework as in Zellner (1962), Gibbons (1982), and Stambaugh (1990), the unconditional two-step approach in Chan and Chen (1988), and an empirical design proposed by Chen, Grundy and Stambaugh (1990) that models the stochastic beta. Estimation of the return-spread relationship, taking into account factors such as the stochastic beta, the stochastic risk premium and the importance of the precision of the estimated betas, resulted in no reliable return-spread relationship being evident.

Eleswarapu and Reinganum (1993) were the next to test the return-spread relationship. Using the Amihud and Mendelson (1986) spread data (which they extended by ten years), they investigated whether the return-spread relationship is different in January and non-January months and whether the results of Amihud and Mendelson (1986) are sensitive to their restrictive portfolio selection criteria. Eleswarapu and Reinganum (1993) took on board the Chen and Kan (1989) findings regarding the methodology used by Amihud and Mendelson (1986), and used Fama and MacBeth (1973) cross-section regressions which do not assume that the risk premium is constant over the entire sample period.

To be included in the Amihud and Mendelson (1986) tests, a firm had to have been in existence for the previous ten years. While replicating the Amihud and Mendelson (1986) portfolio formation criteria for the sake of comparison, Eleswarapu and Reinganum (1993) developed a criteria that required a firm to have been in existence for three years prior to be included in their tests. They argued that the restrictive criterion employed by Amihud and Mendelson (1986) systematically excluded smaller firms from the sample and, hence, biased the results against finding a size effect.

For both the Amihud and Mendelson (1986) portfolio formation procedure and their own (over the time period 1961-90), Eleswarapu and Reinganum (1993) found that a statistically significant (at the 5% level) relationship between spread and return only existed in January months. This provided further evidence that the Amihud and Mendelson (1986) finding is restricted to their methodology. In addition, Eleswarapu and Reinganum (1993) found a statistically significant negative relationship between size and return (at the 5% level) in the regression that included

spread, beta, and size<sup>18</sup> for the sample that had been formed based on their portfolio formation procedure. This was not true of the Amihud and Mendelson (1986) portfolio formation procedure, confirming the hypothesis that this procedure is biased against small firms.

Eleswarapu and Reinganum (1993) documented a negative relationship between spread and return in non-January months. This relationship was statistically significant (at the 5% level) for the test period 1981-90. However, no attempt was made to interpret this finding.

Eleswarapu (1997) employed the Fama and MacBeth (1973) and Seemingly Unrelated Regression techniques in his empirical examination of the return-spread relationship for stocks listed on the Nasdaq stock market over the period 1973-90. He argued that spreads on Nasdaq are a better proxy for the actual cost of transacting than spreads on the NYSE. This argument is endorsed by Peterson and Fialkowski (1994), who estimated the correlation between the effective and posted spreads on the NYSE to be as low as 10%. Huang and Stoll (1996b) also provided evidence that the probability of trade occurring inside the spreads is much higher on the NYSE than on Nasdaq.

Eleswarapu (1997) found that although the spread effect was stronger in January months, there was still a statistically significant (at the 5% level) effect over all months. Papers such as Kothari, Shanken, and Sloan (1995b) have suggested that liquidity is a possible explanation of the book-to-market equity effect. However, Eleswarapu (1997) and Hu (1997b) found, using NYSE and Nasdaq data respectively, that both spread and book-to-market equity had a statistically significant (at the 5% level) positive relationship with return (when they were both included in the same regression equation). They argued that this suggests that there are two distinct effects – a liquidity premium and a book-to-market equity effect.

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<sup>18</sup> This was found for both January and non-January months.

Amihud and Mendelson (1989) provided a link between spread and Merton's (1987) "degree of investor recognition factor."<sup>19</sup> They pointed out that an asset's spread had been found to be related to the number of investors holding the asset, which, in accordance with Merton (1987), reflects the availability of information about it (the degree of investor recognition of the asset).<sup>20</sup> Using the same data set and methodology as their 1986 study, Amihud and Mendelson (1989) confirmed the existence of a positive return-spread relationship. In addition, residual risk, as measured by the standard deviation of an asset's returns, was found to have no effect on the return-spread relationship.

Kadlec and McConnell (1994) documented the effect on share value of over-the-counter (OTC) stocks listing on the NYSE, using Merton's (1987) investor recognition factor and what they termed Amihud and Mendelson's (1986) "liquidity factor" as explanatory variables. Using regression analysis, they found evidence of both factors. In support of the Amihud and Mendelson (1986) model, they stated (p. 635) that "controlling for changes in the number of shareholders, firms that experience a reduction in spreads following listing exhibit a greater increase in stock price in response to the listing announcement." However, this finding was qualified. They pointed out that "the significance level of this relationship is sensitive to the manner in which changes in spread are measured" (Kadlec and MacConnell, 1994, p. 635).

Further evidence of a positive return-spread relationship was provided by Pontiff (1995), in his comprehensive study of the determinants of closed-end fund returns. He found that while the relationship was statistically significant at the 5% level, spreads were not as reliable a predictor of closed-end fund returns as fund premia.

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<sup>19</sup> According to the Merton (1987) model, all else equal, an increase in the size of a firm's investor base (characterised by Merton as the degree of investor recognition) will lower investors' expected return and increase the market value of the firm's shares. Merton also proposed that asset returns are positively related to size, beta, and residual risk (due to imperfect diversification of this risk).

<sup>20</sup> Demsetz (1968) found that a larger number of shareholders brought about a narrower spread. Subsequent studies found transaction volume to be highly correlated with spread (cf. Garbade, 1982). Others, such as Bagehot (1971), Copeland and Galai (1983), and Glosten and Milgrom (1985) have shown directly that the spread decreases with an increase in public information about an asset.

Other studies have found evidence against a positive relationship between return and spread. Brennan and Subrahmanyam (1996)<sup>21</sup> found, using NYSE data for the period 1984-91, that there was a statistically significant (at the 5% level) negative relationship. This relationship became insignificant after an inverse price level variable was included, leading Brennan and Subrahmanyam (1996, p. 460) to conclude that the spread effect occurs “due to the spread acting as proxy for a risk variable that is associated with (the reciprocal of) price variable.” Brennan, Chordia, and Subrahmanyam (1997) also documented a statistically significant negative (at the 5% level) relationship between spread and return, using NYSE individual company data for the period 1977-89. When portfolio data was used for the same period, the relationship was found to be both positive and negative, depending on how the portfolios were formed.

Chalmers and Kadlec (1998) investigated the return-spread relationship using the Fama and MacBeth (1973) approach and 1983-92 NYSE data. Their study differed from previous work, in their use of the effective spread as a proxy for transaction costs. Following Blume and Goldstein (1992) and Lee (1993) they defined the effective spread as the transaction price minus the mid-point of the prevailing bid-ask quote. Chalmers and Kadlec found no statistically significant (at the 5% level) relationship between spread and return.

Barclay, Kandel, and Marx (1998) investigated the effect of changes in spreads on returns for stocks that moved from Nasdaq<sup>22</sup> to the NYSE or AMEX, and stocks that moved from AMEX to Nasdaq. They used an event study methodology to consider the cumulative abnormal return (CAR) over four event windows relating to the change in trading location of a stock. Barclay et al. (1998) recognised that the CAR of a stock reflects a variety of information relating to a change in trading location. So they focused on the differences between the CARs for a sub-sample with large changes in spread (stocks that are not traded in odd eighths on Nasdaq) and a sub-

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<sup>21</sup> Brennan and Subrahmanyam (1996) used transactions data to estimate both the variable (trade size dependent) and fixed costs of transacting. This allowed them to shed light on the importance of the empirical measures of adverse selection in influencing asset returns. However, use of this model has been limited in the literature. This can probably be attributed to its large data and computational requirements.

<sup>22</sup> Clyde, Schultz, and Zaman (1997) and Barclay (1997) have both shown spreads to be larger on Nasdaq than the NYSE or AMEX.

sample with smaller changes in spread (stocks that are quoted on both odd and even eighths on Nasdaq).<sup>23</sup> They found that the difference in the CARs for the two sub-samples was not statistically significant (at the 5% level) for either stocks that move from an exchange to Nasdaq or vice versa. This result was confirmed by regression analysis of changes in CAR and changes in effective spreads, causing Barclay et al. (1998) to conclude that transaction costs have no statistically significant (at the 5% level) effect on returns.

The inconclusive empirical evidence regarding the effect of transaction costs (namely spread) on return is consistent with the theoretical models of Vayanos (1998) and Vayanos and Vila (1999). These models propose that transaction costs primarily affect holding periods and trading volumes and that their effect on expected return is second order.

The inverse effect of transaction costs on trading volumes has been well documented in the theoretical literature on trading volume. Brown, Keim, Kleidon, and Marsh (1983) who discussed a tax-loss selling<sup>24</sup> motive for trade recognised that transaction costs play a role in the tax-loss selling decision.

The “differences of opinion”<sup>25</sup> hypothesis of trading volume advanced by Bessembinder, Chan, and Sequin (1996) also recognises the impact of transactions costs on trading volume. Bessembinder et al. (1996, p. 129) explained that trade on the valuation effects of market-wide information will only occur “in those stocks for which the costs of transacting are sufficiently low.”

In addition, George, Kaul, and Nimalendran (1991) showed, theoretically, that trading motivated by asymmetric information is also sensitive to how transaction

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<sup>23</sup> Odd-eight quote avoidance on Nasdaq has been shown to cause spreads to increase, on average, by more than 1% of the stock price. (See Barclay (1997), Benston and Wood (1997), Bessembinder (1997), and Christie and Schultz (1997)).

<sup>24</sup> Brown, Keim, Kleidon, and Marsh (1983, p. 107) explained that the tax-loss selling hypothesis “maintains that tax laws influence investors’ portfolio decisions by encouraging the sale of securities that have experienced recent price declines so that the (short-term) capital loss can be offset against taxable income.”

<sup>25</sup> Harris and Raviv (1993, p. 474) proposed that the difference of opinion hypothesis relates to a situation when “traders receive common information but differ in the way in which they interpret this information, and each trader believes absolutely in the validity of his or her assumption.”

costs are modelled. Recent studies by Knez and Ready (1996) and Barclay, Kandel, and Marx (1998) have confirmed empirically, that transaction costs are a determinant of trading volumes.

While the effect of transactions costs on trading volumes is well documented, there appears to be only one study that empirically proves the proposition of Amihud and Mendelson (1986) and Constantinides (1986) that assets with higher transactions costs are held for longer periods. Defining holding period as shares outstanding in year  $t$  divided by trading volume in year  $t$ , Atkins and Dyl (1997) found strong evidence that, as predicted, the length of investors' holding period is positively related to spreads. This relationship was found to be stronger on Nasdaq where spreads are larger.

### **2.3 Turnover Rate and Asset Pricing**

The link between holding period and spread proved to be one of the catalysts for the development of a new proxy for liquidity – turnover rate. Datar, Naik, and Radcliffe (1998), who along with Hu (1997a, b), were the first to provide theoretical justification for the turnover rate proxy, drew heavily on the Atkins and Dyl (1997) study. Defining turnover rate as trading volume in year  $t$  divided by shares outstanding in year  $t$  (the inverse of the Atkins and Dyl (1997) holding period measure), Datar et al. (1998) were able to conduct a joint test of propositions one and two from the Amihud and Mendelson (1986) model.<sup>26</sup> Datar et al. (1998) concluded that since these two propositions jointly imply that the observed (gross) asset returns must be an increasing function of the expected holding periods, the propositions also imply that the observed asset return must be a decreasing function of the turnover rate of the asset.

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<sup>26</sup> To refresh the reader's memory, proposition one holds that "assets with higher spreads are allocated in equilibrium to portfolios with (the same or) longer expected holding periods," while proposition two holds that "in equilibrium, the observed market (gross) return is an increasing and concave piecewise-linear function of the (relative) spread" (Amihud and Mendelson, 1986, p. 228).

In two closely related papers, Hu (1997a, b) sought to provide alternative theoretical justification for a negative relationship between turnover rate and return.<sup>27</sup> His first two hypotheses attempt to link the liquidity premium with turnover through transaction costs. His “order-processing” hypothesis argues that in the presence of fixed order-processing costs, a higher turnover can lower dealers’<sup>28</sup> average fixed costs and, by competition, will lower the transaction costs paid by investors. His second hypothesis, the “information-based trading” hypothesis, draws on the finding of Easley, Kiefer, O’Hara, and Paperman (1996) that a higher volume (and hence a higher turnover) stock has a lower probability of information-based trading and hence a lower spread.<sup>29</sup>

The use of a negative relationship between transaction costs and turnover rate, to prove a negative relationship between turnover rate and return, relies on there being a clear positive relationship between transaction costs and return. Since the return-spread relationship has been shown theoretically and empirically to be somewhat tenuous, this would seem to be a rather big leap in logic.

Hu’s (1997b) third explanation, referred to as the “difference of opinion”<sup>30</sup> hypothesis, for the negative return-turnover rate relationship is borrowed from the volume determinants literature. As in Miller (1977), divergent investor opinions are said to lead to a higher current price and lower expected future returns. In conjunction with increased trading volume, Hu (1997b) concluded that this implies a negative relationship between turnover rate and expected returns.

Theoretically, turnover rate is a more powerful liquidity proxy than spread, given the Constantinides (1986) and Vayanos (1998) finding that transactions costs primarily affect holding periods and trading volumes, and that the effect on expected returns is second-order.

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<sup>27</sup> Hu (1997a, b) also used a similar explanation to Datar et al. (1998) in his proposition of a negative relationship between turnover and return.

<sup>28</sup> This hypothesis obviously relates to a quote driven market such as Nasdaq.

<sup>29</sup> Copeland and Galai (1983), and Glosten and Milgrom (1985) have also documented the positive relationship between information based trading and spread.

<sup>30</sup> The differences in opinion hypothesis is discussed by, among others, Bessembinder, Chan, and Sequin (1996), Kandel and Pearson (1995), and Harris and Raviv (1993).

Previous research seems to have failed to make one very important point about the return-turnover relationship. It could be that previous authors have felt it to be implicit in their analysis. The point is that studies that have documented both theoretically and empirically, the negative relationship between return and turnover refer to gross return. An individual who makes an investment based on knowledge of the existence of such a relationship would presumably purchase low turnover stocks. However, it is well documented by Hu (1997a, b) that low turnover rate stocks have higher transaction costs (spreads) so the investor is not assured of earning an abnormal net return from purchasing low turnover stocks.

The return-turnover relationship has been tested empirically on three different markets.<sup>31</sup> Haugen and Baker (1996) used the Fama and MacBeth (1973) cross-sectional regression approach to test the relationship between return and turnover using 1979-86 monthly data for stocks listed on the Russell 3000 stock index.<sup>32</sup> Haugen and Baker (1996, p. 412) calculated turnover rate (they called it “trading volume”) as the “total dollar amount of trading in the stock over the trailing month as a percent of market capitalisation.” Using portfolios of stocks based on prior year return, Haugen and Baker (1996) found a statistically significant (at the 5% level) negative relationship between return and turnover rate in the two sub-periods of 1979-86 and 1986-93.

Datar et al. (1998) used the methodology of Litzenberger and Ramaswamy (1979), which is a refinement of the Fama and MacBeth (1973) methodology, to test the return<sup>33</sup>-turnover<sup>34</sup> relationship using all non-financial firms listed on the NYSE between 1963 and 1991. Using individual company data rather than portfolios, they found a negative statistically significant (at the 5% level) return-turnover rate relationship, even after well known determinants of return such as size, book-to-market equity, and beta were controlled for. The finding of turnover rate and book-

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<sup>31</sup> Others, such as Denis and Stickland (1998), have used turnover rate as a proxy for liquidity in a study that considered the impact of stock splits on liquidity.

<sup>32</sup> This index consists of 3000 largest stocks listed in the United States (approximately).

<sup>33</sup> Unlike most studies in this area, Datar et al. (1998) do not use excess returns. Instead, they calculated return as the actual return on the stock.

<sup>34</sup> Datar et al. (1998) measured the turnover rate of a stock in month  $t$  as the average number of shares traded in the previous three months divided by the number of shares outstanding of the firm. They explained that defining the turnover rate as the average number of shares traded over the previous month, six months, nine months, and a year did not substantially alter their findings.

to-market equity both being statistically significant (at the 5% level) is said to confirm the Eleswarapu (1997) proposition that a book-to-market equity effect is distinct from a liquidity effect.

Unlike Eleswarapu and Reinganum (1993), but consistent with Amihud and Mendelson (1986), Datar et al. (1998) found no evidence of a seasonal component in the liquidity premium for NYSE data. Datar et al. (1998) verified the robustness of their findings by running the same tests on a trimmed data set<sup>35</sup> and data from two sub-periods. No material differences were found in the return-turnover relationship.

Consistent with Datar et al. (1998), Hu (1997b) found, using individual NYSE company data for the period 1963-95 and the Fama and MacBeth (1973) methodology,<sup>36</sup> the return-turnover<sup>37</sup> relationship to be negative and statistically significant (at the 5% level). In addition to controlling for size, beta, and book-to-market equity, Hu (1997b) also controlled for the cumulative return over month  $t-12$  to  $t-2$ , where  $t$  is the test month. Hu (1997b) found that trimming his sample by excluding observations with the highest or lowest 1% turnover had no material effect on the results. He also showed that his results were robust over sub-periods. Like Datar et al. (1998), Hu (1997b) found no evidence of a seasonal relationship between return and turnover. When portfolios were formed based on turnover rate, size or book-to-market equity, the return-turnover rate relationship remained statistically significant (at the 5% level). However, this relationship became insignificant (at the 5% level) when portfolios were formed using beta.

Using the same methodology on individual Nasdaq company data for the period 1983-95, Hu (1997b) found a statistically significant negative (at the 5% level) relationship between return and turnover after controlling for size, beta, book-to-market equity, and cumulative return factors. This relationship was evident in both the full and trimmed samples. When portfolios were formed based on turnover, the

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<sup>35</sup> The trimmed data set excluded the highest and lowest 1% of turnover observations.

<sup>36</sup> As well as using the traditional Fama and MacBeth methodology, Hu (1997a, b) used a refinement where the time-series average of the estimated coefficient is found using the standard error from the first step regression (assuming homoskedasticity and zero cross-sectional correlations). Hu (1997a, b) explained that this refinement is more efficient if the cross-sectional variance is time varying.

<sup>37</sup> Hu (1997b) defined turnover as the number of shares traded during the previous year (month  $t-12$  to  $t-1$ ) divided by the number of shares outstanding.

return-turnover relationship remained statistically significant (at the 5% level). However, this relationship became statistically insignificant (at the 5% level) when portfolios were formed using beta, size or book-to-market equity.

Hu (1997a) tested the return-turnover relationship using 1976-93 Tokyo Stock Exchange data. Using the Fama and MacBeth (1973) methodology on individual company data, and controlling for size, book-to-market equity, and cash flow-to-price factors, Hu (1997a) found a statistically significant (at the 5% level) negative relationship between return and turnover. However, no statistically significant (at the 10% level) relationship was evident in the 1984-93 sub-period. Additionally, no clear seasonal pattern was evident. However, rather than a consistent return-turnover relationship in all months, a statistically significant (at the 5% level) relationship was found only in the months of March, June, November, and December.

Hu (1997b) found, using individual Nasdaq company data and the Fama and MacBeth methodology, that when both turnover and spread were included in the same regression, both variables remained statistically significant (at the 5% level) but their coefficients became slightly smaller in magnitude. This led Hu (1997b, p. 13) to conclude that “both turnover and spread are imperfect proxies for the true transaction cost.”

## 2.4 Amortised Spread and Asset Pricing

Chalmers and Kadlec (1998) developed a superior measure of transaction costs, which they called “Amortised Spread.” They pointed out that if stocks with similar spreads trade with different frequencies, the magnitude of the spread is not a sufficient proxy for the amortised cost of the spread. Chalmers and Kadlec (1998) defined amortised spread as the product of the effective spread<sup>38</sup> and the number of shares traded, summed over all trades for the day, and expressed as an annualised fraction of equity value. However, they pointed out that amortised spread is approximately equal to effective spread multiplied by share turnover.

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<sup>38</sup> The measure of effective spread followed Blume and Goldstein (1992) and Lee (1993).

Using 1983-92 NYSE and AMEX data and the Fama and MacBeth (1973) methodology, Chalmers and Kadlec (1998) found a statistically significant positive relationship between amortised spread and excess return when beta, size, book-to-market equity, and the standard deviation of monthly returns were all included as control variables. However, no statistically significant relationship (at the 10% level) was found when subsets of these control variables were used.

While they maintain that amortised spread is a superior liquidity proxy than spread, Chalmers and Kadlec (1998) identified several limitations in the amortised spread measure. They acknowledged that the impact of spreads on required returns is determined by expected holding periods whereas the measure of amortised spread they employ reflects realised holding periods. In addition, they pointed out that their amortised spread measure only reflects the average holding period of all investors. This means that if an individual with an unusually long holding period holds a large portion of a company's stock, their measure of amortised spread may understate the amortised spread for the marginal investor.

## 2.5 Market Microstructure and Liquidity

Additional evidence of a link between stock returns and liquidity is provided by studies, which have considered returns and liquidity following a change in market microstructure. Amihud, Mendelson, and Lauterbach (1997) analysed the value effects of changes in trading mechanism on the Tel Aviv Stock Exchange. Using change in relative volume and a measure of market depth<sup>39</sup> to proxy liquidity they found a positive association between liquidity gains and price appreciation. Berkman and Eleswarapu (1998) considered the abolition and subsequent reinstatement of the forward trading facility (*Badla*) on the Bombay Stock Exchange. Using the same two measures of liquidity as Amihud et al. (1997), they found that the price reaction on the announcement of the abolition of the *Badla* system was positively correlated with the change in liquidity.

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<sup>39</sup> Market depth was measured as the trading volume associated with a unit change in stock price as in Kyle (1985).

## Chapter Three

# Stock Exchanges and Liquidity

### 3.1 Introduction

Research has investigated the link between liquidity and asset pricing in the Tokyo, New York, and Nasdaq stock markets. However this is the first study (that the author is aware of) to consider the return-liquidity relationship in pure order driven stock exchanges. The New Zealand Stock Exchange (NZSE) and the Australian Stock Exchange (ASX) are quite different to the hybrid quote driven markets of New York and Nasdaq. In quote driven markets, designated market makers supply liquidity to the market by continuously quoting the bid and ask prices at which they are willing to trade. In order driven systems, public limit orders provide liquidity to the market and establish the bid-ask spread (Brockman and Chung, 1999a).

Following the reforms of 1997, Nasdaq can no longer be described as a pure quote driven market. However, on a market structure continuum, Nasdaq would be at the quote driven extreme, followed by the NYSE positioned closer to the middle. Then, moving towards the order driven extreme, would be the Tokyo Stock Exchange (TSE) followed by the NZSE and the ASX.

This chapter begins with a description of the trading mechanisms of Nasdaq, the NYSE, TSE, ASX, and NZSE. A comparison of liquidity levels across these exchange mechanisms is then undertaken to provide an indication of the likely strength of the liquidity asset pricing relationship on the ASX and NZSE.

## 3.2 Nasdaq

Nasdaq,<sup>1</sup> which was written originally as NASDAQ, for the National Association of Securities Dealers Automated Quotation System,<sup>2</sup> began its life in 1971 as a pure quote driven market. However, in 1997, new rules were imposed on Nasdaq causing it to become a hybrid market<sup>3</sup> (Nasdaq, 1999).

Nasdaq's original purpose was to electronically disseminate quotes of professional securities dealers, for stocks not listed on exchanges, in the so-called over-the-counter (OTC) market.<sup>4</sup> There is no central trading floor like those used by the securities exchanges. Trading on Nasdaq revolves around the approximately 550 National Association of Security Dealers, Inc. (NASD) members, who make a market in at least one security. The key responsibility of a market maker is to post continuous, two-sided quotes (i.e. bid and ask), which consist of a price and a size. Between 9:30am and 4:00pm Eastern Time, these quotes must be "firm." This means that if any NASD member presents an order to a market maker, the market maker is obligated to trade at terms no worse than its quotes.<sup>5</sup> Failure to do so constitutes "backing away," which can be subject to a regulatory sanction (Smith, Selway III, and McCormick, 1998).

Nasdaq market makers can be divided into a number of categories: wholesalers, whose primary business is making markets in Nasdaq stocks; integrated national firms, who generate order flow through retail brokerage operations for the market making arm of the firm to execute; regional firms which tend to be smaller, with the market making operation supporting the underwriting and brokerage activities of the firm; and UTP Market Makers, who are exchange specialists permitted to make

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<sup>1</sup> On October 30, 1998 Nasdaq and AMEX (the US's second largest floor-based exchange) officially joined forces to form the Nasdaq-AMEX Market group. However, each market continued to operate as an independent subsidiary. (Nasdaq, 1999).

<sup>2</sup> By virtue of its frequent usage, "Nasdaq" is considered a proper name, not an acronym. Therefore, the convention of writing Nasdaq rather than NASDAQ is followed.

<sup>3</sup> Both before and after the 1997 changes Nasdaq is commonly referred to as a "dealer market."

<sup>4</sup> Before Nasdaq, quotes were disseminated by means of paper copy, newspapers, and a number of private electronic systems.

<sup>5</sup> NASD Rule 3320

markets in Nasdaq stocks pursuant to Unlisted Trading Privileges granted by the Security and Exchange Commission (SEC)<sup>6</sup> (Smith et al. 1998).

Trading practices on Nasdaq came under intense scrutiny in the early 1990s with Christie and Schultz (1994) questioning the competitiveness of the market. It was proposed that dealers tacitly colluded to inflate bid-ask spreads, and excluded the public from the price-setting process<sup>7</sup> to earn economic rents<sup>8</sup> (Barclay, Christie, Harris, Kandel, and Marx, 1999). These findings culminated in the Security and Exchange Commission imposing new Order Handling Rules (OHR), that while applicable to all U.S. markets, were specifically targeted at Nasdaq. The new OHR rules were phased in from February 1997.

Of the new OHRs, two are particularly important. The Limit Order Rule requires that market makers display investors' limit orders that are priced better than the market makers' quote, making it possible for investors to trade against limit orders that previously would not have been exposed to the market. The Quote Rule requires that market makers publicly display their most competitive quotes. Previously, market makers might have displayed more favourable prices on proprietary trading systems (PTSs) available only to financial professionals (McInish, Van Ness, and Van Ness, 1998).

In June 1997, the minimum quotable variation on Nasdaq, often referred to as the tick size,<sup>9</sup> was changed from 1/8 to 1/16 of a (U.S.) dollar for stocks with a bid price exceeding \$10. The minimum quotable tick size remains at 1/32 of a dollar for stocks with a bid price less than \$10 (Huang and Stoll, 1999).

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<sup>6</sup> In 1998 only the Chicago Stock Exchange traded Nasdaq stocks via UTP.

<sup>7</sup> Before the reforms of 1997 dealers could effectively ignore limit orders.

<sup>8</sup> Examples of empirical and theoretical research linked to the competitive issues raised by Christie and Schultz (1994) include Barclay (1997), Bessembinder (1997), Demsetz (1997), Dutta and Madhavan (1997), Furbush and Smith (1996), Huang and Stoll (1996a), and Kandel and Marx (1997).

<sup>9</sup> Unlike the NYSE, tick size restrictions on Nasdaq have always been applied to quotations only. Trade prices, for the purpose of clearing and settlement, can be expressed down to an increment of 1/256 of a dollar (Smith, 1998).

The practice of preferencing, which involves routing order flow to a market maker in contravention to strict price-time priority,<sup>10</sup> is common place on Nasdaq as a result of market makers competing in ways other than quoted price. For example, a market maker may be willing to trade an amount that exceeds its quoted size. Payment for order flow arrangements<sup>11</sup> is another reason for preferencing. In these arrangements, a market maker offers a rebate to order entry firms in exchange for the right to execute the firm's order flow. Rebates are typically on a per-share basis and have historically been about US\$0.02 a share. However, rebates may involve services such as research instead (Smith et al. 1998).

### 3.3 New York Stock Exchange

The New York Stock Exchange (NYSE) is also a hybrid market structure. The NYSE's trading system is complex, with the Exchange's trading floor<sup>12</sup> acting as a meeting place where floor brokers, the electronic limit order book, and the specialist interact and provide liquidity to the market (Sofianos and Werner, 1997).

NYSE members bring all orders<sup>13</sup> to the Exchange floor either electronically, through the SuperDot system, or through a floor broker. The limit order book ("the book") consists of all active limit orders arrayed in descending price for buys and in ascending price for sells. The specialist is responsible for maintaining the book and representing orders to the market (Harris and Hasbrouck, 1996). Although the use of SuperDot has increased markedly since its inception in 1976, floor brokers, who represent customer orders in person at specialist posts, remain an important contributor to NYSE liquidity. Sofianos and Werner (1997) estimated that in 1996 forty five percent of twice trading volume<sup>14</sup> came from SuperDot, while forty six

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<sup>10</sup> In other words, the first market maker to quote the prevailing best price does not necessarily receive the order flow.

<sup>11</sup> See Kandel and Marx (1999) for more details on payment for order flow arrangements on Nasdaq.

<sup>12</sup> On the trading floor, there are 17 trading posts each operated by specialists and specialist clerks. Every listed security is traded at a unique location at one of these posts and by one specialist. Computer monitors above each specialist location display which stocks are traded there and other information such as the last price the stock was sold for (New York Stock Exchange, 1999).

<sup>13</sup> There are two types of orders: market and limit. A market order demands immediate execution at the best available price while a limit order is a price-contingent order to sell (buy) if the price rises above (falls below) a pre-specified limit price (Seppi, 1997).

<sup>14</sup> Total buy and sell executed share trading volume.

percent of twice trading volume reached the specialist's post through floor brokers. The remaining nine percent was attributed to trading by specialists.

Specialists are central to the NYSE. They are charged with managing the market in the stocks allocated to them (usually between five and ten). As well as acting as an agent for orders, the specialist also buys and sells on their own account. In doing so, the specialist has both affirmative and negative obligations. Their affirmative obligation is to minimise order imbalances and maintain continuity and depth, even if this means trading at adverse prices. Under their negative obligation, they are precluded from trading, unless it is necessary for a fair and orderly market (Lindsey and Schaede, 1992). As a matter of trading protocol, the specialist is required to better any limit order price before they can take the trade themselves<sup>15</sup> (Kavajecz, 1999). Specialist performance is evaluated by the NYSE based on four main criteria: price continuity, quotation spreads, market depth, and stabilisation<sup>16</sup> (Cao, Choe, and Hatheway, 1997).

Stocks listed on the NYSE may also be traded in the regional exchanges,<sup>17</sup> Nasdaq,<sup>18</sup> and other forums.<sup>19</sup> These markets are linked to the NYSE by three electronic systems which are collectively referred to as the National Market System (NMS) (Battalio, 1997). The first system is the Consolidated Tape Association (CTA), which reports the trading activity of NYSE-listed stocks on the NYSE, as well as the regional exchanges and Nasdaq. The second is the Consolidated Quotation System (CQS), which distributes current quotations on most U.S. markets for NYSE-listed stocks. The third is the Intermarket Trading System (ITS), which allows exchange members and dealers on Nasdaq to route an order to another market for execution at the quote of that market.

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<sup>15</sup> NYSE Rule 2029.

<sup>16</sup> A stabilisation trade is defined as a trade where the specialist buys after a price decrease and sells after a price increase.

<sup>17</sup> There are five regional exchanges (Boston, Chicago, Cincinnati, Pacific, and Philadelphia). These exchanges provide trading facilities for local companies that are not large enough to list on a national exchange, and enable local brokers who are not members of a national exchange to trade in national exchange listed stocks (Reily, 1986).

<sup>18</sup> The Nasdaq market is also referred to as the over-the-counter (OTC) market. Trading of NYSE listed securities in Nasdaq is referred to as third market trading.

<sup>19</sup> Organisations that are not members of the NYSE, such as Instinet, and Posit, also stand ready to make markets and facilitate trades in NYSE listed stocks.

Another facet of the NYSE is the so-called upstairs market. In the upstairs market large transactions are accomplished through a search-brokerage mechanism where an intermediary or broker locates counterparties to a trade before sending it to the downstairs market (the NYSE floor) for execution<sup>20</sup> (Keim and Madhavan, 1996).

In June 1997, the NYSE reduced the minimum tick size for quoting and trading stocks with a price of US\$1 or more from 1/8 of a dollar per share to 1/16 of a dollar per share.<sup>21</sup> The minimum tick sizes for stocks trading in the price ranges of \$0.50 to \$1 and less than \$0.50 remained at 1/16 of a dollar and 1/32 of a dollar respectively<sup>22</sup> (Anonymous, 1998).

### 3.4 Tokyo Stock Exchange

Trading on the Tokyo Stock Exchange (TSE) underwent minor changes in August 1998. As well as outlining the current system, a description of the conditions under which trade occurred prior to these changes is also included, as these are the conditions that the TSE liquidity asset pricing study that is referred to in this study was conducted under.

The Tokyo Stock Exchange (TSE) is an order driven market. Trading does not rely on designated dealers or market makers. Instead, liquidity is supplied by traders who submit limit price orders. Stocks are listed on one of two sections. The first section consists of large and actively traded stocks, while the second section consists of smaller, less actively traded stocks.<sup>23</sup> Prior to May 1999, the most actively traded first section stocks were traded on a trading floor, while the remaining first section and all of the second section stocks were system traded with the assistance of a computerised matching system called CORES.<sup>24</sup> Trading rules for floor and system

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<sup>20</sup> Under NYSE Rule 76, it is generally illegal to pre-negotiate trades on the NYSE; the order must be exposed to the public in accordance with auction principles of price and time priority for possible price improvements. See Hasbrouck, Sofianos, and Soesbee (1993) for further details. Thus, an upstairs market maker only finds counterparties for the trade; they do not finalise the terms of the trade.

<sup>21</sup> At the same time the NYSE voted to adopt of system of decimal pricing from the turn of the century (Bollen and Whaley, 1998).

<sup>22</sup> The NYSE tick rules only apply to trades that take place on the NYSE. When NYSE-listed stocks trade on another market, the rules of the other market apply (Angel, 1997).

<sup>23</sup> See Hamao (1991) for more information on the distinction between the first and second sections.

<sup>24</sup> Computerised Order Routing and Execution System.

stocks were essentially identical. The only difference was the degree of automation that these rules were implemented with. Since May 1999 all listed securities have been traded electronically (Muranaga, 1999).

On the TSE there are regular members, who trade securities on their own and on their client's behalf, and a *saitori* member. The *saitori*, or order clerk firm, neither represents customer orders nor trades for their own account. The *saitori* functions solely as an intermediary of transactions between regular members. Maintaining the public limit order book,<sup>25</sup> is the responsibility of the *saitori*. Prior to 1998 its responsibilities also included issuing warning quotes and halting trading when order execution would have resulted in price changes that exceeded exchange-mandated maximums<sup>26</sup> (Tokyo Stock Exchange, 1999). However, in August 1998, the TSE stopped the quotation of warning quotes and eased the standard for special quote indication in order to increase continuity of price discovery (Muranaga, 1999).

TSE trading takes place in two different trading sessions. The morning session begins at 9:00am and ends at 11:00am, while the afternoon session begins at 12:30pm and ends at 3:00pm.

Trade at the beginning of each session is initiated through a single-price auction called the *itayose*. Under the *itayose* mechanism, buyers and sellers submit market or limit orders that are cumulated into supply and demand schedules. The intersection determines the equilibrium.<sup>27</sup> The single-price auction at the beginning of each trading session is followed by the continuous market called the *zaraba*. After the *itayose* clears, the best unexecuted buy and sell orders establish the bid and ask prices for the start of the *zaraba* (Hamao and Hasbrouck, 1995).

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<sup>25</sup> For floor traded issues, customer orders were relayed by telephone to a regular member on the exchange floor who orally communicated the order to the *saitori* who entered it into the floor-trading computer system. With system traded issues a customer order is entered at a terminal at a regular member's lead office then electronically transmitted to CORES.

<sup>26</sup> The process that is used to slow down the trading process, the issuance of *chui* and *tokubetsu kehai* (warning and special quotes), is described more fully below.

<sup>27</sup> Stocks do not always open at the beginning of each trading session since five conditions must be met for trade to begin.

Within the *zaraba*, traders may submit limit or market orders. The TSE is unique in its treatment of market orders. Suppose a market order to buy arrives at the exchange. If the best ask price is a “regular”<sup>28</sup> quote and if the order can be entirely filled at that quote (i.e., the depth of the quote is sufficient), the *saitori* will match the market order to the best limit order and execute the trade. However, if the market order cannot be fully executed at the current quote, it partially executes up to the size of the current quote, and the remaining portion is converted into a limit order at the current quote. This is briefly displayed as an indicative quote, an invitation for competing liquidity suppliers to hit the quote. If no such orders arrive, the original order is allowed to proceed to the next price in the book. Before August 1999, this process continued, with the *saitori* issuing warning quotes at each price, up to the point where the price change would exceed the exchange-mandated maximum.<sup>29</sup> At this point, the *saitori* issued a final warning quote and temporarily halted trade. During the trading halt, the *saitori* issued special quotes in an effort to fully execute the order<sup>30</sup> (Lehmann and Modest, 1994).

On the TSE tick sizes depend on the stock price, ranging from 1 yen for stocks with a price less than 2,000 yen to 10,000 yen for stocks with a price more than 1,000,000 yen (Tokyo Stock Exchange, 1999).

The TSE is linked to seven regional exchanges. However, the links are not as formalised as those in the U.S. Trade reporting is consolidated but there is no consolidated quote reporting. It is the broker’s responsibility to survey the quotes and determine how to route an order. Regional exchanges are often used to cross block trades that have been facilitated by brokers in the upstairs market.

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<sup>28</sup> The quote is considered regular if the price change from the last trade satisfies prescribed conditions set by the TSE.

<sup>29</sup> On the TSE there are two maximum price change limits – daily and trade-to-trade. Both price limits are absolute yen limits rather than percentage changes (Bremer, Hiraki and Sweeney, 1997). See Kim and Rhee (1997) and George and Hwang (1995) for a discussion on the impact of these maximum price change limits.

<sup>30</sup> For a more comprehensive description of the procedure used to slow down trade and attract liquidity before the changes adopted in August 1998 see Hamao and Hasbrouck (1995), Lehmann and Modest (1994), and Lindsey and Schaede (1992).

### 3.5 Australian Stock Exchange / New Zealand Stock Exchange

Both the Australian Stock Exchange (ASX) and the New Zealand Stock Exchange (NZSE)<sup>31</sup> are pure order driven markets,<sup>32</sup> which use a fully automated trading system known as SEATS.<sup>33</sup> SEATS is an order-matching system based around the concept of “priority” trading, where orders are ranked in priority of price, then in time within price. Under SEATS, market liquidity is provided by the limit orders of traders - there are no market makers (New Zealand Stock Exchange, 1999).

Buy and sell orders (either market or limit) that are entered into the system via trading terminals in members’ offices are immediately displayed to all operators in the network. Orders that can be matched, either fully or partially, by an opposing order are automatically traded. SEATS allows brokers to place one of a variety of limit orders. The type of order placed is confidential and is not shown to other brokers (Aitken, Frino, McKensy, 1993).

Specific types of limit orders which may be placed include: “all or nothing” where an order is accepted only if the entire order can be satisfied at the time of entry; “fill and kill” where only that portion of the order which matches the best price at the opposite side of the market is executed and the remainder is cancelled; and “improvement” where the price level of the order is ticked one price step closer to the other side of the market (Aitken, Frino, Jarnecic, McCorry, Segara, and Winn, 1998).

Members of both exchanges, commonly referred to as “brokers,” may involve themselves in both agency<sup>34</sup> and principle<sup>35</sup> trades. However, principle trading in both markets is subject to strict conditions. Brokers are prohibited from trading as principles with their clients, without full disclosure and informed client consent.<sup>36</sup>

<sup>31</sup> The provision of NZSE information by Kathy Gruschow of the NZSE is much appreciated.

<sup>32</sup> The term “pure order driven” is used to differentiate the ASX and the NZSE from the TSE where the *saitori* exchange member influences trading by calling a halt when maximum price change limits are exceeded. There is no *saitori* equivalent on either the ASX or the NZSE.

<sup>33</sup> Stock Exchange Automated Trading System.

<sup>34</sup> Agency trades are transactions in which a broker acts as an agent for the clients in the purchase or sale of securities.

<sup>35</sup> Principle trades are transactions in which a brokers trades in securities for their own company’s account.

<sup>36</sup> For more information on principle and agency trades of stockbrokers see Aitken and Swan (1993).

As well as the official market (the order book) there is also an unofficial “upstairs” market in both countries. For large parcels of shares, it is common practice for brokers to attempt to arrange a buyer / seller on the upstairs market before placing the order in the official market. This ensures that the order is filled on the most favourable terms (Blennerhasset and Bowman, 1998).

On the NZSE, there are two minimum tick sizes. For shares with prices less than 20c, and 20c and over the minimum tick sizes are 0.1c and 1c respectively. On the ASX, there are four minimum tick sizes. For shares with a price of 10c or less, between 10c and 50c, between 50c and \$998.99, and over \$999 the minimum tick sizes are 0.1c, 0.5c, 1c, and \$1 respectively<sup>37</sup> (Aitken et al., 1998).

Both the ASX and the NZSE are in the process of upgrading their trading systems. The ASX’s new system, which is to be known as SEATS 97, is being implemented using a phased approach with phase one already completed. SEATS 97, which will be able to handle increased trading volume, has an enhanced functional Trader Workstation that is Windows based, and a more open interface that will provide brokers with increased access to trading information (Australian Stock Exchange, 1999). The NZSE’s new system is to be known as FASTER Trading, although the technology is known as the Automated Screen Trading System (ASTS) in stock exchanges that already use it.<sup>38</sup> Like SEATS 97, FASTER, which is scheduled to be implemented on 10/9/99, is also Windows based which presents more functionality for the user. For example, brokers will be able to customise their screen appearances and filter data depending on the stocks they are interested in (Sheeran, 1999).

### **3.6 Liquidity Across Stock Exchange Mechanisms**

This is the first study (that the author is aware of) to consider the liquidity asset pricing relationship in pure order driven stock exchanges. A comparison of liquidity levels across different exchange mechanisms is now undertaken to give an indication

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<sup>37</sup> Amounts are quoted in NZ dollars and Australian dollars respectively.

<sup>38</sup> Stock Exchanges that currently use ASTS include Oslo, Hungary, and Jakarta.

of the likely strength of the liquidity asset pricing relationship on the NZSE and the ASX.

Studies that have compared liquidity across stock exchange mechanisms have invariably used spreads rather than theoretically superior liquidity measures such as turnover rate and amortised spread. While there are well documented weaknesses in the ability of spread to proxy for liquidity,<sup>39</sup> their wide accessibility appears to make them attractive to researchers.

Spreads are typically viewed as being determined by order processing, inventory holding, and asymmetric information costs.<sup>40</sup> Order processing costs consist of exchange and clearing fees, bookkeeping and back office costs, a market maker's (broker's) time and effort and other costs of doing business<sup>41</sup> (Brockman and Chung, 1999a). Inventory holding costs have traditionally been seen as compensation for the non-optimal inventory levels the market-maker has to sustain in equilibrating order imbalance. However, in order driven markets, they can be viewed as being determined by a trader's ability to unload unwanted inventory, which in turn is determined by the number of traders in the market.<sup>42</sup> The interpretation of asymmetric information costs also differs depending on the trading mechanism. Under a quote driven system, they are seen as the expected losses of the market maker to informed traders, while in an order driven system, they are seen as the cost of leaving limit orders that can be "picked off" by traders with private information<sup>43</sup> (Wang, 1999).

Frino and McCorry (1996) compared liquidity on a pure order driven market to a hybrid quote driven market. Using effective and quoted spreads to proxy for liquidity and controlling for other possible determinants of liquidity such as price,

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<sup>39</sup> See Brockman and Chung (1999b), Blume and Goldstein (1997), Ross, Shapiro, and Smith (1996), Petersen and Fialwolski (1994), and Lee, Muchlow and Ready (1993).

<sup>40</sup> Flood, Huisman, Koedijk, and Lyons (1998) found that search costs (costs of finding a counterparty to trade with) are also an important factor in spreads in fragmented dealership markets.

<sup>41</sup> For more discussion on order processing costs see Stigler (1964), Demsetz (1968), Tinic (1972), Benston and Hagerman (1974), Tinic and West (1974), and Branch and Freed (1977).

<sup>42</sup> For more discussion on inventory holding costs see Garman (1976), Stoll (1978), Amihud and Mendelson (1980), Ho and Stoll (1981, 1983), and Hansch, Naik, and Viswanathan (1998).

<sup>43</sup> For more discussion on asymmetric information costs see Bagehot (1971), Copeland and Galai (1983), Kyle (1984, 1985), Glosten and Milgrom (1985), and Easley and O'Hara (1987).

trade size, level of trading activity, and volatility, they found that the ASX was more liquid than the NYSE. The difference in liquidity levels was found to be greatest for small trades. Other studies have arrived at similar results. De Jong, Nijman, and Roell (1995) and Pagano and Roell (1990) used the effective and quoted spreads of dual listed companies to show that liquidity is higher on the Paris Bourse<sup>44</sup> than London's SEAQ International stock exchange.<sup>45</sup> Again, this difference was largest for small trades. Pagano and Roell (1996) postulated that this liquidity differential is due to the greater transparency of order driven markets.<sup>46</sup> Consistent with this proposition, Brown and Zhang (1997) found the introduction of limit orders to a quote driven system increases the informational efficiency of prices. In a unique study, Viswanathan and Wang (1998) proposed that the best market, in terms of liquidity, is dependent on the risk preferences of the investor.<sup>47</sup>

Further insight into liquidity differences between pure order driven markets and hybrid quote markets can be gained by considering the effect that limit orders have on hybrid quote markets. Studies have tended to find that the existence of limit orders on these markets lowers the spread and therefore increases liquidity. Chung, Van Ness, and Van Ness (1999, p. 3) found that with reference to the NYSE, "spreads are widest when both the bid and ask prices are quoted by the specialists alone, and narrowest when both sides of the quote originate from the limit-order book."

Both Barclay, Christie, Harris, Kandel, and Schultz (1999) and McNish, Van Ness, and Van Ness (1998) found that the introduction of the Limit Order Display Rule on Nasdaq resulted in a reduction in spreads. However, the Limit Order Display Rule

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<sup>44</sup> The Paris Bourse is a pure order driven market similar to the ASX and NZSE (Biases, Hillion, and Spatt, 1995).

<sup>45</sup> SEAQ International is a quote driven market. In October 1997 the London Stock Exchange introduced electronic order book trading for FTSE 100 (the top 100) stocks. Remaining stocks continue to be traded on SEAQ International (London Stock Exchange, 1999).

<sup>46</sup> Pagano and Roell (1996), and Ui (1999) showed, theoretically, that greater transparency results in the losses traders suffer to those with inside information being reduced, leading to smaller spreads, and less price volatility. Gravelle (1999) found support for this proposition using US Treasury, and Government of Canada bond market data. However, Scalia and Vacca (1999) refuted this proposition using Italian Treasury Bond Market data.

<sup>47</sup> A risk neutral investor is said to prefer a order driven market. A risk averse investor is said to prefer a dealership market when the number of market makers or the variation on order size is large, and a hybrid market in other circumstances (Viswanathan and Wang, 1998).

was introduced at the same time as other changes in Nasdaq, so it is not possible to completely dis-entangle their effects. In a study that does not suffer from this problem, Naik and Yadav (1999) considered the introduction of order driven trading for FTSE 100 stocks on the London Stock Exchange. They found that the average daily signed effective spread of public investors (as a group) had fallen more substantially than the change in absolute effective spread documented for Nasdaq stocks by Barclay et al. (1999). In contrast to these studies, Kavajecz (1999) found that specialists on the NYSE play an important role in narrowing the spread, especially for smaller and less frequently traded stocks.

The numerous studies that have compared liquidity levels<sup>48</sup> on the NYSE (which has always allowed limit orders)<sup>49</sup> and Nasdaq (before the 1997 Limit Order Rule was introduced) provide further insight into liquidity differences between pure order driven and quote driven markets. Hamilton (1976), Quandt and Newton (1979), and Klemkosky and Conroy (1985) all found that stocks moving from Nasdaq to the NYSE in the 1970s experienced a spread reduction. Baker and Elderman (1992), Christie and Huang (1994), Barclay (1997), and Bessembinder (1998) all confirmed that this reduction in trade execution costs was experienced by firms making the switch in the 1980s and 1990s too. Clyde, Schultz, and Zaman (1997) reinforced these findings by showing that spreads increased for firms that moved from AMEX<sup>50</sup> to Nasdaq. As further evidence, Huang and Stoll (1999) showed that spreads are higher for stocks listed on the London Stock Exchange,<sup>51</sup> than their American Depository Receipt (ADR) NYSE traded counterparts.

Using a different approach, Huang and Stoll (1996b) compared trade execution costs<sup>52</sup> for a matched sample of large capitalisation firms traded on both Nasdaq and the NYSE and found that trade execution costs were more than twice as large on

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<sup>48</sup> Chan and Lakonishok (1997) and Keim and Madhavan (1997) pointed out that there are difficulties in comparing spread across the NYSE and Nasdaq since prices on Nasdaq are quoted net of commissions (at least for large investors), and many trades on both markets occur within the spread.

<sup>49</sup> In fact, Chung, Van Ness, and Van Ness (1999) found that the majority of bid-ask spreads on the NYSE came from the limit order book.

<sup>50</sup> AMEX's trading mechanism is very similar to that of the NYSE.

<sup>51</sup> The data used predates the London Stock Exchange switch to order driven trading for FTSE 100 stocks.

<sup>52</sup> Execution costs were measured as the quoted spread, the effective spread, the realised spread, and the implied spread.

Nasdaq. Bessembinder and Kaufman (1997) extended this comparison to smaller firms, and found that liquidity advantage of the NYSE is greater for small firms and small trades.

Further reinforcing the superior liquidity of the NYSE over Nasdaq, LaPlante and Muscarella (1997) used matched samples of NYSE and Nasdaq firms to dispel the notion that quote driven markets are superior for large block trades (10,000 shares or more).<sup>53</sup> This finding is consistent with Keim and Madhavan (1995).

Bessembinder (1999) found that while trade execution costs remained lower on the NYSE than Nasdaq following the 1997 reforms of Nasdaq, the differential between the markets was smaller. This confirmed the findings of studies that have suggested that the introduction of Limit Order Rule on Nasdaq resulted in a reduction in spreads.

Several possible explanations have been given for the trade execution cost differential between the NYSE and Nasdaq. Bessembinder (1999), Bloomfield and O'Hara (1998), Dutta and Madhavan (1997), Huang and Stoll (1996b), and Godek (1996) all proposed that preferencing and internalisation, which are commonplace on Nasdaq, are a disincentive to Nasdaq market makers to reduce their spreads. In a very recent paper, Heidle and Huang (1999) found that traders are more anonymous on Nasdaq than the NYSE resulting in the probability of meeting an informed trader being higher on Nasdaq.<sup>54</sup> This in turn is said to cause spreads to be larger on Nasdaq.

Martens (1998) proposed that open outcry (floor) trading, which is often used to trade derivative contracts, is comparable to a dealership market in which traders can trade with competing market makers at their publicly announced bids and asks. Electronic (screen) trading of derivative contracts, with traders entering market and limit orders via computer screens, is said to be comparable to order driven stock

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<sup>53</sup> Madhavan (1992), De Jong, Nijman, and Roell (1995), and Viswanathan and Wang (1998) all proposed this.

<sup>54</sup> This is consistent with Kim, Lin, and Slovin (1997) who found that, when informational efficiency is high, a centralised market such as the NYSE is more efficient than a competitive but fragmented dealer market such as Nasdaq.

exchanges. Thus, comparing the liquidity of these two derivative trading mechanisms provides further insight into the liquidity differential among the ASX, NZSE, and Nasdaq (before the Limit Order Rule).

Domowitz (1993) carried out various simulations of trading to evaluate the liquidity of floor trading relative to screen trading.<sup>55</sup> His study focused on the absence of time precedence<sup>56</sup> in floor traded markets. He found that the average spread is lower in a screen trading environment. A number of other papers have compared spreads (as a proxy for liquidity) of Bund futures, which are simultaneously traded by open outcry on the floor of the LIFFE,<sup>57</sup> and in a screen-traded environment on the DTB.<sup>58</sup> Both Pirrong (1995) and Kofman and Moser (1997) found that estimates of realised spreads are lower on the DTB than the LIFFE. In contrast, Shyy and Lee (1995) found that quoted spreads on the DTB are wider than the LIFFE. A problem with these three studies is that they do not control for differences in the determinants of spreads, which are unrelated to the trading mechanisms. After controlling for trading volume and price volatility,<sup>59</sup> Frino, McInish, and Toner (1998) found that quoted spreads were wider on the LIFFE than the DTB. This supports the view that spreads are lower in an order driven environment than a quote driven environment.

Aitken, Duffy, and Frino (1998) compared quoted spreads for futures traded on the floor of the Sydney Futures Exchange and its overnight screen trading system (SYCOM), controlling for trading volume and price volatility. They found that during periods of high trading activity, spreads are lower in screen traded markets, while during periods of high price volatility spreads are lower in floor traded markets. This finding is consistent with what has been postulated in the theoretical

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<sup>55</sup> Domowitz (1993) used the system specifications for GLOBEX, the automated trading system of the Chicago Mercantile Exchange (CME), (which is one of the three Chicago Futures and Options exchanges) for his specification of a screen-traded system. The CME is used for his specification of a floor-traded system.

<sup>56</sup> Screen trading systems use an order book that maintains strict price and time priority of orders, while orders entered under the floor system “evaporate” once a higher bid or lower offer is submitted to the market.

<sup>57</sup> London International Financial Futures Exchange.

<sup>58</sup> Deutsche Terminborse.

<sup>59</sup> McInish and Wood (1992) suggested that these are the main determinants of intra-day spreads.

literature. Pirrong (1996) proposed that while screen trading increases liquidity<sup>60</sup> it may also impair liquidity due to the longer lived nature of quotes, which can impose greater price risk on limit order traders. This is consistent with Frino, McInish, and Toner's (1998) finding that spreads on the DTB increase more rapidly as price volatility (a proxy for asymmetric information) increases relative to the LIFFE, and Franke and Hess' (1995) finding of an increase in the proportion of trading conducted on the LIFFE trading floor during times of high "informational intensity." Further evidence is provided by Wang (1999), who used Sydney Futures Exchange data to show that the spreads of screen trading futures have a higher asymmetric information component than the spreads of their exchange traded counterparts.

An additional comparison of liquidity on the ASX and NZSE as opposed to a fragmented market such as Nasdaq, is provided by two studies that have analysed changes in liquidity following the independent switches of the ASX and NZSE from open outcry trading (carried out across regional exchanges) to consolidated trading in an electronic order book. Blennerhassett and Bowman (1998) reported a spread reduction, an increase in on-market trading within New Zealand, and an increase in the proportion of trades of dual listed companies carried out on the NZSE following the adoption of screen trading. These three factors suggest an increase in liquidity in the New Zealand market following the introduction of the electronic order book. Similarly, Aitken, Frino, and McKensey (1993) found a decrease in spreads and an increase in liquidity following the introduction of the electronic limit order book in Australia. This liquidity increase was found to be particularly marked for thinly and moderately traded stocks.

The analysis of minimum tick sizes across stock exchanges also provides an insight into relative liquidity levels. The minimum tick sizes on the ASX and NZSE are considerably lower than those on the NYSE and Nasdaq.<sup>61</sup> Harris (1994) predicted that smaller tick size should lead to a narrower spread. This prediction has been

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<sup>60</sup> Reasons given include increased timeliness, and accuracy of reporting, the reduction in communication errors in executing trades, enhancements in the ability of regulators to monitor trading and reduce default risk, a reduction in the possibility of fragmentation of order flow, and a reduction in the possibility of collusion among traders.

<sup>61</sup> The minimum tick sizes on the NZSE, ASX, NYSE, and Nasdaq are NZ\$0.001, AUS\$0.001, \$US1/32 (0.031), and \$US 1/32 (0.031) respectively.

verified by studies<sup>62</sup> that have considered spread changes following tick size reductions for the NYSE, Nasdaq, AMEX, TSE, and the Toronto Stock Exchange. In a recent paper Ball and Chordia (1999) made a substantial contribution to the theoretical evidence regarding tick size and spread. On testing their proposition using NYSE data, they showed that in 1992, when the minimum tick size was \$1/8, the true spread that would have prevailed in the absence of a minimum tick size would have been between 10% and 27% of the actual quoted spread.

The substantial literature that has compared liquidity levels across stock exchange mechanisms, indicates that liquidity tends to be greater on exchanges that allow limit orders. In fact, it appears that, in general, the closer the exchange is to a pure order driven system, the more liquid it is. This has largely been borne out in the existing liquidity asset pricing literature. Hu (1997a) found that the liquidity premium on the Tokyo Stock Exchange, which is order driven, was period specific. Chen and Kan (1989) found no evidence of a liquidity premium on the NYSE (which allows limit orders), while Eleswarapu and Reinganum (1993) only found a relationship in January months. In contrast, Eleswarapu (1997) and Hu (1997b) found strong evidence of a liquidity premium on Nasdaq.<sup>63</sup>

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<sup>62</sup> For NYSE studies see Ricker (1998), Bollen and Whaley (1998), and Goldstein and Kavajecz (1998). For a Nasdaq study see Jones and Lipson (1998). For an AMEX study see Ahn, Cao, and Choe (1996). For a Tokyo Stock Exchange study see Muranaga (1999). For Toronto Stock Exchange studies see MacKinnon and Nemiroff (1999), Bacidore (1997), and Chung, Kryzanowski and Zhang (1997).

<sup>63</sup> Both Eleswarapu (1997) and Hu (1997b) considered Nasdaq before the 1997 Limit Order Rule was introduced.

# PART TWO

## DATA & METODOLOGY

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Part Two provides a description of the data and methodologies used in the empirical analysis of this study. Chapter Four begins with an outline of the data from the New Zealand and Australian stock markets. This is followed by variable definitions. Chapter Four concludes with a description of the portfolio formation techniques employed and a review of the literature that discusses the disadvantages of portfolio use. The two methodologies adopted in this thesis are different to those employed by the majority of previous studies, which have considered the effect of liquidity on asset pricing. Chapter Five begins with a description of the methodologies employed by previous studies, together with reasons for the chosen methodology in this thesis. The methodology of this study – the Seemingly Unrelated Regression (SUR) Model and a variant of the General Pooled Cross-Sectional Time-Series Model, known as the Cross Sectionally Correlated Timewise Autoregressive (CSCTA) Model, are then described in detail. Details of the tests that were undertaken to confirm the applicability of these two models are also included. Chapter Five concludes with a description of the specific models that are tested using the SUR and CSCTA Models.

## Chapter Four Data Description

### 4.1 Raw Data and Variable Definition

This study investigates the impact of liquidity on stock returns in pure order driven stock markets, specifically the Australian Stock Exchange (ASX)<sup>1</sup> and the New Zealand Stock Exchange (NZSE).<sup>2</sup> Consequently, most of the data used comprises stock market data from these two markets.

Before describing the data, a justification of the time-periods studied would seem appropriate. The New Zealand market is considered over the period 1993 to 1998, while the Australian market is considered over the period 1994 to 1998. The first reason for the choice of these periods is the desire to have data that is as recent as possible. Analysing both markets over a longer period was preferable. However, this was not attempted for the Australian market because the necessary data was not available. Pre 1993 New Zealand data was available. However, analysis of this data was not attempted because following the 1987 stock market crash there was major upheaval in the New Zealand market with many companies ceasing to exist. The use of a longer time-period would therefore have resulted in small sample sizes for the years in the late 1980s and early 1990s.

This study employs three liquidity proxies. Following Amihud and Mendelson (1986), Chen and Kan (1989), Eleswarapu and Reinganum (1993), and Reinganum

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<sup>1</sup> The Securities Industry Research Centre of Asia Pacific (SIRCA) supplied the ASX data. The help of Giancarlo Filippo Maisetti is much appreciated.

<sup>2</sup> The University of Otago supplied the NZSE data (excluding book-value data). The help of Peter Grundy is much appreciated. New Zealand company book-value data was collected from yearly DATEX publications.

(1997) the relative bid-ask spread (hereafter spread), which is defined as  $(\text{ask} - \text{bid}) / ((\text{ask} + \text{bid}) / 2)$ , is used. Studies that have considered liquidity on the hybrid quote driven market of the New York Stock Exchange (NYSE) have found that many trades occur inside the spread, making spread a poor proxy for liquidity on the NYSE.<sup>3</sup> However, there is evidence to suggest that spread might be a more accurate liquidity proxy in order driven markets with Lehman and Modest (1994, p. 956) having found that on the Tokyo Stock Exchange “there are virtually no trades between the bid and ask prices.” Regardless of the shortcoming of spread as a liquidity proxy, its use in this study of two pure order driven markets provides a comparison with the seminal liquidity asset pricing papers, which all examined the return-spread relationship on hybrid quote driven markets.

Weekly bid and ask price data was gathered for all companies (for which there was the necessary data) listed on each market over the time periods studied. Individual company weekly spreads were then calculated using the following formula:  $(\text{ask} - \text{bid}) / ((\text{ask} + \text{bid}) / 2)$ , where ask and bid are the Wednesday closing ask and bid prices respectively.<sup>4</sup> The monthly company spread was then calculated as the mean of the weekly spreads.

This constitutes a major improvement on the Amihud and Mendelson (1986), Chen and Kan (1989), and Eleswarapu and Reinganum (1993) studies. These studies all calculated the spread for a firm in a given month by taking the average of that firm’s spread at the beginning and end of the previous year.<sup>5</sup> This obviously does not capture the variation of the spread for a particular firm within the year, which is of concern, given the finding of seasonality in monthly spreads by Clark, McConnell, and Singh (1992) and Fortin, Grube, and Joy (1989).

Following Hu (1997a, b) and Datar, Naik, and Radcliffe (1998), turnover rate, defined as monthly volume divided by yearly number of shares outstanding (shares

<sup>3</sup> See Lee, Mucklow, and Ready (1993) and Petersen and Fialkowski (1994)

<sup>4</sup> If Wednesday was a holiday, the next trading day of the week was used. Stocks were excluded from consideration, in a given test year, if there was not a bid and ask price on at least one Wednesday (or the next trading day if Wednesday is a holiday) in any given month within the test year.

<sup>5</sup> These three studies used the same limited data set. In using yearly spread data to proxy for monthly spreads, the questionable assumption that liquidity is constant throughout the year was made.

on issue), is also used as a proxy for liquidity. Both Hu (1997a, b) and Datar et al. (1998) argued that turnover rate is theoretically superior to spread as a liquidity proxy.

Volume data for each company was collected on a monthly basis, while the number of shares outstanding data was collected on an annual basis. If there was a change in shares outstanding during the year, the weighted average was used.

The third liquidity proxy employed in this study is known as “Amortised Spread.” This measure, which has its foundations in Chalmers and Kadlec (1998), is a combination of spread and turnover rate. Specifically, amortised spread is measured as spread  $\times$  turnover rate. Chalmers and Kadlec (1998) argued that by taking the spread and investor trading into account, amortised spread is superior to both spread and turnover used individually.

Consistent with Datar et al. (1998) the return for a given stock in month  $t$  is defined as:  $(\text{price in month } t - \text{price in month } t-1) / \text{price in month } t-1$ . Monthly price data was gathered. Specifically, the price for a month is the price (adjusted for dividends, share splits, bonus issues etc) at which the last transaction on the last trading day of the month occurred.

Along the lines of previous liquidity asset pricing studies,<sup>6</sup> beta and size are included as control variables in this study. The additional control variable of book-to-market equity was used in the New Zealand analysis. However, Australian book value data was unavailable so calculating book-to-market equity for the Australian companies was not possible.

Following Amihud and Mendelson (1986) and Eleswarapu and Reinganum (1993) an equally weighted market index, which was calculated using monthly stock prices that were adjusted for dividends, share splits, and bonus issues, was used to estimate beta. The use of an equally weighted index is particularly important in the New Zealand

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<sup>6</sup> See Datar et al. (1998) and Eleswarapu (1997).

market where one company (Telecom) constitutes more than thirty percent of the total market capitalisation.<sup>7</sup>

In accordance with Chin (1998) the size of a company in year  $t$  is calculated as the number of shares outstanding multiplied by the last transaction price on the last trading day, both measures relating to December in year  $t-1$ . Consistent with Eleswarapu (1997), the natural log of size for each company each month is computed to reduce the influence of outliers.

Following Chin (1998), the book-to-market ratio of each New Zealand company in year  $t$  is calculated as a ratio of the book value of the company in year  $t-1$  to the size of the company in year  $t-1$ . In line with Brennan, Chordia, and Subrahmanyam (1998), book value in year  $t-1$  is measured as the most recently reported total shareholders funds plus deferred taxation. Consistent with Eleswarapu (1997), the natural log of the book-to-market ratio for each company is computed.

Lastly, the 90 Day Bank Bill rate and the 13 Week Treasury Note rate are used as proxies for the risk-free rate in the New Zealand and Australian portfolios respectively. Specifically, the rate for the last day of the month was used. Both the 90 Day Bank Bill rate and the 13 Week Treasury Note rate are commonly stated in annualised terms. They were both converted to nominal monthly rates before being used in this research.<sup>8</sup> Following the convention of previous asset pricing research, excess portfolio returns and excess market returns (where the excess returns are calculated as the actual returns minus the risk-free rate) are used. Testing the CAPM using excess returns is popular in the literature because the excess returns market model not only provides a beta estimate but also provides an implicit test of the CAPM. If the CAPM holds, the estimate of the intercept parameter should be zero.<sup>9</sup>

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<sup>7</sup> The 1998 NZSE Fact Book reports that on 31/12/98 Telecom Corporation of New Zealand made up 31.1% of total market capitalisation.

<sup>8</sup> The formula  $r^* = [(1 + r)^{1/m} - 1]$  was used, where  $r^*$  = nominal monthly rate and  $r$  = nominal annualised rate.

<sup>9</sup> See Brailsford, Faff, and Oliver (1997, p. 9) for more discussion on this point.

## 4.2 Portfolio Formation

Three liquidity proxies are used in this research, as specified previously. This makes it more comprehensive than previous studies which have tended to use only one, and in the case of Hu (1997b) and Chalmers and Kadlec (1998), two of the said liquidity proxies.

Portfolios of stocks were formed for each market to aid the examination of the effect of liquidity on stock returns. The use of portfolios rather than individual securities in tests of asset pricing models has been criticised from opposing perspectives by Roll (1977) and Lo and MacKinlay (1990). Roll (1977) argued that the portfolio formation process, by concealing possibly return relevant security characteristics within portfolio averages, makes it difficult to reject the null hypothesis of no effect on returns. Lo and MacKinlay (1990) made the almost precisely opposite point, that if the researcher forms portfolios on the basis of characteristics which prior research has shown to be relevant to expected returns, he will be inclined to reject the null hypothesis too often due to a “data snooping bias.” It is worth emphasising that the Roll (1977) and Lo and MacKinlay (1990) critiques of the portfolio formation approach are complementary rather than competing; portfolio formation may both make some return-irrelevant characteristics appear significant, and disguise the empirical relevance of other return-relevant characteristics (Brennan, Chordia, and Subrahmanyam, 1997).

While acknowledging the potential of portfolios to bias results, portfolios have been used because they are a necessary part of the methodologies of this study, the Seemingly Unrelated Regressions (SUR) and Cross-Sectionally Correlated and Timewise Autoregressive (CSCTA) Models. Without portfolios, the number of risk parameters and the dimension of the error variance matrix would become unmanageable in these models. In other words, it has been perceived that the advantages that arise from the use of these techniques outweigh the disadvantages that stem from the use of portfolios.

Three portfolios were formed for each of the three liquidity proxies for the New Zealand data set for each test year, while ten portfolios were formed for each liquidity proxy for each test year for the Australian data set. Six years (1993 - 1998) of New Zealand data and five years (1994 - 1998) of Australian data was available. Portfolios were formed in year  $t$  using data from year  $t-1$ . As a result, there are five test years (1994 - 1998) in the New Zealand data set and four test years (1995 - 1998) in the Australian data set.

A company was placed in a particular spread portfolio in year  $t$  based on its average yearly spread in year  $t-1$  (this is calculated as the sum of the average monthly spreads / 12). For a company to be included in a portfolio in year  $t$ , it had to have spread data for years  $t-1$  and  $t$ , price data for year  $t$  and December of year  $t-1$  (necessary for the calculation of returns and size), shares outstanding data for December of year  $t-1$  (necessary for the calculation of size and the book-to-market ratio), and book value data for year  $t-1$  (necessary for the calculation of the book-to-market ratio).

After the portfolios had been formed, the monthly excess returns of each portfolio for each month were calculated. These were computed as the average return of the stocks in the portfolio that month less the proxy for the risk-free rate. The average spread of each portfolio for each month was then calculated as the mean of the spreads of the stocks within the portfolio. Both the portfolio  $\log(\text{size})$  and portfolio  $\log(\text{book-to-market})$  ratio were calculated in a given year  $t$  by taking the mean of these attributes (for the stocks in the portfolio) in year  $t-1$ . i.e. within a test year, any given portfolio has the same  $\log(\text{size})$  and the same  $\log(\text{book-to-market})$  ratio.

The spread portfolio formation process was then replicated for turnover rate. As with the spread portfolios, a company was placed in a particular turnover rate portfolio in year  $t$ , based on its average yearly turnover rate in year  $t-1$ . For a company to be included in a portfolio in year  $t$  it had to have turnover rate data for years  $t-1$  and  $t$ , price data for year  $t$  and December of year  $t-1$ , shares outstanding data for December of year  $t-1$ , and book value data for year  $t-1$ .

After the portfolios had been formed, the average turnover rate of each portfolio for each month was found. This was calculated as the mean of the turnover rates for the

stocks within the portfolio. The portfolio return,  $\log(\text{size})$ , and  $\log(\text{book-to-market})$  ratio were then calculated in the same way as the spread portfolios.

The spread and turnover rate portfolio formation process was then repeated for amortised spread. A company was placed in a particular amortised spread portfolio for in year  $t$  based on its average yearly amortised spread in year  $t-1$ . For a company to be included in a portfolio in year  $t$  it had to have amortised spread data for years  $t-1$  and  $t$ , price data for year  $t$  and December of year  $t-1$ , shares outstanding data for December of year  $t-1$ , and book value data for year  $t-1$ .

After the portfolios had been formed, the average amortised spread of each portfolio for each month was found. This was calculated as the mean of the amortised spreads for the stocks within the portfolio. The portfolio return,  $\log(\text{size})$ , and  $\log(\text{book-to-market})$  ratio were then calculated in the same way as the spread and turnover rate portfolios.

Chan, Hamao, and Lakonishok (1991) proposed that there is a possibility for bias in using portfolios formed on this basis in the SUR framework (the same argument also applies to the CSCTA framework) due to time variation in the explanatory variables. To account for this variation, they adjusted their portfolios by dividing each fundamental variable by its cross-sectional average from the previous June, thus preserving cross-sectional differences when pooling data across time.

The Chan et al. (1991) method of forming scaled portfolios was also used for comparison. The initial regression results from these portfolios were very similar to those that were obtained with the standard portfolio formation procedure, so the use of the non-scaled portfolios was reverted to. The results presented in this thesis relate to the non-scaled portfolios.

## Chapter Five Methodology

### 5.1 Introduction

This study investigates the relationship between return and liquidity using two similar methodologies. The first is the Seemingly Unrelated Regressions (SUR) technique, which was developed by Zellner (1962). The second is a variant of the general Pooled Cross-Sectional Time-Series Model that accounts for cross-sectional correlation. This model is commonly referred to as a “Cross-Sectionally Correlated and Timewise Autoregressive (CSCTA) Model.” These two models, which are described in detail in Sections 5.3 and 5.4, are different to those used by the majority of previous liquidity asset pricing studies.<sup>1</sup> Therefore, this chapter begins with a description of the methodologies of previous studies and justifications for not using these methodologies.

### 5.2 Methodology of Previous Liquidity Asset Pricing Studies

The methodology of previous liquidity asset pricing research is best discussed in three sections: Long Portfolio Formation Period, the Errors-In-Variables problem, and Beta Estimation problems.

#### 5.2.1 Long Portfolio Formation Period

In the seminal liquidity asset pricing paper of Amihud and Mendelson (1986), portfolios were formed by dividing the data into twenty overlapping periods of

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<sup>1</sup> Eleswarapu (1997) and Brennan and Subrahmanyam (1996) are two previous liquidity asset pricing studies that used the SUR and Pooled Cross-Sectional Time-Series techniques.

eleven years each. Each period consisted of a five-year beta estimation period,<sup>2</sup> a five-year portfolio formation period,<sup>3</sup> and a one-year cross-section test period.<sup>4</sup> To be included in the study, a stock had to have all the necessary data for the entire eleven-year period. Amihud and Mendelson (1986) were obviously aware of the shortcomings of such a long portfolio formation period and pointed out that “the long trading period requirement might have eliminated from our sample the riskier and higher-spread stocks, thus reducing the variability of our data” (Amihud and Mendelson, 1986, p. 233).

Using a modified portfolio formation technique, Eleswarapu and Reinganum (1993) assigned a stock to a portfolio based on the stock’s spread in the previous year and the stock’s beta estimated with 36 months of preceding returns. Thus, only three years of pre-formation data was needed for an asset to be included in the tests. Eleswarapu and Reinganum (1993) tested the cross-sectional relationship between return, spread, and the control variables, beta and size, using the Fama and MacBeth (1973) technique. Eleswarapu (1997)<sup>5</sup> also used the portfolio formation technique of Eleswarapu and Reinganum (1993) in his study of the return-liquidity relationship on the Nasdaq market.

Following the 1987 stock market crash, there was a period of major change on the New Zealand stock market with many companies de-listing. Many of today’s listed companies were not listed 10 – 15 years ago. For this reason, methodology that does not require the portfolio formation methods of Amihud and Mendelson (1986), Eleswarapu and Reinganum (1993), and Eleswarapu (1997) was employed in this study.

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<sup>2</sup> The beta estimation period involved estimating the beta coefficients of individual stocks using market model regressions on the sixty months of return data.

<sup>3</sup> The portfolio formation period was used to form test portfolios, based on the spread and beta of stocks in the previous year. The beta, spread, size, and return parameters of the portfolio were then estimated.

<sup>4</sup> In the cross-section test period, the relationship between return, spread, and the control variables of beta and size was tested for each portfolio.

<sup>5</sup> Eleswarapu (1997) also used a different portfolio technique and the SUR Model.

### 5.2.2 Errors-In-Variables Problem

The Fama and MacBeth (1973) two-step cross-sectional regression technique is the methodological foundation for the majority of asset pricing tests,<sup>6</sup> despite the fact that it has a potential errors-in-variables (EIV) problem. That is, errors in computing the betas in the first step can affect inferences about the variables estimated in the second stage.

The errors-in-variables problem, which is comprehensively discussed by Shanken (1992) and Kim (1995), is modified here to incorporate spreads.<sup>7</sup> The Fama and MacBeth (1973) second pass cross-sectional regression model of estimating the return-spread relationship at a specific time  $t$  is:

$$R_t = \gamma_{0t} + \gamma_{1t}\beta_t + \gamma_{2t}S_{t-1} + \gamma_{3t}V_{t-1} + \varepsilon_t \quad (1)$$

where  $R_t = (R_{1t}, \dots, R_{Nt})'$  is the return vector in excess of the riskless return,  $\beta = (\beta_{1t}, \dots, \beta_{Nt})'$  is the market beta vector,  $S_{t-1} = (S_{1t-1}, \dots, S_{Nt-1})'$  is the spread vector measured without error at  $t-1$ ,  $V_{t-1} = (V_{1t-1}, \dots, V_{Nt-1})'$  is the logarithm of market values (size) measured without error at  $t-1$ ,  $\varepsilon_t = (\varepsilon_{1t}, \dots, \varepsilon_{Nt})'$  is the idiosyncratic error vector, and  $N$  is the number of assets. Since  $\beta_t$  is unobservable, the estimated market beta,  $\hat{\beta}_{t-1}$ , is used as a proxy for the unknown  $\beta_t$ . The independent variable is therefore observed with error:

$$\hat{\beta}_{t-1} = \beta_t + \xi_{t-1} \quad (2)$$

where  $\hat{\beta}_{t-1} = (\hat{\beta}_{1t-1}, \dots, \hat{\beta}_{Nt-1})'$  is the market beta vector estimated from the first-pass time-series regression model (the market model) using  $T$  time-series data up to  $t-1$ , and  $\xi_{t-1} = (\xi_{1t-1}, \dots, \xi_{Nt-1})'$  is the measurement error vector. In the Fama and MacBeth

<sup>6</sup> Eleswarapu and Reinganum (1993), Hu (1997a, b), and Chalmers and Kadlec (1998) are among the liquidity asset pricing papers that have employed the Fama and MacBeth (1973) methodology.

<sup>7</sup> Obviously, a similar modification could be made to incorporate either turnover rate or amortised spread.

(1973) risk premia estimation procedure, the estimates  $\hat{\gamma}_{1t}$  are taken to be independent and identical sampled values of the price of beta risk,  $\gamma_1$ .

The cross-sectional regression model of equation 1 has one explanatory variable measured with error and two explanatory variables measured without error. Kim (1995) combined the findings of Richardson and Wu (1970), McCallum (1972), and Aigner (1974) to show that based on the assumption that the measurement error and the idiosyncratic error are independent, the traditional OLS estimator  $\hat{\gamma}_{1t}$  is negatively (downward) biased. He also showed that after including the firm size variable,  $\hat{\gamma}_{1t}$  becomes even more underestimated. The traditional least squares coefficient associated with the firm size variable  $\hat{\gamma}_{3t}$  is said to be negatively biased, as long as the estimated beta and the firm size variable are negatively correlated. In other words, the cross-sectional regression coefficient associated with the size variable is, on average, estimated more negatively than its true value, using the traditional least squares estimation procedure.

Eleswarapu (1997) documented a negative correlation between size and beta, and a positive correlation between average spread and beta. Thus by applying the same logic to the spread variable, it would seem that it can be concluded that the least squares estimate of  $\hat{\gamma}_{2t}$  is positively (upward) biased; that is, the average value of the least squares estimate of  $\hat{\gamma}_{2t}$  is greater than its true value. This means that the explanatory power of spread for average stock returns is exaggerated under the traditional Fama and MacBeth (1973) estimation procedure.

### 5.2.3 Beta Estimation Problems

The errors-in-variables problem is even more pronounced when stocks are infrequently traded. This is due to the difficulties associated with obtaining unbiased and consistent beta estimates for thinly traded stocks. Thin trading leads to the

problem of non-synchronous trading (stocks not trading at regular intervals) (Ibbotson, Kaplan, and Peterson, 1997).

Denis and Kadlec (1994), like many researchers before them, observed that the presence of non-synchronous trading causes serial cross-correlations in security returns, which leads to biased estimates of systematic risk. Brailsford, Faff, and Oliver (1997, p. 22) commented that “this can be a particularly significant problem when dealing with many of the smaller stocks in the Australian and New Zealand Equity markets.” The same authors also noted that thin trading in individual stocks also affects the market return because the individual stock returns form part of the market portfolio returns. This led to the Bartholdy and Riding (1994) explanation, that to the extent the security is more (less) thinly traded than the market index, beta estimates are biased downward (upward).

Scholes and Williams (1977) and Dimson (1979) proposed alternative bias correcting procedures for beta estimation in the presence of non-synchronous trading.

However, in a study of the efficacy of alternative estimation techniques in the New Zealand stock market, Bartholdy and Riding (1994) found that neither the Dimson nor the Scholes-Williams procedures provide incremental benefits over standard ordinary least squares regression.

### **5.3 Methodology of This Study**

Use of the SUR and CSCTA Models to test the cross-sectional relationship between the liquidity proxy and return is advantageous because they simultaneously estimate the portfolio beta. In doing so, they eliminate the errors-in-variables problem that is inherent in techniques such as the one developed by Fama and MacBeth (1973), which use prior-period betas as forecasts of future betas. This is particularly important in markets such as New Zealand and Australia where there are well-documented problems associated with accurate beta estimation due to non-synchronous trading. Also, since no prior beta estimation is necessary, there is no need for a restrictive portfolio formation process. This is especially relevant in the New Zealand market where many stocks have not been listed for a long period. By

not relying on a long portfolio formation period the likelihood of introducing survivorship bias into the data is reduced.

Another advantage of both the SUR and CSCTA Models is that they account for the fact that the cross-sectional unit (in this case portfolio) errors may be contemporaneously (same time period) correlated. This is particularly important, as it is likely that the movements of stocks (or portfolios of stocks) in the same market will be correlated.

The SUR and CSCTA techniques are not flawless. Unlike the Fama and MacBeth (1973) procedure, which updates betas periodically, the SUR and CSCTA Models assume that the beta and the coefficients of the other explanatory variables for each portfolio, are constant over time. The CSCTA Model also involves the additional assumption that the betas of each portfolio are equal. It is therefore possible that the liquidity variable proxies for changes in the market risk premium. However, this weakness is outweighed by the advantages associated with the SUR and CSCTA techniques. Thus their use in this research.

A description of the SUR and CSCTA Models is now undertaken.<sup>8</sup>

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<sup>8</sup> The following explanation of the SUR and CSCTA Models owes much to the following sources: Griffiths, W.E., Hill, R.C., and Judge, G.G. (1993). *Learning and practising econometrics*. John Wiley & Sons, New York.  
 Judge, G.G., Griffiths, W.E., Hill, R.C., Lutkrpohl, H., Less, T-C. (1985). *The theory and practice of econometrics* (2<sup>nd</sup> ed.). John Wiley and Sons, New York.  
 Judge, G.G., Hill, R.C., Griffiths, W.E., Lutkrpohl, H., Less, T-C. (1988). *Introduction to the theory and practice of econometrics* (2<sup>nd</sup> ed.). John Wiley and Sons, New York.  
 Kmenta, J. (1986). *Elements of econometrics* (2<sup>nd</sup> ed.). Macmillan, New York.  
 White, K.J. (1997). *SHAZAM The econometrics computer program version 8.0: User's reference manual*. McGraw-Hill. New York.

## 5.4 Seemingly Unrelated Regression (SUR) Model

A SUR system comprising of  $M$  cross-sectional units (equations), each containing  $T$  timewise observations, can be written as:

$$\begin{aligned} Y_{1t} &= \beta_{10} + \beta_{11}X_{1t,1} + \beta_{12}X_{1t,2} + \cdots + \beta_{1K_1}X_{1t,K_1} + e_{1t} \\ Y_{2t} &= \beta_{20} + \beta_{21}X_{2t,1} + \beta_{22}X_{2t,2} + \cdots + \beta_{2K_2}X_{2t,K_2} + e_{2t} \\ &\vdots \\ Y_{Mt} &= \beta_{M0} + \beta_{M1}X_{Mt,1} + \beta_{M2}X_{Mt,2} + \cdots + \beta_{MK_M}X_{Mt,K_M} + e_{Mt} \end{aligned}$$

$$t = 1, 2, \dots, T$$

Or using matrix notation:

$$\begin{aligned} y_1 &= X_1\beta_1 + e_1 \\ y_2 &= X_2\beta_2 + e_2 \\ &\vdots \\ y_M &= X_M\beta_M + e_M \end{aligned}$$

The assumptions underlying the SUR Model are as follows:

1. All disturbances have a zero mean.

$$E[e_{it}] = 0 \quad i = 1, 2, \dots, M; \quad t = 1, 2, \dots, T$$

2. In a given cross-sectional unit, the disturbance variance is constant over time; but each cross-sectional unit can have a different variance.

$$\begin{aligned} \text{var}(e_{1t}) &= E[e_{1t}^2] = \sigma_1^2 = \sigma_{11} \\ \text{var}(e_{2t}) &= E[e_{2t}^2] = \sigma_2^2 = \sigma_{22} \\ &\vdots \\ \text{var}(e_{Mt}) &= E[e_{Mt}^2] = \sigma_M^2 = \sigma_{MM} \end{aligned} \quad t = 1, 2, \dots, T$$

3. Two disturbances in different cross-sectional units but corresponding to the same time period are correlated (contemporaneous correlation).

$$\text{covar}(e_{it}, e_{jt}) = E[e_{it}e_{jt}] = \sigma_{ij} \quad i, j = 1, 2, \dots, M$$

4. Disturbances in different time periods, whether they are in the same cross-sectional unit or not, are uncorrelated (autocorrelation does not exist).

$$\text{covar}(e_{it}, e_{js}) = E[e_{it}e_{js}] = 0 \quad \text{for } t \neq s \text{ and } i, j = 1, 2, \dots, M$$

In matrix notation these assumptions can be written more succinctly as:

$$E[\mathbf{e}_i] = 0 \text{ and } E[\mathbf{e}_i \mathbf{e}_j'] = \sigma_{ij} \mathbf{I}_M \quad i, j = 1, 2, \dots, M$$

Given that it is likely that portfolios of stocks formed from the same market are contemporaneously correlated, the SUR Model is commonly used in finance research. If contemporaneous correlation does not exist, the least squares rule applied separately to each equation (portfolio) is fully efficient, so there is no need to employ the SUR estimator to the set of equations (Judge, Hill, Griffiths, Lutkrpohl, and Lee, 1988). Thus, the adoption of the SUR Model could be expected to be justified with evidence of the existence of contemporaneous correlation. However, papers such as Eleswarapu (1997), George and Hwang (1995), Pontiff (1995), Chan, Hamao, and Lakonishok (1991), Jaffe, Keim, and Westerfield (1989), and Brown, Kleidon, and Marsh (1983) all fail to do this.

The Breusch-Pagan (1980) Lagrange multiplier statistic is used to test for the existence of contemporaneous correlation. The null and alternative hypotheses are:

**H<sub>0</sub>**: a diagonal covariance matrix i.e.  $\sigma_{ij} = 0$  for  $i, j = 1, 2, \dots, M$  ( $i \neq j$ )

**H<sub>1</sub>**: at least one covariance is non-zero

The squared correlation coefficient of residuals is given by:

$$r_{ij}^2 = \frac{\hat{\sigma}_{ij}^2}{\hat{\sigma}_{ii} \hat{\sigma}_{jj}}$$

The Breusch-Pagan (1980) test statistic is computed as:

$$\lambda = N \sum_{i=2}^m \sum_{j=1}^{i-1} r_{ij}^2$$

Under the null hypothesis of a diagonal covariance structure, the statistic has an asymptotic  $\chi^2_{(M(M-1)/2)}$  distribution.

The results of these tests, which are presented in Chapters Six and Seven, indicate that there is strong evidence to suggest there is contemporaneous correlation among the cross-sectional units in both the New Zealand and Australian markets, so the use of the SUR Model is beneficial in both instances.

From assumption 2 it is evident that the SUR Model is based on the assumption that the disturbance variance is constant over time or homoskedastic within each cross-sectional unit. To test whether this holds for this study's data, the Breusch-Pagan (1979) test, which is described below, is used:

$$BP = \frac{SSR}{2\bar{\sigma}^4}$$

where:

SSR = regression sum of squares or explained variation,

$$\text{and } \bar{\sigma}^4 = \left( \frac{\sum \hat{e}_t^2}{T} \right)^2$$

When the null hypothesis of homoskedasticity is true, BP has a large sample approximate  $\chi^2_{(S)}$  distribution, with the number of degrees of freedom  $S$  being equal to the number of variables.

These test results, which are also presented in Chapters Six and Seven, indicate that the null hypothesis of a constant disturbance variance within each cross-sectional unit cannot to be rejected; so this assumption is satisfied.

From assumption 4, it is evident that the SUR technique is also based on the assumption of no autocorrelation between disturbances.

The Durbin and Watson (1950, 1951, 1971) test is used to detect the existence of first order autocorrelation within each cross-sectional unit. This test is based on the Durbin-Watson statistic:

$$d = \frac{\sum_{t=2}^T (\hat{e}_t - \hat{e}_{t-1})^2}{\sum_{t=1}^T \hat{e}_t^2} \quad \text{where } \hat{e}_t \text{ is an element of } \hat{e} = y - \beta X$$

The results of these tests (see Chapters Six and Seven) indicate that there is some evidence of first order autocorrelation in some of the cross-sectional units in both the New Zealand and Australian data. The data therefore violates the fourth assumption of the SUR Model to a small extent. Second to twelfth order autocorrelation was tested for using a variant of the Durbin-Watson statistic (see White p. 57). There was insufficient evidence to reject the null hypothesis of no autocorrelation at the 5% level in each of these tests.

An in-depth consideration of the SUR Model is now undertaken.

In a general specification of  $M$  seemingly unrelated regression equations the  $i$ th equation is given by:

$$y_i = X_i \beta_i + e_i \quad i = 1, 2, \dots, M \quad (5.1)$$

where  $y_i$  and  $e_i$  are of dimension  $(T \times 1)$ ,  $X_i$  is  $(T \times K_i)$  and  $\beta_i$  is  $(K_i \times 1)$ .

Combining all equations into one model yields:

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_M \end{bmatrix} = \begin{bmatrix} X_1 & 0 & \cdots & 0 \\ 0 & X_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & X_M \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_M \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_M \end{bmatrix} \quad (5.2)$$

or alternatively,

$$y = X\beta + e \quad (5.3)$$

where the dimensions of  $y$ ,  $X$ ,  $\beta$ , and  $e$  are  $(MT \times 1)$ ,  $(MT \times K)$ ,  $(K \times 1)$ , and  $(MT \times 1)$  respectively, with  $K = \sum_{i=1}^M K_i$ .

Consideration is now given to how the assumption of contemporaneous correlation is reflected in the error matrix of equations 5.1, 5.2, and 5.3.

$$e = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_M \end{bmatrix} \sim N \left[ \begin{pmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix}, E \begin{pmatrix} e_1 e_1' & e_1 e_2' & \cdots & e_1 e_M' \\ e_2 e_1' & e_2 e_2' & \cdots & e_2 e_M' \\ \vdots & \vdots & \ddots & \vdots \\ e_M e_1' & e_M e_2' & \cdots & e_M e_M' \end{pmatrix} \right] \quad (5.4)$$

Consider the generic off-diagonal block  $E[e_i e_j']$ . In full it is given by:

$$E[e_i e_j'] = E \left[ \begin{pmatrix} e_{ii} \\ e_{ij} \\ \vdots \\ e_{iT} \end{pmatrix} \begin{pmatrix} e_{ji} & e_{jj} & \cdots & e_{jT} \end{pmatrix} \right] = E \begin{bmatrix} e_{ii} e_{ji} & e_{ii} e_{jj} & \cdots & e_{ii} e_{jT} \\ e_{ij} e_{ji} & e_{ij} e_{jj} & \cdots & e_{ij} e_{jT} \\ \vdots & \vdots & \ddots & \vdots \\ e_{iT} e_{ji} & e_{iT} e_{jj} & \cdots & e_{iT} e_{jT} \end{bmatrix} \quad (5.5)$$

The elements on the diagonal of this matrix are the contemporaneous covariances. That is, they represent the covariance between the errors from the different equations (cross-sectional units) in the same time-period.

This covariance is denoted by  $\sigma_{ij}$ . That is:

$$\text{cov}(e_{it}, e_{jt}) = E[e_{it}e_{jt}] = \sigma_{ij} \quad t=1,2,\dots,T \quad (5.6)$$

The off-diagonal elements in the above matrix involve covariances between the errors from the two different equations in different time periods. Such covariances are assumed to be zero as below.

$$\text{cov}(e_{it}, e_{js}) = E[e_{it}e_{js}] = 0 \quad (t \neq s) \quad (5.7)$$

Substituting these results into equation 5.5 yields:

$$E[\mathbf{e}_i \mathbf{e}_j'] = \begin{bmatrix} \sigma_{ij} & 0 & \cdots & 0 \\ 0 & \sigma_{ij} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{ij} \end{bmatrix} = \sigma_{ij} I_T \quad (5.8)$$

If for notational convenience  $\sigma_i^2 = \sigma_{ii}$  and  $\sigma_j^2 = \sigma_{jj}$ , the covariance matrix for the complete error vector can be written as:

$$\Omega = E[\mathbf{ee}'] = \begin{bmatrix} \sigma_{11} I_T & \sigma_{12} I_T & \cdots & \sigma_{1M} I_T \\ \sigma_{21} I_T & \sigma_{22} I_T & \cdots & \sigma_{2M} I_T \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{M1} I_T & \sigma_{M2} I_T & \cdots & \sigma_{MM} I_T \end{bmatrix} = \Sigma \otimes I_T \quad (5.9)$$

where  $\otimes$  represents the Kronecker product and

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{21} & \sigma_{22} & \cdots & \sigma_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{M1} & \sigma_{M2} & \cdots & \sigma_{MM} \end{bmatrix}$$

The matrix  $\Sigma$  is, of course, symmetric, so that,  $\sigma_{ij} = \sigma_{ji}$ . It is also assumed to be nonsingular and hence positive definite.

Thus, the error matrix can be written as:

$$e = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_M \end{bmatrix} \sim N \left[ \begin{pmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{11}I_T & \sigma_{12}I_T & \cdots & \sigma_{1M}I_T \\ \sigma_{21}I_T & \sigma_{22}I_T & \cdots & \sigma_{2M}I_T \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{M1}I_T & \sigma_{M2}I_T & \cdots & \sigma_{MM}I_T \end{pmatrix} \right] \quad (5.10)$$

In practice the variances and covariances ( $\sigma_{ij}$ ) are unknown and must be estimated, with their estimates being used to form the SUR estimator.

Following Eleswarapu (1997) and Chan, Hamao, and Lakonishok (1991) linear restrictions were imposed so that the coefficient of each variable (other than return on market) is the same across equations. The imposition of such linear restrictions is common in the SUR framework. Zellner (1962) pointed out that if the coefficient vectors for each equation are all equal,  $\beta_1 = \beta_2 = \dots = \beta_M$ , the use of data aggregated over microunits does not lead to aggregation bias.

The authors Eleswarapu (1997) and Chan, Hamao, and Lakonishok (1991) do not provide any evidence to suggest that they conducted tests before the restrictions were imposed to assess their appropriateness. In this research, tests were conducted to check that the restrictions are indeed realistic, before they were imposed on the SUR Model.

A set of  $q$  linear restrictions may be written in the form  $R\beta = r$  where  $R$  and  $r$  are known matrices of dimensions  $(q \times P)$  and  $(q \times 1)$  respectively.

Turning to the question of testing  $H_0: R\beta = r$  against the alternative  $H_1: R\beta \neq r$ , it is noted that when  $H_0$  is true,

$$R\hat{\beta} \sim N(r, RCR')$$

$$\text{where } C = [X'(\Sigma^{-1} \otimes I)X]^{-1}$$

$$\text{Thus } g = \left( R \hat{\beta} - r \right)' \left( RCR' \right)^{-1} \left( R \hat{\beta} - r \right) \sim \chi_{(q)}^2$$

This result is a finite sample one (providing the errors are normally distributed), but it is not operational because it depends on the unknown covariance matrix  $\Sigma$ . When  $\Sigma$  is replaced by  $\hat{\Sigma}$ , we have the asymptotic result

$$\hat{g} = \left( R \hat{\hat{\beta}} - r \right)' \left( R \hat{C} R' \right)^{-1} \left( R \hat{\hat{\beta}} - r \right) \xrightarrow{d} \chi_{(q)}^2$$

Since the above equation holds only when the null hypothesis of  $R\beta = r$  is true, the null hypothesis is rejected if a calculated value for  $\hat{g}$  exceeds the appropriate critical value from a  $\chi_{(q)}^2$  distribution.

The results of these tests (see Chapters Six and Seven), indicate that the imposition of such restrictions is appropriate in some instances and inappropriate in others. In spite of this, the estimation of a restricted SUR was proceeded with due to the desire to have one set of results for the whole market for each country rather than separate results for each portfolio.

The first step in the SUR estimation procedure is the estimation of the  $\sigma_{ij}$  from OLS residuals as:

$$\hat{\sigma}_{ij} = \frac{1}{N} \left( y_i - X_i \hat{\beta}_{OLS,i} \right) \left( y_j - X_j \hat{\beta}_{OLS,j} \right)$$

$$\text{where } \hat{\beta}_{OLS,i} = \left( X_i' X_i \right)^{-1} X_i' y_i.$$

With the matrix  $\hat{\Sigma}$  containing individual elements,  $\hat{\sigma}_{ij}$ , the restricted SUR estimator, is obtained by minimising:

$$(y - X\beta)' \left( \hat{\Sigma}^{-1} \otimes I \right) (y - X\beta)$$

subject to the linear restrictions  $R\beta = r$ .

The restricted SUR estimator is:

$$\hat{\beta}_{\text{SUR}_R} = \hat{\beta} + \hat{C} R' (R \hat{C} R')^{-1} (r - R \hat{\beta})$$

where

$$\hat{C} = \left[ X' \left( \hat{\Sigma}^{-1} \otimes I \right) X \right]^{-1}$$

and

$$\hat{\beta} = \hat{C} X' \left( \hat{\Sigma}^{-1} \otimes I \right) y$$

The generalised  $R^2$  measure for the SUR Model,  $\tilde{R}^2$ , indicates the proportion of the generalised variance in  $Y$  “explained” by variation in the right-hand side variables in the system of equations, and is computed as follows:

$$\tilde{R}^2 = 1 - \frac{|EE|}{|Y_* Y_*|}$$

where  $Y_*$  is an  $(N \times M)$  matrix with column  $i$  containing the observations of the left hand side variable for equation  $i$ , measured as deviations from the sample mean, and

$E$  is an  $(N \times M)$  matrix with estimated residuals for equation  $i$  in column  $i$ . This statistic is frequently very high and should be interpreted with caution.<sup>8</sup>

## 5.5 Cross-Sectionally Correlated and Timewise Autoregressive (CSCTA) Model

Attention is now turned to the CSCTA Model.

This model can be written as:

$$Y_{it} = \beta_0 + \beta_1 X_{it,1} + \beta_2 X_{it,2} + \dots + \beta_K X_{it,K} + e_{it}$$

$$(i = 1, 2, \dots, N; t = 1, 2, \dots, T)$$

where  $N$  represents cross-sectional units and  $T$  represents periods of time.

The assumptions underlying the CSCTA Model are as follows:

1. All disturbances have a zero mean.

$$E[e_{it}] = 0 \quad \text{for } i = 1, 2, \dots, N; \quad t = 1, 2, \dots, T$$

2. In a given cross-sectional unit, the disturbance variance is constant over time, but each cross-sectional unit can have a different variance.

$$\text{var}(e_{it}) = E(e_{it}^2) = \sigma_{ii} \quad i = 1, 2, \dots, N$$

3. Two disturbances in different cross-sections but corresponding to the same time period are correlated (contemporaneous correlation).

$$\text{covar}(e_{it}, e_{jt}) = E[e_{it}e_{jt}] = \sigma_{ij} \quad i, j = 1, 2, \dots, N$$

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<sup>8</sup> See Berndt (1991, p. 468) for more discussion.

4. Disturbances in successive time periods in the same cross-sectional unit are correlated. i.e. first order autocorrelation within each cross-sectional unit can exist.

$$e_{it} = \rho_i e_{i,t-1} + u_{it}$$

where  $u_{it} \sim N(0, \phi_{ii}), \quad E(e_{i,t-1} u_{jt}) = 0,$   
 $E(u_{it} u_{jt}) = \phi_{ij}, \quad E(u_{it} u_{js}) = 0 \quad (t \neq s),$

$$\sigma_{ii} = \frac{\phi_{ii}}{1 - \rho_i^2}, \quad \sigma_{ij} = \frac{\phi_{ij}}{1 - \rho_i \rho_j},$$

$$i, j = 1, 2, \dots, N,$$

$$t = 1, 2, \dots, T.$$

The initial value of  $e$  is assumed to have these properties:

$$e_{i1} \sim N\left(0, \frac{\phi_{ii}}{1 - \rho_i^2}\right), \quad E(e_{i1} e_{j1}) = \frac{\phi_{ij}}{1 - \rho_i \rho_j}$$

Assumptions 1, 2, and 3 are similar to the first three SUR assumptions. However, unlike the SUR Model, the CSCTA Model accounts for first order autocorrelation within each cross-sectional unit. This property is particularly attractive, given that there is first order autocorrelation in some of the cross-sectional units of the data.

In the CSCTA Model, the restricted error matrix  $\Omega$  is as follows:

$$\Omega = \begin{bmatrix} \sigma_{11} V_{11} & \sigma_{12} V_{12} & \cdots & \sigma_{1N} V_{1N} \\ \sigma_{21} V_{21} & \sigma_{22} V_{22} & \cdots & \sigma_{2N} V_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{N1} V_{N1} & \sigma_{N2} V_{N2} & \cdots & \sigma_{NN} V_{NN} \end{bmatrix} \quad (5.11)$$

where  $\sigma_{11} \dots \sigma_{NN}$  are the cross-sectional error variances and covariances, and  $V$  is the matrix of powers of correlation coefficients of  $\rho_i$ , as shown below:

$$V_{ij} = \begin{bmatrix} 1 & \rho_j & \rho_j^2 & \dots & \rho_j^{T-1} \\ \rho_i & 1 & \rho_j & \dots & \rho_j^{T-2} \\ \rho_i^2 & \rho_i & 1 & \dots & \rho_j^{T-2} \\ \vdots & \vdots & \vdots & & \vdots \\ \rho_i^{T-1} & \rho_i^{T-2} & \rho_i^{T-3} & \dots & 1 \end{bmatrix} \quad (5.12)$$

To obtain consistent estimates of the elements of equation 5.11, the following process was undertaken. First, the ordinary least squares method was applied to all  $N \times T$  observations. The resulting estimates, which are unbiased and consistent, were then used to calculate the regression residuals  $e_{it}$ . From these residuals, consistent estimates of  $\rho_i$ , say  $\hat{\rho}_i$ , were obtained. When  $T$  is small,  $\hat{\rho}_i$  may exceed one in absolute value. To avoid this possibility,  $\rho_i$  was estimated by the sample coefficient of correlation between  $e_{it}$  and  $e_{i,t-1}$ , i.e., by,

$$\hat{\rho}_i = \frac{\sum e_{it} e_{i,t-1}}{\sqrt{\sum e_{it}^2} \sqrt{\sum e_{i,t-1}^2}} \quad (t = 2, 3, \dots, T)$$

The value of this consistent estimator of  $\rho_i$ , is confined to the interval  $[-1, 1]$  for any sample size.

Next, the  $\hat{\rho}_i$ 's were used to transform the observations. That is the following were formed:

$$Y_{it}^* = \beta_1 X_{it,1}^* + \beta_2 X_{it,2}^* + \dots + \beta_K X_{it,K}^* + u_{it}^* \quad (5.13)$$

where:

$$Y_{it}^* = \sqrt{1 - \hat{\rho}_i^2} Y_{it} \quad \text{for } t = 1,$$

$$Y_{it}^* = Y_{it} - \hat{\rho}_i Y_{i,t-1} \quad \text{for } t = 2, 3, \dots, T,$$

and

$$X_{it,k}^* = \sqrt{1 - \hat{\rho}_i^2} X_{it,k} \quad \text{for } t = 1,$$

$$X_{it,k}^* = X_{it,k} - \hat{\rho}_i X_{i,t-1,k} \quad \text{for } t = 2, 3, \dots, T,$$

$$k = 1, 2, \dots, K$$

$$i = 1, 2, \dots, N$$

The purpose here was to estimate  $\sigma_i^2$  from observations that are, at least asymptotically, nonautoregressive since estimated variances based on autoregressive disturbances are, in general, biased. The ordinary least squares method was again applied to equation 5.13 and the residuals  $\hat{u}_{it}^*$  calculated. The variances and covariances of the errors (i.e.  $\sigma_{ij}$ ) were then estimated by:

$$s_{ij} = \frac{\hat{\phi}_{ij}}{1 - \hat{\rho}_i \hat{\rho}_j},$$

where

$$\hat{\phi}_{ij} = \frac{1}{T - K} \sum_{t=1}^T \hat{u}_{it}^* \hat{u}_{jt}^*$$

Having obtained consistent estimates of  $\rho_i$  and  $\sigma_{ij}$ , the task of deriving consistent estimators of the elements of  $\Omega$  is completed. By substituting for  $\hat{\Omega}$  in

$$\hat{\beta} = \left( X' \hat{\Omega}^{-1} X \right)^{-1} \left( X' \hat{\Omega}^{-1} y \right) \quad \text{and} \quad \left( X' \hat{\Omega}^{-1} X \right)^{-1}$$

the desired estimates of the regression coefficients and their variances are obtained.

The Buse (1973)  $R^2$ , which is used as a measure of goodness-of-fit, is calculated as:

$$R^2 = 1 - \frac{e' \Omega^{-1} e}{(Y - DY)' \Omega^{-1} (Y - DY)} \quad \text{with } D = \frac{l' \Omega^{-1}}{l' \Omega^{-1} l}$$

(where  $l$  is an  $N \times 1$  vector of ones).

## 5.6 Specific Models Used

Consideration is now given to the models that are used to estimate the relationship between each liquidity proxy and return.

### 5.6.1 New Zealand Return-Spread Models

The Basic SUR Model used to test the relationship between return and spread in the New Zealand stock market is as follows:

$$R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Size}_{pt} + \gamma_3 \text{BM}_{pt} + \beta_p R_{mt} + \eta_{pt}$$

$p = 1, 2, 3$  ( $p$  represents the portfolio).

$t = 1, 2, 3, \dots, 60$  ( $t$  represents the month).

where:

- $R_{pt}$  is the excess return of portfolio  $p$  in month  $t$ .

- $\text{Spread}_{pt}$  is the spread of portfolio  $p$  in month  $t$ .

- $\text{Size}_{pt}$  is the log(size) of portfolio  $p$  in month  $t$ .

- $\text{BM}_{pt}$  is the log(book-to-market) ratio of portfolio  $p$  in month  $t$ .

- $R_{mt}$  is the excess return of the market index in month  $t$ .

This model's major purpose is to determine the relationship between return and spread. The other three variables, which have been found by previous studies to influence return (see Chapter One), are included as control variables.

As was mentioned earlier, the SUR Model is restricted so that the coefficient of each of the variables, other than return on market (hereafter  $R_m$ ), is the same across each cross-sectional unit (portfolios). There is no need to impose this constraint on  $R_m$  because a system beta (the coefficient of  $R_m$ ) is of no interest. Beta is a measure of the relationship between an individual security's (or portfolio's) return and  $R_m$ . Thus the beta for the whole system, which should be very close to one, is meaningless.

Unlike the SUR Model, the CSCTA Model automatically constrains the coefficient of each variable (including  $R_m$ ) to be the same across portfolios. The Basic CSCTA Model used to test the relationship between return and spread in the New Zealand market is as follows:

$$R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta R_{mt} + \eta_{pt}$$

$p = 1, 2, 3$  ( $p$  represents the portfolio).

$t = 1, 2, 3, \dots, 60$  ( $t$  represents the month).

Comparison of the SUR and corresponding CSCTA Models reveals that the difference between these two models lies in the coefficient of  $R_{mt}$ . In the SUR Model the coefficient of  $R_{mt}$  is  $\beta_p$ , indicating that  $\beta$  is allowed to vary across portfolios. However, in the CSCTA Model the coefficient of  $R_{mt}$  is  $\beta$  indicating that there is only one  $\beta$  for the whole model.

The SUR and CSCTA Models used to test for a seasonal relationship between return and spread in the New Zealand market are as follows:

**SUR**

$$R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanSize_{pt} + \gamma_7 JanBM_{pt} + \eta_{pt}$$

**CSCTA**

$$R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanSize_{pt} + \gamma_7 JanBM_{pt} + \eta_{pt}$$

$p = 1,2,3$  ( $p$  represents the portfolio).

$t = 1,2,3,\dots,60$  ( $t$  represents the month).

where:

- $Jan_{pt}$  is a dummy variable that takes on the value of one in January months and zero in non-January months.

- $JanSpread_{pt}$  is a dummy variable that takes on the value of  $Spread_{pt}$  in January months and zero in non-January months.

- $JanSize_{pt}$  is a dummy variable that takes on the value of  $Size_{pt}$  in January months and zero in non-January months.

- $JanBM_{pt}$  is a dummy variable that takes on the value of  $BM_{pt}$  in January months and zero in non-January months.

These models are used to determine whether the relationship between return and spread is unique to January months. The relationship between return and both size and BM in January and non-January months is also considered.

**5.6.2 New Zealand Return-Turnover Models**

The Basic SUR and CSCTA Models used to test the relationship between return and turnover rate in the New Zealand market are as follows:

**SUR**

$$R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Size}_{pt} + \gamma_3 \text{BM}_{pt} + \beta_p Rm_t + \eta_{pt}$$

**CSCTA**

$$R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Size}_{pt} + \gamma_3 \text{BM}_{pt} + \beta_p Rm_t + \eta_{pt}$$

$p = 1,2,3$  ( $p$  represents the portfolio).

$t = 1,2,3,\dots,60$  ( $t$  represents the month).

where:

-*Turnover* is the Turnover Rate of portfolio  $p$  in month  $t$ .

The SUR and CSCTA Models used to test for a seasonal relationship between return and turnover rate in the New Zealand market are as follows:

**SUR**

$$R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Size}_{pt} + \gamma_3 \text{BM}_{pt} + \beta_p Rm_t + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanTurnover}_{pt} + \gamma_6 \text{JanSize}_{pt} + \gamma_7 \text{JanBM}_{pt} + \eta_{pt}$$

**CSCTA**

$$R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Size}_{pt} + \gamma_3 \text{BM}_{pt} + \beta_p Rm_t + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanTurnover}_{pt} + \gamma_6 \text{JanSize}_{pt} + \gamma_7 \text{JanBM}_{pt} + \eta_{pt}$$

$p = 1,2,3$ . ( $p$  represents the portfolio).

$t = 1,2,3,\dots,60$ . ( $t$  represents the month).

where:

-*JanTurnover* <sub>$pt$</sub>  is a dummy variable that takes on the value of *Turnover* <sub>$pt$</sub>  in January months and zero in non-January months.

### 5.6.3 New Zealand Return-Amortised Spread Models

The Basic SUR and CSCTA Models used to test the relationship between return and amortised spread in the New Zealand market are as follows:

#### SUR

$$R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta_p Rm_t + \eta_{pt}$$

#### CSCTA

$$R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta Rm_t + \eta_{pt}$$

$p = 1,2,3$ . ( $p$  represents the portfolio).

$t = 1,2,3,\dots,60$ . ( $t$  represents the month).

where:

- $Am.Spread_{pt}$  is the Amortised Spread of portfolio  $p$  in month  $t$ .

The SUR and CSCTA Models used to test for a seasonal relationship between return and amortised spread in the New Zealand market are as follows:

#### SUR

$$R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanSize_{pt} + \gamma_7 JanBM_{pt} + \eta_{pt}$$

#### CSCTA

$$R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Size_{pt} + \gamma_3 BM_{pt} + \beta Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanSize_{pt} + \gamma_7 JanBM_{pt} + \eta_{pt}$$

$p = 1,2,3$ . ( $p$  represents the portfolio).

$t = 1,2,3,\dots,60$ . ( $t$  represents the month).

where:

- $JanAm.Spread_{pt}$  is a dummy variable that takes on the value of  $Am.Spread_{pt}$  in January months and zero in non-January months.

The models used to test the return-liquidity relationship in the Australian market are identical to their New Zealand counterparts in all but two aspects. Calculating the book-to-market ratios of the Australian companies was not possible due to the unavailability of data, so there is no BM or JanBM variables in the Australian regressions. The second difference relates to the time period studied and the number of portfolios used. For the New Zealand market there is five years of data so  $t = 1, 2, 3, \dots, 60$  ( $t$  represents a month) and three portfolios so  $p = 1, 2, 3$ . For the Australian market there is four years of data ( $t = 1, 2, 3, \dots, 48$ ) and ten portfolios ( $p = 1, 2, 3, \dots, 10$ ).

# PART THREE

## RESULTS & ANALYSIS

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Part Three presents the results of this thesis, together with a discussion of their implications. Chapter Six provides the results from the New Zealand market. This chapter includes summary statistics, results of the tests undertaken to assess the relevance of the Seemingly Unrelated Regression (SUR) and Cross-Sectionally Correlated Timewise Autoregressive (CSCTA) Models, and the regression results from these two models. Interpretations of the results are also included. Chapter Seven, which presents the Australian results follows an identical format to Chapter Six. This means that the New Zealand and Australian results can be read independently. Chapter Eight discusses the results described in Chapters Six and Seven. A comparison of the New Zealand and Australian results is made. These results are then compared to those of earlier studies in this area. A detailed analysis is undertaken, with explanations provided for observed differences.

## Chapter Six New Zealand Results

### 6.1 New Zealand Data Characteristics

Table 6.1 outlines the number of stocks included in the portfolios, which were formed based on each of the three liquidity proxies. For each liquidity proxy, each year, stocks were placed in one of three portfolios based on their level of the liquidity proxy in the previous year. Data was gathered for every company listed on the New Zealand Stock Exchange (NZSE) over the period 1993-98 that met the portfolio formation criteria described in Chapter Four. However, the 1993 data was only used to form the 1994 portfolios. Accordingly, this chapter only includes data pertaining to the five test years (1994-98).

**Table 6.1**  
**Number of New Zealand Companies Used in Analysis**

Liquidity Proxy	1994	1995	1996	1997	1998
Spread	92	108	110	113	118
Turnover	96	105	112	112	116
Amortised Spread	87	101	108	109	112

Summary statistics for the three portfolios formed for each liquidity proxy are included in Tables 6.2 – 6.4. Return, spread, turnover, amortised spread, and beta are all expressed in decimal (rather than percentage) form. The book-to-market ratio (of which the logarithm is taken) is also expressed as a decimal. Log(size) is the logarithm of total market capitalisation, which is measured in dollars.

**Table 6.2**  
**Spread Model Summary Statistics (New Zealand)**

The figures for each portfolio represent the time-series average over the period 1994-98.

Portfolio	Return	Spread	Beta	Log(Size)	Log(BM)
1	0.0013	0.0161	1.0077	19.669	-0.7324
2	0.0015	0.0311	1.0437	18.107	-0.6576
3	0.0023	0.1080	1.0599	16.286	-0.2766
Average	0.0017	0.0517	1.0371	18.207	-0.5555

**Table 6.3**  
**Turnover Model Summary Statistics (New Zealand)**

The figures for each portfolio represent the time-series average over the period 1994-98.

Portfolio	Return	Turnover	Beta	Log(Size)	Log(BM)
1	-0.0016	0.0363	1.0332	18.435	-0.5352
2	0.0005	0.0164	1.0552	18.143	-0.5954
3	0.0078	0.0080	1.0001	17.328	-0.4578
Average	0.0023	0.0202	1.0295	17.969	-0.5295

**Table 6.4**  
**Amortised Spread Model Summary Statistics (New Zealand)**

The figures for each portfolio represent the time-series average over the period 1994-98.

Portfolio	Return	Am.Spread	Beta	Log(Size)	Log(BM)
1	0.0007	0.0003	0.9517	19.053	-0.6313
2	0.0009	0.0005	1.0654	18.217	-0.6139
3	0.0041	0.0011	0.9787	16.831	-0.3790
Average	0.0019	0.0006	0.9986	18.034	-0.5414

The beta of each portfolio was estimated by means of an Ordinary Least Squares (OLS) regression of the sixty monthly portfolio excess returns<sup>1</sup> against the corresponding monthly excess market returns.<sup>2</sup> Brailsford, Faff, and Oliver (1997) advocated the use of four to five years of monthly return data when estimating beta. However, Bartholody, Fox, Gilbert, Hibbard, McNoe, Potter, Shi, and Watt (1996) found that beta estimation with a Market Model (OLS regression) and five years of monthly data is less than perfect in the New Zealand market, so the portfolio beta estimates should be interpreted with caution.

<sup>1</sup> Excess returns were calculated as the actual return minus the 90 Day Bank Bill rate.

<sup>2</sup> An equally weighted market index was used.

The Seemingly Unrelated Regression (SUR) and the Cross-Sectionally Correlated and Timewise Autoregressive (CSCTA) techniques both simultaneously estimate beta, so the beta estimates that were obtained using the Market Model are only presented in the Summary Statistics Tables and used in the Correlation Matrices. The relationship between return and the explanatory variables is discussed in detail in Sections 6.2 and 6.3. However, based on the results in Tables 6.2 – 6.4, it would appear that there is a positive relationship between return and illiquidity and a negative relationship between return and log(size). The relationship between return and beta, and return and log(BM) is less clear. The relationship between the explanatory variables is considered in detail in the correlation matrices (Tables 6.6 – 6.8).

Excess returns were analysed in more detail to see whether there is any evidence of seasonality, in particular a January effect. Table 6.5 displays the results.

**Table 6.5**  
**Return Seasonality (New Zealand)**

The figures represent cross-sectional (across portfolios) and time-series (for the period 1994-98) averages.

	Spread Portfolios	Turnover Portfolios	Am.Spread Portfolios
Januaries only	0.0205	0.0165	0.0210
Non-Januaries only	0.0006	0.0015	0.0001
All Months	0.0023	0.0027	0.0019

These results indicate that excess returns are consistently larger in January months. A January dummy variable is included in the regression analysis to determine if the larger returns in January months are statistically significant.

Consideration is now given to the correlation coefficients. These were measured, for each liquidity proxy, across the three portfolios and across time (1994-98). A description on how the non-beta variables were computed can be found in Chapter Four. As described earlier, the beta value of each portfolio was estimated using OLS regression.

**Table 6.6****Spread Model Correlation Coefficients (New Zealand)**

The correlation coefficients were measured across the spread portfolios across time (1994-98).

Variable	Spread	Beta	Log(Size)	Log(BM)
Spread	1			
Beta	0.2831	1		
Log(Size)	-0.5411	0.4799	1	
Log(BM)	0.6951	0.0166	-0.6147	1

**Table 6.7****Turnover Model Correlation Coefficients (New Zealand)**

The correlation coefficients were measured across the turnover portfolios across time (1994-98).

Variable	Turnover	Beta	Log(Size)	Log(BM)
Turnover	1			
Beta	0.1879	1		
Log(Size)	0.3738	0.6251	1	
Log(BM)	-0.1919	-0.2902	-0.3646	1

**Table 6.8****Amortised Spread Model Correlation Coefficients (New Zealand)**

The correlation coefficients were measured across the amortised spread portfolios across time (1994-98).

Variable	Am.Spread	Beta	Log(Size)	Log(BM)
Am.Spread	1			
Beta	0.0437	1		
Log(Size)	-0.2410	0.6597	1	
Log(BM)	0.2402	-0.2668	-0.5216	1

Examination of Tables 6.6 – 6.8 reveals that the highest correlation coefficient is 0.6951. This indicates that collinearity is not a major problem in any of the three models.<sup>3</sup>

Bearing in mind that increased liquidity is indicated by decreased spread and amortised spread but increased turnover, it is evident that there is a positive relationship between liquidity and size. Large firms tend to have lower spreads and amortised spreads and higher turnover rates.

<sup>3</sup> As previously explained, the return on market (Rm) variable was used in the regression analysis instead of beta. While not included in Tables 6.6 – 6.8, the correlation coefficients of Rm and the non-Rm variables (excluding beta) were also calculated. The largest absolute value of these is 0.4.

Similarly, growth firms (those with low book-to-market ratios) tend to be more liquid. No consistent relationship between liquidity and beta is evident. This could well be due to inaccurate estimation of beta and / or liquidity. The conclusions made so far need to be qualified with the observation that the size of the correlation coefficients is relatively small in most instances.

A consistent, reasonably strong, positive relationship between beta and size is evident across the three liquidity proxy models. This indicates that large firms tend to have higher betas on average. In other words, large firms are more risky than their smaller counterparts.

There is no consistent relationship between beta and the book-to-market ratio across the three liquidity proxy models. Inaccurate beta estimation is a possible explanation.

Interestingly, a consistent negative relationship between size and book-to-market ratio is evident across the three liquidity models. This indicates that value firms tend to have smaller market capitalisations.

The issue of seasonality in the three liquidity proxies is considered in Table 6.9. The monthly figures represent cross-sectional (across portfolios) and time-series (for the period 1994-98) averages of each liquidity proxy.

**Table 6.9**  
**Seasonality of Liquidity Proxies (New Zealand)**  
 Each figure represents the monthly average of the three portfolios.

<b>Month</b>	<b>Average Spread</b>	<b>Average Turnover</b>	<b>Average Am.Spread</b>
January	0.0521	0.0166	0.0005
February	0.0536	0.0214	0.0006
March	0.0506	0.0242	0.0007
April	0.0449	0.0201	0.0004
May	0.0491	0.0184	0.0005
June	0.0514	0.0185	0.0005
July	0.0454	0.0260	0.0005
August	0.0441	0.0198	0.0005
September	0.0531	0.0181	0.0006
October	0.0547	0.0213	0.0006
November	0.0583	0.0232	0.0012
December	0.0636	0.0205	0.0007

Table 6.9 indicates that there is no consistent seasonality in the three liquidity proxies. Spreads are lowest in August and highest in December. Turnover rates are lowest in January and highest in July. Amortised spreads are lowest in April and highest in November.

Consideration is now given to the issue of time-variation in each of the three liquidity proxies. The yearly figures represent cross-sectional (across portfolios) averages for each liquidity proxy.

**Table 6.10**  
**Time-Variation in Liquidity Proxies (New Zealand)**  
 Each figure represents the yearly average of the three portfolios.

<b>Year</b>	<b>Average Spread</b>	<b>Average Turnover</b>	<b>Average Am.Spread</b>
1994	0.0504	0.0195	0.0008
1995	0.0569	0.0172	0.0006
1996	0.0421	0.0186	0.0005
1997	0.0448	0.0204	0.0005
1998	0.0645	0.0255	0.0006

In addition to no consistent seasonality, there appears to be inconsistent time-variation among the three liquidity proxies. Spreads are lowest in 1996 and highest in 1998. Turnover rates are lowest in 1995 and highest in 1998. Amortised spreads are lowest in 1997 and highest in 1994.

This finding of no consistent seasonality and time-variation across the three liquidity proxies does not necessarily indicate that all three liquidity proxies are inaccurate. For instance, it is possible that amortised spread is a very good proxy of the true level of liquidity, and spread and turnover are both poor proxies.

The results of the tests that were carried out to assess the appropriateness of the SUR and CSCTA Models are now considered. Details of these tests can be found in Chapter Five.

The Lagrange Multiplier test was used to investigate the existence of contemporaneous (same time period) correlation among the cross sectional units (portfolios). A description of the models employed for each liquidity proxy is included first, followed by the Lagrange Multiplier results for each model. The term “Basic Model” refers to the model for each liquidity proxy that excludes the January dummy variables. The term “Full Model” is used to indicate the model for each liquidity proxy that includes the January dummy variables.

## Basic Models

### Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 \text{Log(BM)}_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \gamma_3 \text{Log(BM)}_{pt} + \beta_p Rm_t + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \gamma_3 \text{Log(BM)}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

### Turnover

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 \text{Log(BM)}_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \gamma_3 \text{Log(BM)}_{pt} + \beta_p R_{mt} + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \gamma_3 \text{Log(BM)}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

### Amortised Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 \text{Log(BM)}_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta_p R_{mt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \gamma_3 \text{Log(BM)}_{pt} + \beta_p R_{mt} + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \gamma_3 \text{Log(BM)}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

**Table 6.11**

#### Basic Model Breusch-Pagan Lagrange Multiplier Statistics (New Zealand)

The Breusch-Pagan Lagrange Multiplier was used to test for the existence of contemporaneous correlation among the three portfolios in each Basic Liquidity Proxy Model (models with no January dummy variables). The null hypothesis of each test is no contemporaneous correlation.

	DF	Spread	Model Turnover	Am.Spread
A	3	108.58***	110.42***	106.66***
B	3	110.17***	119.40***	107.96***
C	3	109.80***	117.79***	107.45***
D	3	50.79***	34.26***	49.47***
E	3	49.82***	34.67***	48.63***
F	3	105.43***	105.89***	105.86***

\*\*\* significant at 1% level

Under the null hypothesis of a diagonal covariance structure (i.e. no contemporaneous correlation) the Breusch-Pagan Lagrange Multiplier statistic has an asymptotic  $\chi^2_{(M(M-1)/2)}$  distribution ( $M$  is the number of cross-section units).

The results in Table 6.11 indicate that there is very strong statistical evidence to reject the null hypothesis of no contemporaneous correlation. This confirms the

appropriateness of the use of SUR and CSCTA techniques (which both account for contemporaneous correlation) to estimate the Basic Models.

## Full Models

### Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

### Turnover

$$(A) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanTurnover_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanTurnover_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(G) \quad R_{pt} = \alpha + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

### Amortised Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

( $t = 1, 2, 3, \dots, 60$ , and  $p = 1, 2, 3$ ).

**Table 6.12**

**Full Model Breusch-Pagan Lagrange Multiplier Statistics (New Zealand)**

The Breusch-Pagan Lagrange Multiplier was used to test for the existence of contemporaneous correlation among the portfolios in each Full Liquidity Proxy Model (models with January dummy variables). The null hypothesis of each test is no contemporaneous correlation.

	DF	Spread	Model Turnover	Am.Spread
A	3	52.07***	34.78***	51.54***
B	3	51.03***	34.79***	50.15***
C	3	89.55***	96.27***	85.52***
D	3	98.42***	95.88***	85.30***
E	3	101.51***	105.11***	87.36***
F	3		104.66***	
G	3		104.40***	

\*\*\* significant at 1% level

The results in Table 6.12 indicate that there is also very strong statistical evidence to reject the null hypothesis of no contemporaneous correlation in the Full Models.

This indicates that the use of both the SUR and CSCTA Models to estimate the Full Models is also appropriate.

The issue of homoskedasticity is now considered. Both the SUR and CSCTA Models are based on the assumption of homoskedasticity (constant disturbance variance) within each cross-sectional unit, so tests were conducted within each portfolio. The results presented in Table 6.13 relate to the Full Model for each liquidity proxy.<sup>4</sup>

<sup>4</sup> The Breusch-Pagan diagnostic test was also conducted on the respective Basic Models. There was insufficient evidence, at the 10% level of significance, to reject the null hypothesis of homoskedasticity within each portfolio in each of these tests.

**Table 6.13****Full Model Breusch-Pagan Homoskedasticity Test Results (New Zealand)**

The Breusch-Pagan Test was conducted separately for each portfolio for each liquidity proxy using the respective Full Models (the models that include the January dummy variables). The null hypothesis of each test is homoskedasticity.

<b>Portfolio</b>	<b>Portfolio Number</b>	<b>DF</b>	<b>Chi-square statistic</b>
Spread	1	7	10.082
	2	7	7.463
	3	7	2.550
Turnover	1	7	5.721
	2	7	11.749
	3	7	2.894
Am.Spread	1	7	0.638
	2	7	4.249
	3	7	11.951

Under the null hypothesis that homoskedasticity exists, the Breusch-Pagan test has a large sample approximate  $\chi^2_{(S)}$  distribution, with the number of degrees of freedom  $S$  being equal to the number of explanatory variables. The results displayed in Table 6.13 show that the null hypothesis of homoskedasticity within each portfolio is not rejected at the 10% significance level in the Full Models for each of the three liquidity proxies.

The SUR Model relies on the assumption of no autocorrelation, while the CSCTA Model accounts for first order autocorrelation. The Durbin-Watson test for first order autocorrelation was used to determine whether the CSCTA Model is superior to the SUR Model based on this feature.<sup>5</sup>

The results of these tests, which were conducted separately for each portfolio within each liquidity proxy model, are included in Table 6.14. The Full Model was used in the tests.

<sup>5</sup> As mentioned in Chapter Five, a variant of the Durbin Watson test (see White, 1997, p. 83) was used to test for second to twelfth order autocorrelation in each portfolio for each liquidity proxy (the Full Model was used). There was insufficient evidence (at the 5% level) to reject the null hypothesis of no autocorrelation in each of these tests.

**Table 6.14**  
**Full Model Durbin-Watson Test Results (New Zealand)**

The Durbin-Watson Test was conducted separately for each portfolio for each liquidity proxy using the respective Full Models (the models that include the January dummy variables). The null hypothesis of each test is no first order autocorrelation.

Model	Portfolio Number	RHO	D-W Statistic
Spread	1	+ve	1.243**
	2	+ve	1.959
	3	+ve	1.938
Turnover	1	-ve	1.964
	2	-ve	2.211
	3	-ve	2.972***
Am.Spread	1	+ve	1.980
	2	-ve	2.824***
	3	-ve	2.224

\*\*\* significant at 1% level

\*\* significant at 5% level

The coefficient of Rho indicates the sign of the first order autocorrelation. For the Spread Model the null hypothesis of no first order autocorrelation in portfolio one is rejected at the 5% significance level. For the Turnover and Amortised Spread Models, the null hypothesis of no first order autocorrelation is rejected at the 1% significance level for portfolios three and two respectively. Therefore, there are benefits in estimating each of the liquidity models using the CSCTA Model rather than the SUR Model.

As was discussed in Chapter Five, this study adopts a variant of the general SUR Model where the coefficients of each variable, other than return on market (hereafter Rm), are restricted to be the same across cross-sectional units (portfolios). The CSCTA Model constrains the coefficients of every variable, including Rm, to be the same across portfolios.

The appropriateness of such restrictions was investigated with two types of tests. The first series of tests, which have the null hypothesis that the coefficient of each variable is the same across portfolios, were computed separately for each variable. The second test has the null hypothesis that the coefficients of each like variable are all the same across portfolios. Each series of tests was conducted for each of the three liquidity proxy models. The results of the first series of tests are presented first, followed by the results of the second test.

**Table 6.15**  
**Results of Tests for Variable Coefficient Equality Across Portfolios in the Spread Model (New Zealand)**

Each of the tests has the null hypothesis that the coefficient of each variable is the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

<b>Variable</b>	<b>DF</b>	<b>Wald Chi-square statistic</b>
Spread	2	12.139 <sup>***</sup>
Log(BM)	2	0.597
Log(Size)	2	0.732
Rm	2	0.223
Jan	2	4.805 <sup>*</sup>
JanSpread	2	4.739 <sup>*</sup>
JanLog(BM)	2	0.357
JanLog(Size)	2	4.621 <sup>*</sup>

\*\*\* significant at 1% level

\* significant at 10% level

**Table 6.16**  
**Results of Tests for Variable Coefficient Equality Across Portfolios in the Turnover Model (New Zealand)**

Each of the tests has the null hypothesis that the coefficient of each variable is the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

<b>Variable</b>	<b>DF</b>	<b>Wald Chi-square statistic</b>
Turnover	2	1.223
Log(BM)	2	0.905
Log(Size)	2	1.699
Rm	2	0.317
Jan	2	2.273
JanTurnover	2	0.009
JanLog(BM)	2	6.420 <sup>**</sup>
JanLog(Size)	2	2.399

\*\* significant at 5% level

**Table 6.17**  
**Results of Tests for Variable Coefficient Equality Across Portfolios in the Amortised Spread Model (New Zealand)**

Each of the tests has the null hypothesis that the coefficient of each variable is the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

<b>Variable</b>	<b>DF</b>	<b>Wald Chi-square statistic</b>
Am.Spread	2	3.481
Log(BM)	2	1.494
Log(Size)	2	1.022
Rm	2	5.899*
Jan	2	4.145
JanAm.Spread	2	4.169
JanLog(BM)	2	1.022
JanLog(Size)	2	3.364

\* significant at 10% level

**Table 6.18**  
**Results of Tests for Variable Coefficient Equality Across All Portfolios in Each Liquidity Model (New Zealand)**

Each of the tests has the null hypothesis that the coefficients of each like variable are all the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

<b>Variable</b>	<b>DF</b>	<b>Wald Chi-square statistic</b>
Spread	14	24.362**
Turnover	14	13.841
Am.Spread	14	18.650

\*\* significant at 5% level

Beta equality across portfolios was tested for because the coefficient of the Rm variable (beta) is constrained to be equal by the CSCTA technique. The results show that the null hypothesis of beta equality across portfolios is rejected at the 10% significance level in the Amortised Spread Model. However, the same null hypothesis is not rejected in the Spread and Turnover Models. Therefore, it appears that the restriction imposed on the Rm variable by the CSCTA technique is not unrealistic.

Further analysis of the first series of test results shows that, for the Spread Model the null hypothesis that the coefficients of the spread variable are equal across portfolios is rejected at the 1% significance level. In addition, the null hypotheses that the

coefficients of the Jan, JanSpread, and JanLog(Size) variables are equal across portfolios are rejected at the 10% significance level. In the Turnover Model, the null hypothesis that the coefficients of the JanLog(BM) variable are the same across portfolios is rejected at the 5% significance level. The null hypotheses that the coefficients of each of the variables (other than  $R_m$ ) are the same across portfolios are not rejected in the Amortised Spread Model.

The null hypothesis that the coefficients of each like variable are all the same across portfolios is rejected at the 5% level of significance in the Spread Model. However, the same null hypothesis is not rejected in either the Turnover or Amortised Spread Models. Thus, it appears that the restriction of coefficient equality across portfolios is justified with the possible exception of the Spread Model. Despite this, the restricted SUR and CSCTA techniques were employed for all three liquidity proxy models due to the desire to have one set of results for the whole New Zealand market rather than portfolio specific results.

## 6.2 New Zealand Basic Model Regression Results

The regression results from the Basic Models that were run for each liquidity proxy are now considered. Each Basic Model was estimated using both the SUR and CSCTA techniques. The models that were tested are presented first, followed by the results.

### Basic Models

#### Spread

##### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 \text{Log}(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(BM)_{pt} + \beta_p Rm_t + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(BM)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log}(\text{Size})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 \text{Log}(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(BM)_{pt} + \beta Rm_t + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(BM)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

Comparison of the SUR and CSCTA Models reveals that the difference between these two models, as they are applied here, lies in the treatment of the return on market (Rm) variable. In the SUR Model, the coefficient of the Rm variable has not been restricted to be the same across cross-sectional units (portfolios). Whereas the CSCTA Model automatically restricts the coefficients of all variables, including Rm, to be equal across portfolios.

**Table 6.19**  
**Basic Spread Model SUR Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F
Constant	-0.076 <sup>***</sup> (0.000)	-0.074 <sup>**</sup> (0.029)	-0.075 <sup>***</sup> (0.008)	0.002 (0.001)	0.043 (0.430)	-0.022 (0.052)
Spread	-0.036 (0.056)				-0.069 (0.054)	-0.160 (0.103)
Log(Size)		-0.000 (0.002)			-0.002 (0.002)	-0.002 (0.003)
Log(BM)			0.005 (0.008)		0.007 (0.006)	0.012 (0.011)
Rm				1.036 <sup>***</sup> (0.034)	1.030 <sup>***</sup> (0.046)	
N	180	180	180	180	180	180
R <sup>2</sup>	67.81%	67.78%	67.89%	86.01%	95.60%	68.13%

**Table 6.20**  
**Basic Spread Model CSCTA Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F
Constant	-0.076 <sup>***</sup> (0.087)	-0.068 <sup>*</sup> (0.038)	-0.072 <sup>***</sup> (0.010)	0.002 (0.002)	0.028 (0.032)	-0.031 (0.059)
Spread	-0.026 (0.081)				-0.068 (0.051)	-0.133 (0.120)
Log(Size)		-0.000 (0.002)			-0.001 (0.002)	-0.002 (0.003)
Log(BM)			0.007 (0.010)		0.007 (0.060)	0.011 (0.012)
Rm				1.038 <sup>***</sup> (0.016)	1.034 <sup>***</sup> (0.016)	
N	180	180	180	180	180	180
R <sup>2</sup>	0.06%	0.03%	0.03%	95.82%	95.83%	0.95%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

The SUR Model produces three coefficients (one for each portfolio) and three corresponding standard errors for the Rm variable. Consequently, some papers that have adopted the SUR methodology do not report any results for the Rm variable. Rather than following this approach and omitting valuable information, the average

coefficient and the average standard error of the  $R_m$  variable are presented in the SUR results table.

When reading the regression results, the reader must remember that return, spread, turnover, amortised spread, and the book-to-market ratio were all tested in decimal (rather than percentage) form. Size was measured in dollars. This means that a coefficient of, for instance, -0.005 for the size variable means that a \$1 increase in size results in a (on average) 0.5% decrease in return.

The Buse (1973)  $R^2$  is reported for the CSCTA Models, while a system  $R^2$  discussed by Berndt (1991) is reported for the SUR Models. The value in comparing these  $R^2$  figures is limited because the Berndt system  $R^2$  has been found to be inflated.<sup>6</sup> However, they are useful tools for analysing the proportion of variation explained by each regression within each model because they both account for the number of explanatory variables in the regression equation.

The convention of firstly examining whether spread,  $\log(\text{size})$ ,  $\log(\text{BM})$ , or  $R_m$  individually explain returns is followed. It is evident from the first three columns of Tables 6.19 and 6.20 that neither spread,  $\log(\text{size})$  nor  $\log(\text{BM})$  are statistically significant at the 10% level in either the SUR or CSCTA Models. The constants in each of these models are statistically significant, indicating that the regressions do not run through the origin. However, this is not economically significant.

In column D of Tables 6.19 and 6.20, it is apparent that the  $R_m$  variable is statistically significant at the 1% level, indicating that movements in the market index are good predictors of return. A positive beta coefficient close to one was expected. Beta for individual stocks, is a measure of the responsiveness of movement in stock returns to movements in the Market index. However in this case, beta is a measure of the average relationship between the return of all stocks listed on the NZSE that satisfied the portfolio formation criteria, and an equally weighted index based on all stocks listed on the NZSE. The  $R^2$  of regression D is also

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<sup>6</sup> See Berndt (1993, p. 468).

considerably higher than the  $R^2$  values of regressions A, B, and C. This is further evidence of the ability of the  $R_m$  variable to explain return.

$R_m$  remains statistically significant at the 1% level when each of the four explanatory variables are included in the same regression. However, the remaining three variables are statistically insignificant. The  $R^2$  of regression E is higher than the  $R^2$  of regression D for both models indicating that the inclusion of all four explanatory variables increases the proportion of variation in return explained

Finally, a regression that included the three non- $R_m$  explanatory variables was run to determine whether the strong significance of the  $R_m$  variable obscures the significance of the non- $R_m$  variables. Each of the non- $R_m$  variables remained statistically insignificant.

The results are very similar for both the SUR and CSCTA Models. Since the SUR Model does not correct for first order autocorrelation but the CSCTA Model does, this indicates that first order autocorrelation does not have a major impact on the results.

## Turnover

### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 Log(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta_p R_{m_t} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p R_{m_t} + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 Turnover_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(C) R_{pt} = \alpha + \gamma_3 \text{Log}(BM)_{pt} + \eta_{pt}$$

$$(D) R_{pt} = \alpha + \beta Rm_t + \eta_{pt}$$

$$(E) R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(BM)_{pt} + \beta Rm_t + \eta_{pt}$$

$$(F) R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(BM)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

**Table 6.21**

**Basic Turnover Model SUR Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F
Constant	-0.074 <sup>***</sup> (0.007)	0.042 (0.060)	-0.067 <sup>***</sup> (0.009)	0.002 <sup>**</sup> (0.001)	-0.002 (0.053)	0.054 (0.120)
Turnover	-0.149 (0.140)				-0.040 (0.111)	0.058 (0.231)
Log(Size)		-0.007 <sup>**</sup> (0.003)			0.001 (0.003)	-0.007 (0.007)
Log(BM)			0.018 (0.013)		0.009 <sup>**</sup> (0.004)	0.004 (0.019)
Rm				1.030 <sup>***</sup> (0.029)	1.029 <sup>***</sup> (0.032)	
N	180	180	180	180	180	180
R <sup>2</sup>	68.03%	68.25%	68.26%	96.18%	96.24%	68.39%

**Table 6.22**

**Basic Turnover Model CSCTA Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F
Constant	-0.079 <sup>***</sup> (0.009)	0.017 (0.086)	-0.073 <sup>***</sup> (0.012)	0.002 <sup>**</sup> (0.001)	0.056 (0.048)	0.028 (0.153)
Turnover	-0.068 (0.165)				-0.034 (0.111)	0.072 (0.245)
Log(Size)		-0.005 (0.005)			-0.003 (0.003)	-0.006 (0.009)
Log(BM)			0.015 (0.015)		0.008 <sup>*</sup> (0.004)	0.007 (0.022)
Rm				1.028 <sup>***</sup> (0.012)	1.028 <sup>***</sup> (0.013)	
N	180	180	180	180	180	180
R <sup>2</sup>	0.13%	0.46%	0.34%	96.01%	96.68%	1.23%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

It is evident that turnover is not statistically significant using either the SUR or CSCTA techniques. Column B of Tables 6.21 and 6.22 reveals a difference between the techniques. Use of the SUR technique results in a statistically significant negative relationship (at the 5% level) between  $\log(\text{size})$  and return, indicating that firms with smaller market capitalisations can be expected to earn higher returns. The coefficient of  $-0.007$  means that a \$1 decrease in the logarithm of firm size can be expected to result in a (approximately) 0.7% increase in return. Therefore, a \$1 decrease in actual firm size would be expected to result in a larger increase in return. However, use of the CSCTA technique resulted in no statistically significant relationship between  $\log(\text{size})$  and return. The techniques are however consistent in their finding of no statistically significant relationship between  $\log(\text{BM})$  and return when  $\log(\text{BM})$  is the sole explanatory variable included in the regression.

As in the Basic Spread Model, column D of Tables 6.21 and 6.22 reveals that  $R_m$  is statistically significant at the 1% level. The size and sign of the coefficient are also similar to those observed in the Basic Spread Model. Also consistent with the Basic Spread Model is the dramatic increase in  $R^2$  in regression D, over regressions A, B, and C.

When each of the four explanatory variables are included in the same regression, the relationship between return and  $\log(\text{BM})$  becomes statistically significant using both the SUR and CSCTA techniques. The only difference is the level of significance. Using the SUR technique,  $\log(\text{BM})$  becomes statistically significant at the 5% level, while under the CSCTA technique,  $\log(\text{BM})$  becomes statistically significant at the 10% level. The positive coefficient of 0.009 and 0.008 for  $\log(\text{BM})$  in the SUR and CSCTA Models respectively indicates that firms with a higher book-to-market ratio (value firms) can be expected to earn higher returns than their low book-to-market counterparts. Specifically, a unit increase in a firm's  $\log(\text{BM})$  ratio can be expected to result in a (approximately) 0.9% increase in the return on that company's stock. Or more realistically, a 0.1 unit increase in a firm's  $\log(\text{BM})$  ratio can be expected to result in a (approximately) 0.09% increase in return. Similar to the situation with firm size, a 0.1 unit increase in the actual book-to-market ratio of a firm would be expected to result in a larger increase in return.

The coefficient of the Rm variable remains statistically significant at the 1% level using both techniques when all four explanatory variables are included in the same regression. The slight difference in results of the SUR and CSCTA techniques can possibly be attributed to first order autocorrelation.

Finally, the three non-Rm explanatory variables were included in the same regression to see if the highly significant nature of the Rm variable is obscuring the significance of the other variables. Regression F shows that this is not the case.

### **Amortised Spread**

#### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 Log(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \eta_{pt}$$

$$(t = 1,2,3,\dots,60, \text{ and } p = 1,2,3).$$

#### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_3 Log(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \beta Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta Rm_t + \eta_{pt}$$

$$(F) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \eta_{pt}$$

$$(t = 1,2,3,\dots,60, \text{ and } p = 1,2,3).$$

**Table 6.23****Basic Amortised Spread Model SUR Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F
Constant	-0.076 <sup>***</sup> (0.006)	-0.124 <sup>***</sup> (0.041)	-0.083 <sup>***</sup> (0.009)	-0.001 (0.001)	0.076 (0.054)	-0.144 <sup>***</sup> (0.055)
Am.Spread	-0.098 (3.980)				-2.017 (2.546)	4.136 (4.981)
Log(Size)		0.003 (0.002)			-0.004 (0.003)	0.003 (0.003)
Log(BM)			-0.011 (0.012)		-0.006 (0.007)	-0.006 (0.015)
Rm				1.002 <sup>***</sup> (0.034)	1.010 <sup>***</sup> (0.041)	
N	180	180	180	180	180	180
R <sup>2</sup>	70.01%	70.04%	69.94%	97.08%	97.10%	70.30%

**Table 6.24****Basic Amortised Spread Model CSCTA Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F
Constant	-0.078 <sup>***</sup> (0.008)	-0.124 <sup>**</sup> (0.048)	-0.082 <sup>***</sup> (0.011)	-0.001 (0.001)	0.008 (0.037)	-0.157 <sup>**</sup> (0.062)
Am.Spread	1.867 (4.298)				-3.898 (2.550)	5.769 (5.058)
Log(Size)		0.003 (0.003)			-0.001 (0.002)	0.004 (0.004)
Log(BM)			-0.011 (0.016)		-0.005 (0.006)	-0.005 (0.018)
Rm				1.001 <sup>***</sup> (0.016)	1.005 <sup>***</sup> (0.016)	
N	180	180	180	180	180	180
R <sup>2</sup>	0.10%	0.53%	0.27%	95.67%	95.78%	1.28%

\*\*\* significant at 1% level

\*\* significant at 5% level

The Basic Amortised Spread Model results are similar to the Basic Spread Model results. Neither amortised spread, log(size), nor log(BM) are statistically significant when they are included either by themselves or together. The Rm variable is statistically significant (at a 1% level) when it is included by itself and with the other three explanatory variables. The sign and size of the beta coefficient and the trend of higher R<sup>2</sup> values when the Rm variable is included, is also evident in the Amortised

Spread Model. The fact that the results are very similar under both the SUR and CSCTA techniques indicates that first order autocorrelation does not have a major impact on the results.

Unlike in the Spread and Turnover Models, the test on the restriction of the coefficient of the  $R_m$  variable in the Amortised Spread Model (see Table 6.17) reveals that the null hypothesis that the coefficients of the  $R_m$  variable are the same across portfolios is rejected at the 10% level. Since the CSCTA technique imposes this restriction while the SUR technique does not, any major divergences in the results could also be attributed to this. With similar results for the two techniques, this is obviously not a major problem.

The regression results from the Full Models are now considered. Each model is estimated under both the SUR and CSCTA techniques. The results follow a description of the models that were tested.

### 6.3 New Zealand Full Model Regression Results

#### Spread

##### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \beta_p R_{m_t} + \gamma_4 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \beta_p R_{m_t} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanSpread}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanSpread}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanSpread}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanSpread}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

CSCTA

$$(A) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta Rm_t + \gamma_4 Jan_{pt} + \eta_{pt}$$

$$(B) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(C) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(D) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \eta_{pt}$$

$$(E) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 60, \text{ and } p = 1, 2, 3).$$

**Table 6.25****Full Spread Model SUR Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E
Constant	0.043 (0.042)	0.020 (0.044)	-0.046 (0.063)	-0.058 (0.057)	-0.055 (0.054)
Spread	-0.070 (0.052)	-0.064 (0.057)	-0.137 (0.121)	-0.119 (0.111)	-0.080 (0.106)
Log(Size)	-0.002 (0.002)	-0.001 (0.002)	-0.001 (0.003)	-0.000 (0.003)	-0.001 (0.003)
Log(BM)	0.007 (0.006)	0.006 (0.006)	0.013 (0.014)	0.014 (0.011)	
Rm	1.029*** (0.045)	1.029*** (0.061)			
Jan	0.0063** (0.003)	0.215** (0.109)	0.526*** (0.200)	0.497*** (0.180)	0.485*** (0.175)
JanSpread		-0.151 (0.160)	-0.775** (0.353)	-0.638** (0.315)	-0.622** (0.310)
JanLog(Size)		-0.011* (0.006)	-0.025** (0.011)	-0.024*** (0.009)	-0.024*** (0.009)
JanLog(BM)		0.016 (0.023)	0.033 (0.048)		
N	180	180	180	180	180
R <sup>2</sup>	95.48%	95.72%	67.84%	67.47%	67.18%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

**Table 6.26****Full Spread Model CSCTA Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

<b>Variable</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
Constant	0.028 (0.032)	0.010 (0.031)	-0.043 (0.069)	-0.054 (0.061)	-0.051 (0.060)
Spread	-0.069 (0.050)	-0.059 (0.052)	-0.137 (0.131)	-0.118 (0.121)	-0.081 (0.118)
Log(Size)	-0.001 (0.002)	-0.000 (0.002)	-0.001 (0.004)	-0.001 (0.003)	-0.001 (0.003)
Log(BM)	0.007 (0.006)	0.006 (0.006)	0.014 (0.015)	0.0132 (0.012)	
Rm	1.031*** (0.016)	1.028*** (0.017)			
Jan	0.007** (0.003)	0.214** (0.107)	0.444** (0.177)	0.415** (0.163)	0.399** (0.161)
JanSpread		-0.150 (0.155)	-0.595* (0.313)	-0.514* (0.284)	-0.487* (0.282)
JanLog(Size)		-0.011* (0.006)	-0.021** (0.009)	-0.021** (0.008)	-0.019** (0.008)
JanLog(BM)		0.016 (0.022)	0.012 (0.012)		
N	180	180	180	18	180
R <sup>2</sup>	95.84%	96.17%	5.37%	5.14%	4.39%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

Regression A in the Full Spread Model includes the four explanatory variables and a dummy variable called Jan, which equals one in January months and zero in non-January months. The Rm variable is statistically significant (at the 1% level), as was the case in the Basic Spread Model. The January dummy variable is statistically significant (at the 5% level) using both the SUR and CSCTA techniques. The positive coefficient of the January dummy indicates that January returns are 0.7% more than non-January month returns, all other factors held constant.

A regression which also included interaction dummy variables for spread, log(size), and log(BM) was then conducted. The Rm and January dummy variables remained statistically significant at their previous levels. In addition, the January log(size) dummy variable was found statistically significant at the 10% level in both the SUR and CSCTA Models. The coefficient of -0.011 indicates that in January months a \$1 decrease in the logarithm of firm size results in a 1.1% increase in return. The R<sup>2</sup>

value associated with both the SUR and CSCTA techniques increased with the inclusion of the January interaction dummy variables. This indicates that their inclusion results in a greater proportion of the variation in return being explained.

As in the Basic Models the  $R_m$  variable was then excluded to determine whether its highly significant nature was obscuring the significance of other variables. This appears to be the case. In column C of Tables 6.25 and 6.26 it is evident that without the  $R_m$  variable the January  $\log(\text{size})$  dummy variable becomes statistically significant at the 5% level, and the absolute value of the size of the coefficient increases. The January spread interaction variable becomes statistically significant at the 5% level in the SUR Model and at the 10% level in the CSCTA Model. The coefficient of  $-0.775$  in the SUR Model indicates that in January months a unit decrease in spread can be expected to lead to a 78% increase in return. Or, more realistically, a 0.01 unit decrease in spread in January leads to an, on average, 0.078% increase in return. The statistically insignificant variables are then excluded in regressions D and E. This resulted in no change occurring to the significance of the Jan, Janspread, and JanLog(Size) variables.

Analysing the  $R^2$  values of the regressions shows that a large proportion of the variation in return is explained by the  $R_m$  variable. When  $R_m$  is excluded in regression C there is a substantial decline in the  $R^2$  values of both the SUR and CSCTA Models. The three statistically significant variables are consistently more significant in the SUR Model than the CSCTA Model. This may be due to first order autocorrelation.

## Turnover

### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \beta_p R_{m_t} + \gamma_4 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \beta_p R_{m_t} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanTurnover}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanTurnover}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$$

- (D)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (E)  $R_{pt} = \alpha + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (F)  $R_{pt} = \alpha + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (G)  $R_{pt} = \alpha + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- ( $t = 1, 2, 3, \dots, 60$ , and  $p = 1, 2, 3$ ).

### CSCTA

- (A)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \beta \text{Rm}_t + \gamma_4 \text{Jan}_{pt} + \eta_{pt}$
- (B)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \beta \text{Rm}_t + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanTurnover}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (C)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_5 \text{JanTurnover}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (D)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (E)  $R_{pt} = \alpha + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_6 \text{JanLog}(\text{Size})_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (F)  $R_{pt} = \alpha + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- (G)  $R_{pt} = \alpha + \gamma_3 \text{Log}(\text{BM})_{pt} + \gamma_4 \text{Jan}_{pt} + \gamma_7 \text{JanLog}(\text{BM})_{pt} + \eta_{pt}$
- ( $t = 1, 2, 3, \dots, 60$ , and  $p = 1, 2, 3$ ).

**Table 6.27****Full Turnover Model SUR Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F	G
Constant	0.003 (0.052)	0.021 (0.057)	0.038 (0.128)	0.059 (0.128)	0.017 (0.080)	0.034 (0.077)	-0.063 (0.010)
Turnover	-0.018 (0.115)	0.009 (0.120)	0.0631 (0.240)	0.115 (0.238)			
Log(Size)	0.000 (0.003)	-0.001 (0.003)	-0.006 (0.008)	-0.007 (0.008)	-0.005 (0.005)	-0.006 (0.005)	
Log(BM)	0.009** (0.004)	0.009* (0.005)	0.018 (0.020)	0.017 (0.020)	0.018 (0.017)	0.016 (0.017)	0.028 (0.014)
Rm	1.029*** (0.032)	1.030*** (0.033)					
Jan	0.002 (0.002)	-0.247 (0.173)	0.573 (0.424)	0.187 (0.294)	0.179 (0.276)	-0.046 (0.034)	-0.046 (0.034)
JanTurnover		-0.532 (0.435)	1.054 (1.169)				
JanLog(Size)		0.014 (0.010)	-0.038 (0.026)	-0.014 (0.018)	-0.013 (0.016)		
JanLog(BM)		-0.019 (0.019)	-0.203** (0.073)	-0.160** (0.066)	-0.018** (0.018)	-0.124** (0.048)	-0.124** (0.048)
N	180	180	180	180	180	180	180
R <sup>2</sup>	87.91%	96.31%	71.04%	70.04%	69.67%	69.39%	69.12%

**Table 6.28****Full Turnover Model CSCTA Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E	F	G
Constant	0.060 (0.048)	0.068 (0.051)	0.045 (0.153)	0.044 (0.156)	-0.000 (0.103)	0.005 (0.099)	-0.068*** (0.011)
Turnover	-0.016 (0.113)	-0.024 (0.115)	0.110 (0.255)	0.122 (0.250)			
Log(Size)	-0.003 (0.003)	-0.003 (0.003)	-0.007 (0.009)	-0.007 (0.009)	-0.004 (0.006)	-0.004 (0.006)	
Log(BM)	0.008* (0.004)	0.009** (0.004)	0.017 (0.022)	0.017 (0.225)	0.019 (0.020)	0.018 (0.019)	0.026 (0.016)
Rm	1.027*** (0.013)	1.026*** (0.013)					
Jan	0.001 (0.002)	-0.201 (0.175)	0.174 (0.385)	0.042 (0.263)	0.035 (0.252)	-0.029 (0.028)	-0.030 (0.028)
JanTurnover		-0.218 (0.445)	0.414 (1.072)				
JanLog(Size)		0.011 (0.010)	-0.013 (0.024)	-0.005 (0.016)	-0.004 (0.015)		
JanLog(BM)		-0.015 (0.020)	-0.146** (0.066)	-0.128** (0.059)	-0.120** (0.056)	-0.112*** (0.044)	-0.113*** (0.044)
N	180	180	180	180	180	180	180
R <sup>2</sup>	97.70%	97.71%	5.56%	5.40%	5.19%	5.08%	5.02%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

As in the Full Spread Model, the first regression for the Full Turnover Model includes the four explanatory variables and the January dummy variable. From Column A of Tables 6.27 and 6.28, it is evident that the  $R_m$  variable is statistically significant at the 1% level. The sign and size of the beta coefficient are both very similar to those from the Full Spread Model. Consistent with regression D in the Basic Turnover Model, the  $\log(BM)$  variable is statistically significant at the 5% and 10% levels under the SUR and CSCTA techniques respectively. The sign and size of the coefficient, which are very similar to those in the Basic Turnover Model, indicate that high book-to-market equity or value firms tend to earn higher returns than their low book-to-market equity counterparts. Including the interaction dummy variables has no effect on these results.

The  $R_m$  variable is then excluded to determine whether its strong significance obscures the significance of the other variables. This is found to be the case. The results of regression C show that the  $\text{JanLog}(BM)$  variable is statistically significant at the 5% level. Its coefficient of  $-0.203$  in the SUR Model indicates that in January months, a unit decrease in the logarithm of the book-to-market ratio can be expected to result in a 20.3% increase in return. Putting this in more realistic terms, a 0.1 unit decrease in  $\log(BM)$  in January results, on average, in a 2.03% increase in return.

The least significant variables are then excluded one-by-one in regressions D to G. The  $\text{JanLog}(BM)$  variable remains the only significant variable. In fact it becomes significant at the 1% level in regressions F and G in the CSCTA Model.

Consistent with the Basic Models and the Full Spread Model, the  $R^2$  values of the regressions show that a large proportion of the variation in return is explained by the  $R_m$  variable. When  $R_m$  is excluded in regression C there is a substantial decline in the  $R^2$  values for both the SUR and CSCTA Models.

The slight difference in significance levels between the SUR and CSCTA techniques maybe due to first order autocorrelation. Analysis of the coefficients and corresponding standard errors of the SUR and CSCTA Models illustrates that the effect of this autocorrelation is only minor.

## Amortised Spread

### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta_p Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(t = 1,2,3,\dots,60, \text{ and } p = 1,2,3).$$

### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta Rm_t + \gamma_4 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \beta Rm_t + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanAm.Spread_{pt} + \gamma_7 JanLog(BM)_{pt} + \eta_{pt}$$

$$(t = 1,2,3,\dots,60, \text{ and } p = 1,2,3).$$

**Table 6.29****Full Amortised Spread Model SUR Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E
Constant	0.073 (0.053)	0.063 (0.056)	-0.156*** (0.060)	-0.159*** (0.057)	-0.083*** (0.011)
Am.Spread	-1.153 (2.459)	-1.241 (2.449)	3.061 (5.191)	3.261 (5.129)	-0.138 (4.426)
Log(Size)	-0.004 (0.003)	-0.004 (0.003)	0.004 (0.003)	0.004 (0.003)	
Log(BM)	-0.006 (0.007)	-0.003 (0.007)	0.003 (0.018)	0.004 (0.017)	-0.007 (0.015)
Rm	1.006*** (0.000)	0.996*** (0.000)			
Jan	0.007** (0.003)	-0.028 (0.151)	-0.117 (0.227)	-0.067 (0.041)	-0.061 (0.041)
JanAm.Spread		14.061 (17.37)	64.823** (29.54)	61.055*** (23.65)	57.920** (23.62)
JanLog(Size)		0.0011 (0.008)	0.003 (0.012)		
JanLog(BM)		-0.016 (0.028)	-0.114* (0.061)	-0.119** (0.056)	-0.110** (0.055)
N	180	180	180	180	180
R <sup>2</sup>	97.10%	98.04%	71.48%	71.24%	71.11%

**Table 6.30****Full Amortised Spread Model CSCTA Regression Results (New Zealand)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to five years of monthly data for three portfolios.

Variable	A	B	C	D	E
Constant	0.004 (0.037)	0.006 (0.039)	-0.168*** (0.065)	-0.177*** (0.063)	-0.085*** (0.002)
Am.Spread	-3.103 (2.490)	-3.434 (2.413)	4.084 (5.029)	4.502 (4.987)	1.497 (4.540)
Log(Size)	-0.000 (0.002)	-0.000 (0.002)	0.050 (0.004)	0.005 (0.004)	
Log(BM)	-0.005 (0.006)	-0.003 (0.006)	0.005 (0.005)	0.007 (0.020)	-0.008 (0.018)
Rm	1.001*** (0.000)	0.990*** (0.000)			
Jan	0.006 (0.003)	-0.105 (0.150)	-0.176 (0.214)	-0.060 (0.039)	-0.053 (0.039)
JanAm.Spread		24.809 (16.81)	69.482** (28.37)	60.346*** (22.77)	56.798** (22.87)
JanLog(Size)		0.005 (0.009)	0.006 (0.012)		
JanLog(BM)		-0.008 (0.027)	-0.103* (0.058)	-0.113** (0.054)	-0.104* (0.053)
N	180	180	180	180	180
R <sup>2</sup>	96.00%	96.09%	6.84%	6.72%	5.52%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

Consistent with the Full Spread and Turnover Models, the first regression in the Full Amortised Spread Model includes the four explanatory variables and the January dummy variable. The  $R_m$  variable is statistically significant at the 1% level. This is in line with both the Full Spread and Full Turnover Models. The January dummy variable is statistically significant at the 5% percent level when the SUR technique is used but is not statistically significant when the CSCTA technique is used. The positive coefficient of the January dummy, similar to what is evident in the Full Spread Model, indicates that returns tend to be 0.7% higher in January than non-January months, all other factors held constant.

None of the interaction dummy variables are statistically significant when the  $R_m$  variable is in the regression. However, the January amortised spread and the January  $\log(BM)$  dummy variables become statistically significant at the 5% and 10% levels respectively when the  $R_m$  variable is omitted from the regression. The coefficient of approximately 69 in regression C in Tables 6.29 and 6.30 indicates that in January months a unit increase in amortised spread results in a 6900% increase in return. Or, more realistically, 0.001 unit increase in Amortised Spread in January results, on average, in a 6.9% in increase in return. Consistent with the Full Turnover Model, the  $JanLog(BM)$  variable has a negative coefficient indicating that in January months growth firms have tended to earn higher returns than their value counterparts.

The procedure of eliminating the statistically insignificant variables was followed in regressions D and E. This resulted in  $JanAm.Spread$  and  $JanLog(BM)$  remaining statistically significant.

The same  $R^2$  trend that was evident in the Full Spread and Full Turnover Models is evident in the Full Amortised Spread Model. When  $R_m$  is excluded from the regressions the  $R^2$  declines dramatically, indicating that a substantial proportion of the variation in return is explained by the  $R_m$  variable. The fact that the results are very similar under both the SUR and CSCTA techniques indicates that neither the first order autocorrelation nor the restriction on the  $R_m$  variable has a major impact on the results.

Comparison of regressions B and C in each of the Full Models (see Tables 6.25 – 6.30) reveals that the Rm variable obscures the statistical significance of the other variables. In the Full Spread Model, the variables Jan, JanSpread, and JanLog(Size) all become statistically significant or more statistically significant when Rm is excluded. In the Full Turnover Model, the variable JanLog(BM) becomes statistically significant when Rm is excluded. In the Full Amortised Spread Model the variables JanAm.Spread and JanLog(BM) become statistically significant when Rm is excluded.

Due to the level of obscurity resulting from the Rm variable, an attempt was made to incorporate it into the prediction equation in the following manner:

Return was regressed against Rm using the SUR Model as follows:

$$R_{pt} = \alpha_l + \beta_p Rm_t + \eta_{pt} \quad (6.1)$$

The other variables were then used to model the variation in the error term,  $\eta_{pt}$ , as shown below:

$$\eta_{pt} = \alpha_2 + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \xi_{pt} \quad (6.2)$$

Substituting for  $\eta_{pt}$  in equation 6.1 from equation 6.2 results in:

$$R_{pt} = \alpha + \beta_p Rm_t + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Log(BM)_{pt} + \gamma_4 Jan_{pt} + \gamma_5 JanSpread_{pt} + \gamma_6 JanLog(Size)_{pt} + \gamma_7 JanLog(BM)_{pt} + \xi_{pt} \quad (6.3)$$

This method was also applied to the Full Turnover and Full Amortised Spread Models. The results (which are not presented in this thesis) showed that none of the variables in equation 6.2, or the equivalent variables in the Full Turnover and Full Amortised Spread Models, were statistically significant at the 10% level. This implies that the variation in the error terms from equation 6.1 is unexplained by the said variables. Therefore, the predictive power of the three models cannot be enhanced using this method. While the explanatory variables excluding Rm do not

explain any of the variation in return left unexplained by  $R_m$ , they are a useful alternative to  $R_m$  when it comes to explaining returns.

#### **6.4 Summary of the New Zealand Results**

This section provides a brief summary of the New Zealand results that are presented throughout Chapter Six. Interpretations are left for Chapter Eight. There is no consistent seasonality or time-variation in the three liquidity proxies employed by this thesis.

The relationship between return and liquidity is also inconsistent in the New Zealand market. A negative statistically significant relationship between return and spread is evident in January months. In contrast, there is a positive statistically significant relationship between return and amortised spread in January. There is no evidence of a statistically significant relationship between return and turnover.

Return on market has a strong positive statistically significant relationship with return. There is evidence of return seasonality - returns appear to be larger in January months. The negative statistically significant relationship between return and size also appears to be unique to January. Evidence of a positive statistically significant relationship between return and book-to-market equity was found for the entire year. Interestingly, this relationship appears to be negative in January.

## Chapter Seven Australian Results

### 7.1 Australian Data Characteristics

Table 7.1 outlines the number of stocks included in portfolios that were formed based on each of the three liquidity proxies. For each liquidity proxy, each year, stocks were placed in one of ten portfolios based on their level of the liquidity proxy in the previous year. Data was gathered for every company listed on the Australian Stock Exchange (ASX) over the period 1994-98 that met the portfolio formation criteria that was described in Chapter Four. However, the 1994 data was only used to form the 1995 portfolios. Therefore, the data presented in this chapter relates to the four test years (1995-98).

**Table 7.1**  
**Number of Australian Companies Used in Analysis**

Liquidity Proxy	1995	1996	1997	1998
Spread	1021	1096	1145	1138
Turnover	1087	1105	1136	1142
Amortised Spread	1015	1085	1121	1133

Summary statistics for the ten portfolios formed for each liquidity proxy are included in Tables 7.2 – 7.4. As with the New Zealand data, return, spread, turnover, amortised spread, and the book-to-market ratio (of which the logarithm is taken) are all expressed in decimal (rather than percentage) form. The logarithm of size (measured in dollars) is used.

**Table 7.2**  
**Spread Model Summary Statistics (Australia)**

The figures for each portfolio represent the time-series average over the period 1995-98.

Portfolio	Return	Spread	Beta	Log(Size)
1	0.0048	0.0527	0.8321	24.351
2	-0.0012	0.0899	1.0421	23.416
3	-0.0056	0.0997	1.2361	21.973
4	-0.0015	0.1093	1.0121	21.771
5	0.0051	0.1128	0.9926	22.784
6	0.0028	0.1005	0.9648	22.769
7	0.0002	0.1067	1.0554	22.708
8	0.0002	0.1452	1.4421	22.527
9	0.0049	0.1594	1.2240	22.465
10	0.0036	0.1814	1.2502	22.105
Average	0.0013	0.1158	1.1052	22.687

**Table 7.3**  
**Turnover Model Summary Statistics (Australia)**

The figures for each portfolio represent the time-series average over the period 1995-98.

Portfolio	Return	Turnover	Beta	Log(Size)
1	0.0028	0.0551	0.8192	21.723
2	0.0048	0.0460	0.9868	23.241
3	0.0043	0.0438	0.9314	23.784
4	0.0011	0.0389	1.1546	23.440
5	0.0036	0.0350	1.0787	22.875
6	0.0036	0.0291	0.9468	22.391
7	-0.0039	0.0229	1.0554	22.124
8	0.0004	0.0189	1.0469	21.944
9	-0.0054	0.0136	0.9856	21.851
10	0.0020	0.0069	1.0456	23.663
Average	0.0013	0.0310	1.0051	22.704

**Table 7.4**  
**Amortised Spread Model Summary Statistics (Australia)**

The figures for each portfolio represent the time-series average over the period 1995-98.

Portfolio	Return	Am.Spread	Beta	Log(Size)
1	0.0006	0.0008	0.9291	26.857
2	-0.0105	0.0007	1.4276	24.952
3	-0.0049	0.0007	1.1251	23.958
4	0.0032	0.0007	1.2640	24.681
5	0.0009	0.0008	1.4370	23.645
6	0.0043	0.0007	1.1288	23.621
7	0.0035	0.0008	1.0359	23.072
8	0.0066	0.0009	1.2428	21.943
9	0.0036	0.0010	0.9569	21.994
10	0.0076	0.0064	1.0426	21.908
Average	0.0015	0.0014	1.1590	23.663

The beta of each portfolio was estimated with an Ordinary Least Squares (OLS) regression of the forty eight monthly portfolio excess returns<sup>1</sup> against the corresponding monthly excess market returns.<sup>2</sup>

The Seemingly Unrelated Regression (SUR) and the Cross-Sectionally Correlated and Timewise Autoregressive (CSCTA) Models both simultaneously estimate beta. Therefore, the beta estimates from the Market Model are only presented in the Summary Statistics tables and used in the Correlation Matrices.

In depth consideration is given to the relationship between return and the explanatory variables in Sections 7.2 and 7.3. However, based on the results in Tables 7.2 – 7.4, it would appear that there is no consistent relationship between return and liquidity, beta, or log(size). The relationship between the explanatory variables themselves is considered in the correlation matrices (Tables 7.6 – 7.8).

Excess returns were analysed in more detail to see whether there is any evidence of seasonality, in particular a January effect. Table 7.5 displays the results.

**Table 7.5**  
**Return Seasonality (Australia)**

The figures represent cross-sectional (across portfolios) and time-series (for the period 1995-98) averages.

	Spread Portfolios	Turnover Portfolios	Am.Spread Portfolios
Januarys only	0.0074	0.0068	0.0072
Non-Januarys only	0.0008	0.0008	0.0010
All Months	0.0013	0.0013	0.0015

These results indicate that returns are consistently larger in January months. The results of the regression analysis, in which a January dummy variable is included, will indicate if the larger returns in January months are statistically significant.

Consideration is now given to the correlation coefficients of each of the explanatory variables. As mentioned in Chapter Four, calculating book-to-market equity for the

<sup>1</sup> Excess returns were calculated as the actual return minus the 13 week Treasury Note rate.

<sup>2</sup> An equally weighted market index was used.

Australian companies was not possible due to data non-availability. For each liquidity proxy the correlation coefficients were measured across the ten portfolios and across time (1995-98).

**Table 7.6**  
**Spread Model Correlation Coefficients (Australia)**

The correlation coefficients were measured across spread portfolios across time (1995-98).

Variable	Spread	Beta	Log(Size)
Spread	1		
Beta	0.5005	1	
Log(Size)	-0.3773	0.1893	1

**Table 7.7**  
**Turnover Model Correlation Coefficients (Australia)**

The correlation coefficients were measured across turnover portfolios across time (1995-98).

Variable	Turnover	Beta	Log(Size)
Turnover	1		
Beta	-0.1949	1	
Log(Size)	0.1405	0.1523	1

**Table 7.8**  
**Amortised Spread Model Correlation Coefficients (Australia)**

The correlation coefficients were measured across amortised spread portfolios across time (1995-98).

Variable	Am.Spread	Beta	Log(Size)
Am.Spread	1		
Beta	-0.3682	1	
Log(Size)	-0.3311	0.1463	1

It is evident that the largest correlation coefficient is 0.5005. This indicates that collinearity is not a major problem in any of the three models.<sup>3</sup>

The results in Tables 7.6 – 7.8 reveal that large firms tend to be more liquid. In other words, large firms have smaller spreads and amortised spreads and higher turnover rates in general.

<sup>3</sup> As explained earlier, a return on market (Rm) variable was used in the regression analysis in place of beta. While not included in Tables 7.6 – 7.8, the correlation coefficients of Rm and the non – Rm variables (excluding beta) were also calculated. The largest value of these was 0.34.

Large firms also tend to have larger beta coefficients than their small firm counterparts. This indicates that large firms are, on average, more risky than smaller firms.

The issue of seasonality in the three liquidity proxies is now considered. The monthly figures represent cross-sectional (across portfolios) and time-series (for the period 1995-98) averages of each liquidity proxy.

**Table 7.9**  
**Seasonality of Liquidity Proxies (Australia)**  
 Each figure represents the monthly average of the ten portfolios.

<b>Month</b>	<b>Average Spread</b>	<b>Average Turnover</b>	<b>Average Am.Spread</b>
January	0.1127	0.0324	0.0012
February	0.1124	0.0360	0.0015
March	0.1144	0.0315	0.0012
April	0.1109	0.0290	0.0010
May	0.1052	0.0379	0.0025
June	0.1125	0.0359	0.0016
July	0.1198	0.0281	0.0013
August	0.1195	0.0286	0.0010
September	0.1201	0.0274	0.0013
October	0.1231	0.0294	0.0013
November	0.1215	0.0290	0.0013
December	0.1172	0.0270	0.0009

Table 7.9 indicates that there is no consistent seasonality in the three liquidity proxies. Spreads are lowest in May and highest in October. Turnover rates are lowest in December and highest in May. Amortised spreads are lowest in December and highest in May.

The issue of time-variation in each of the three liquidity proxies is considered in Table 7.10. The yearly figures represent cross-sectional (across portfolios) averages for each liquidity proxy.

**Table 7.10**  
**Time-Variation in Liquidity Proxies (Australia)**  
 Each figure represents the yearly average of the ten portfolios.

Year	Average Spread	Average Turnover	Average Am.Spread
1995	0.1141	0.0263	0.0009
1996	0.0916	0.0390	0.0014
1997	0.1008	0.0364	0.0013
1998	0.1265	0.0223	0.0016

All three proxies indicate that liquidity is at its lowest level in 1998. However, other time-variation is inconsistent. Spreads are lowest in 1996 and turnover rates are highest in 1996. Yet, amortised spreads are lowest in 1995.

It appears that there is more consistency between spreads and turnover rates than there is with amortised spreads and each of these two proxies. This does not necessarily mean that spread and turnover rate are good liquidity proxies and amortised spread is a poor proxy.

Tests were carried out to determine the appropriate model(s) to analyse the data with. A detailed description of each test can be found in Chapter Five.

A Lagrange multiplier test was undertaken to investigate the existence of contemporaneous (same time period) correlation among the cross sectional units (portfolios). A description of the models employed for each liquidity proxy is included first, followed by the Lagrange Multiplier results for each model.

## Basic Models

### Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \beta_p R_{m_t} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta_p R_{m_t} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

**Turnover**

(A)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \eta_{pt}$

(B)  $R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

(C)  $R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$

(D)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta_p Rm_t + \eta_{pt}$

(E)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$

**Amortised Spread**

(A)  $R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \eta_{pt}$

(B)  $R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

(C)  $R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$

(D)  $R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta_p Rm_t + \eta_{pt}$

(E)  $R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$

**Table 7.11****Basic Model Breusch-Pagan Lagrange Multiplier Statistics (Australia)**

The Breusch-Pagan Lagrange Multiplier was used to test for the existence of contemporaneous correlation among the ten portfolios in each Basic Liquidity Proxy Model (models with no January dummy variables). The null hypothesis of each test is no contemporaneous correlation.

	DF	Model		
		Spread	Turnover	Am.Spread
A	45	750.52***	506.82***	603.99***
B	45	758.52***	481.27***	622.74***
C	45	146.00***	169.03***	513.42***
D	45	147.34***	149.05***	517.94***
E	45	758.94***	527.74***	620.77***

\*\*\* significant at 1% level

Under the null hypothesis of a diagonal covariance structure (i.e. no contemporaneous correlation) the Breusch-Pagan Lagrange Multiplier statistic has an asymptotic  $\chi^2_{(M(M-1)/2)}$  distribution ( $M$  is the number of cross-section units).

Table 7.11 reveals that there is very strong statistical evidence to reject the null hypothesis of no contemporaneous correlation. Use of both the SUR and CSCTA Models (both of which account for contemporaneous correlation) to estimate the Basic Models is therefore appropriate.

## Full Models

### Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{m_t} + \gamma_3 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{m_t} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanSpread}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanSpread}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

### Turnover

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{m_t} + \gamma_3 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{m_t} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanTurnover}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanTurnover}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

### Amortised Spread

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{m_t} + \gamma_3 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{m_t} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanAm.Spread}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Am.Spread}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanAm.Spread}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

**Table 7.12**

**Full Model Breusch-Pagan Lagrange Multiplier Statistics (Australia)**

The Breusch-Pagan Lagrange Multiplier was used to test for the existence of contemporaneous correlation among the ten portfolios in each Full Liquidity Proxy Model (models with January dummy variables). The null hypothesis of each test is no contemporaneous correlation.

	DF	Spread	Model Turnover	Am.Spread
A	45	147.58***	148.37***	512.78***
B	45	147.67***	147.14***	513.93***
C	45	757.54***	513.07***	617.10***
D	45	758.63***		618.46***
E	45	757.95***		619.96***

\*\*\* significant at 1% level

The results in Table 7.12 indicate that there is also very strong statistical evidence to reject the null hypothesis of no contemporaneous correlation in the Full Models.

This indicates that the use of both the SUR and CSCTA Models to estimate the Full Models is also appropriate.

Both the SUR and CSCTA Models are based on the assumption of homoskedasticity (constant disturbance variance) within each cross-sectional unit so homoskedasticity was tested for within each portfolio. The results presented in Table 7.13 relate to the Full Model for each liquidity proxy.<sup>4</sup>

<sup>4</sup> The Breusch-Pagan diagnostic test was also conducted on the respective Basic Models. There was insufficient evidence, at the 10% level of significance, to reject the null hypothesis of homoskedasticity within each portfolio in each of these tests.

**Table 7.13****Full Model Breusch-Pagan Homoskedasticity Test Results (Australia)**

The Breusch-Pagan Test was conducted separately for each portfolio for each liquidity proxy using the respective Full Models (the models that include the January dummy variables). The null hypothesis of each test is homoskedasticity.

Portfolio	Portfolio Number	DF	Chi-square statistic
Spread	1	5	2.688
	2	5	6.159
	3	5	3.648
	4	5	8.467
	5	5	7.801
	6	5	4.986
	7	5	6.611
	8	5	8.729
	9	5	4.982
	10	5	3.451
Turnover	1	5	5.641
	2	5	9.028
	3	5	10.154
	4	5	4.263
	5	5	3.525
	6	5	6.312
	7	5	5.840
	8	5	3.301
	9	5	2.243
	10	5	7.624
Am.Spread	1	5	0.203
	2	5	6.831
	3	5	4.584
	4	5	5.372
	5	5	10.486*
	6	5	4.111
	7	5	9.268
	8	5	11.056*
	9	5	10.479
	10	5	4.432

\* significant at 10% level

Under the null hypothesis that homoskedasticity exists, the Breusch-Pagan test has a large sample approximate  $\chi^2_{(S)}$  distribution, with the number of degrees of freedom  $S$  being equal to the number of explanatory variables. Table 7.13 indicates that the null hypothesis of homoskedasticity within each portfolio is only rejected in Amortised Spread portfolios five and eight at the 10% significance level. Therefore, it would appear that heteroskedasticity is not a major problem in the data.

The SUR Model relies on the assumption of no autocorrelation, while the CSCTA Model accounts for first order autocorrelation. The Durbin-Watson test for first order autocorrelation was employed to see if the CSCTA Model is superior to the SUR Model based on this feature. The Full Model was used.<sup>5</sup>

**Table 7.14**  
**Full Model Durbin-Watson Test Results (Australia)**

The Durbin-Watson Test was conducted separately for each portfolio for each liquidity proxy using the respective Full Models (the models that include the January dummy variables). The null hypothesis of each test is no first order autocorrelation.

Model	Portfolio Number	RHO	D-W Statistic
Spread	1	-ve	2.193
	2	-ve	2.484
	3	+ve	1.938
	4	-ve	2.600**
	5	+ve	1.912
	6	+ve	1.811
	7	+ve	1.188**
	8	+ve	1.730
	9	-ve	2.163
	10	-ve	1.975
Turnover	1	+ve	1.209**
	2	-ve	2.377
	3	-ve	2.033
	4	-ve	2.175
	5	+ve	1.236**
	6	+ve	2.022
	7	-ve	2.277
	8	+ve	1.928
	9	+ve	1.285**
	10	+ve	1.925
Am.Spread	1	-ve	2.197
	2	+ve	1.902
	3	-ve	2.222
	4	-ve	2.009
	5	-ve	2.009
	6	-ve	2.318
	7	-ve	2.278
	8	-ve	2.409
	9	-ve	3.052***
	10	-ve	2.118

\*\*\* significant at 1% level    \*\* significant at 5% level

<sup>5</sup> As mentioned in Chapter Five, a variant of the Durbin Watson test was used to test for second to twelfth order autocorrelation in each portfolio for each liquidity proxy (the Full Model was used). There was insufficient evidence (at the 5% level) to reject the null hypothesis of no autocorrelation in each of these tests.

The coefficient of Rho indicates the sign of the first order autocorrelation. For the Spread Model the null hypothesis of no first order autocorrelation in portfolios four and seven is rejected at the 5% level of significance. For the Turnover Model the null hypothesis of no first order autocorrelation is rejected at the 5% level for portfolios one, five and nine. The null hypothesis is rejected at the 1% level in portfolio nine for the Amortised Spread Model. There appears to be benefits in estimating all three models using the CSCTA Model rather than the SUR Model.

The results of the tests that were conducted to assess the appropriateness of the restrictions placed on the variables by the SUR and CSCTA techniques adopted by this study are now considered. The first series of tests, which have the null hypothesis that the coefficient of each variable is the same across portfolios, are computed separately for each variable. The second test has the null hypothesis that the coefficients of each like variable are all the same across portfolios. Each series of tests was conducted separately for each of the three liquidity proxy models.

**Table 7.15**  
**Results of Tests for Variable Coefficient Equality Across Portfolios in the Spread Model (Australia)**

Each of the tests has the null hypothesis that the coefficient of each variable is the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

Variable	DF	Wald Chi-square statistic
Spread	9	36.703***
Log(Size)	9	10.243
Rm	9	30.222***
Jan	9	14.456
JanSpread	9	18.429**
JanLog(Size)	9	14.994*

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

**Table 7.16**  
**Results of Tests for Variable Coefficient Equality Across Portfolios in the Turnover Model (Australia)**

Each of the tests has the null hypothesis that the coefficient of each variable is the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

Variable	DF	Wald Chi-square statistic
Turnover	9	22.542 <sup>***</sup>
Log(Size)	9	10.561
Rm	9	313.701 <sup>***</sup>
Jan	9	16.277 <sup>*</sup>
JanTurnover	9	4.885
JanLog(Size)	9	15.976 <sup>*</sup>

<sup>\*\*\*</sup> significant at 1% level

<sup>\*</sup> significant at 10% level

**Table 7.17**  
**Results of Tests for Variable Coefficient Equality Across Portfolios in the Amortised Spread Model (Australia)**

Each of the tests has the null hypothesis that the coefficient of each variable is the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

Variable	DF	Wald Chi-square statistic
Am.Spread	9	12.595
Log(Size)	9	40.345 <sup>***</sup>
Rm	9	23.956 <sup>***</sup>
Jan	9	17.252 <sup>*</sup>
JanAm.Spread	9	13.389
JanLog(Size)	9	17.554 <sup>**</sup>

<sup>\*\*\*</sup> significant at 1% level

<sup>\*\*</sup> significant at 5% level

<sup>\*</sup> significant at 10% level

**Table 7.18**  
**Results of Tests for Variable Coefficient Equality Across All Portfolios in Each Liquidity Model (Australia)**

Each of the tests has the null hypothesis that the coefficients of each like variable are all the same across portfolios. The Wald chi-square statistic, which is equivalent to the F statistic multiplied by the number of hypotheses  $q$  and is distributed  $\chi^2$  with  $q$  degrees of freedom, is reported.

Variable	DF	Wald Chi-square statistic
Spread	45	120.841 <sup>***</sup>
Turnover	45	64.763 <sup>**</sup>
Am.Spread	45	95.572 <sup>***</sup>

<sup>\*\*\*</sup> significant at 1% level

<sup>\*\*</sup> significant at 5% level

The results indicate that the null hypothesis that the beta coefficients are the same across portfolios is rejected at the 1% level of significance in all three models. This suggests that the CSCTA Model, which restricts the beta of each portfolio (in each model) to be equal, is quite limiting.

Further analysis of the first series of test results shows that, for the Spread Model, the null hypothesis that the coefficients of the spread variable are equal across portfolios is rejected at the 1% significance level. In addition, the null hypotheses that the coefficients of the JanSpread and JanLog(Size) variables are equal across portfolios are rejected at the 5% and 10% significance levels respectively. In the Turnover Model, the null hypothesis that the coefficients of the turnover variable are the same across portfolios is rejected at the 1% significance level. Additionally, the null hypotheses that the coefficient of the Jan and JanLog(Size) variables are equal across portfolios are rejected at the 10% significance level. In the Amortised Spread Model, the null hypotheses that the coefficients of the log(size), JanLog(Size), and Jan variables are the same across portfolios are rejected at the 1%, 5%, and 10% significance levels respectively.

The results in Table 7.18 reveal that the null hypothesis that the coefficients of each like variable are all the same across portfolios is rejected at the 1% level in the Spread and Amortised Spread Models, and at the 5% level in the Turnover Model. While less than ideal, based on these results, the imposition of restrictions to ensure coefficient equality across portfolios is necessary as it allows one result for the whole data rather than separate results for each portfolio.

## **7.2 Australian Basic Model Regression Results**

Consideration is now given to the regression results from the Basic Models that were employed for each liquidity proxy. Each Basic Model was estimated using both the SUR and CSCTA techniques. The models that were tested are presented first, followed by the results.

## Basic Models

### Spread

#### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \beta_p R_{m_t} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta_p R_{m_t} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

#### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \beta R_{m_t} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta R_{m_t} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 \text{Spread}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

As was discussed in Chapter Six, the SUR Model has not restricted the coefficient of the return on market (Rm) variable to be the same across portfolios, whereas the CSCTA Model has made this restriction.

**Table 7.19**  
**Basic Spread Model SUR Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.059*** (0.002)	-0.101*** (0.013)	0.003* (0.002)	-0.006 (0.021)	-0.114*** (0.015)
Spread	0.004 (0.015)			-0.026* (0.014)	0.027 (0.017)
Log(Size)		-0.002*** (0.001)		0.001 (0.001)	-0.003*** (0.001)
Rm			1.045*** (0.037)	1.029*** (0.473)	
N	480	480	480	480	480
R <sup>2</sup>	92.25%	92.48%	96.17%	96.71%	92.47%

**Table 7.20**  
**Basic Spread Model CSCTA Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.061*** (0.002)	-0.097*** (0.014)	0.003* (0.002)	-0.013 (0.012)	-0.108*** (0.016)
Spread	0.007 (0.016)			-0.016 (0.013)	0.025 (0.018)
Log(Size)		-0.002*** (0.001)		0.001 (0.001)	-0.002*** (0.001)
Rm			1.064*** (0.030)	1.063*** (0.030)	
N	480	480	480	480	480
R <sup>2</sup>	0.04%	1.55%	72.58%	72.86%	2.01%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

As discussed in Chapter Six, the Buse (1973) R<sup>2</sup> is reported for the CSCTA Models, while a system R<sup>2</sup> advocated by Berndt (1991) is reported for the SUR Models. The convention of firstly examining whether spread, log(size), or Rm explain returns by themselves is followed. The results in the first two columns of Tables 7.19 and 7.20 indicate that spread is not statistically significant in either the SUR or CSCTA Models. The log(size) variable is however statistically significant at the 1% level. The coefficient of -0.002 indicates that a \$1 decrease in the logarithm of firm size can be expected to result in a 0.2% increase in return. A \$1 decrease in actual firm

size can be expected to result in a larger increase in return. The constants in models A and B are statistically significant, indicating that the regressions do not run through the origin. However, this is not economically significant.

From column C in Tables 7.19 and 7.20, it is evident that the  $R_m$  variable is statistically significant at a 1% level, indicating that movements in the Market Index are good predictors of return. A positive beta coefficient close to one was expected. Beta for individual stocks, is a measure of the responsiveness of movement in stock returns to movements in the Market index. In this case, beta is a measure of the average relationship between the return of all stocks listed on the ASX that satisfied the portfolio formation criteria, and an equally weighted index based on all stocks listed on the ASX. The  $R_m$  variable remains statistically significant at the 1% level when all three explanatory variables are included in the same regression. The spread variable has a statistically significant (at the 10% level) negative coefficient when the SUR technique is used but not when the CSCTA technique is used.

The  $R_m$  variable was then excluded in regression E to see if its highly significant nature was obscuring the significance of the other variables. The results indicate that this is the case. When  $R_m$  was excluded, the  $\log(\text{size})$  variable became statistically significant at the 1% level.

The Buse (1973)  $R^2$  values reported for the CSCTA Models (which are likely to be more accurate than the system  $R^2$  reported for the SUR Model) of regressions C and D are considerably higher than the  $R^2$  values of regressions A, B, and E in each of the models. This gives further indication of the importance of the  $R_m$  variable in explaining return.

The difference between the SUR and CSCTA results for the Basic Spread Model are quite small. This indicates that first order autocorrelation and the restriction of beta equality across portfolios have little effect on the SUR and CSCTA techniques respectively.

**Turnover**SUR

(A)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \eta_{pt}$

(B)  $R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

(C)  $R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$

(D)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta_p Rm_t + \eta_{pt}$

(E)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$

CSCTA

(A)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \eta_{pt}$

(B)  $R_{pt} = \alpha + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

(C)  $R_{pt} = \alpha + \beta Rm_t + \eta_{pt}$

(D)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \beta Rm_t + \eta_{pt}$

(E)  $R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log(Size)}_{pt} + \eta_{pt}$

$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$

**Table 7.21****Basic Turnover Model SUR Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.045 <sup>***</sup> (0.001)	0.020 <sup>*</sup> (0.012)	0.005 <sup>***</sup> (0.001)	-0.015 (0.022)	0.033 <sup>***</sup> (0.013)
Turnover	-0.322 <sup>***</sup> (0.064)			0.114 <sup>***</sup> (0.038)	-0.366 <sup>***</sup> (0.071)
Log(Size)		-0.004 <sup>***</sup> (0.001)		0.001 (0.001)	-0.004 <sup>***</sup> (0.001)
Rm			1.081 <sup>***</sup> (0.000)	0.995 <sup>***</sup> (0.000)	
N	480	480	480	480	480
R <sup>2</sup>	81.97%	88.74%	93.24%	94.46%	89.11%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

**Table 7.22****Basic Turnover Model CSCTA Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.048*** (0.019)	0.053*** (0.020)	0.010*** (0.002)	0.021* (0.013)	0.046*** (0.017)
Turnover	-0.261*** (0.064)			0.033 (0.036)	-0.306*** (0.070)
Log(Size)		-0.005*** (0.001)		-0.001 (0.001)	-0.005*** (0.001)
Rm			1.169*** (0.028)	1.163*** (0.027)	
N	480	480	480	480	480
R <sup>2</sup>	3.28%	5.65%	78.67%	78.68%	9.21%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

Column A of Tables 7.21 and 7.22 indicates that turnover is statistically significant at the 1% level using both the SUR and CSCTA techniques. The coefficient of -0.322 in the SUR Model means that a one unit decrease in turnover can be expected to result in an, on average, 32.2% increase in return. Or, more realistically, a 0.1 unit decrease in turnover rate can be expected to result in a 3.22% increase in return.

Consistent with the Basic Spread Model, a statistically significant (at the 1% level) negative relationship between return and log(size) and positive relationship between return and Rm are evident. When all three explanatory variables are included in the same equation (regression D) log(size) is not statistically significant using either technique, while turnover is not statistically significant using the CSCTA technique. Regression E confirms that the strong significance of the Rm variable obscures the results. When Rm is excluded, both turnover and log(size) are statistically significant at the 1% level.

The dominance of the Rm variable in explaining returns is confirmed by the R<sup>2</sup> values of each regression. When the Rm variable is included the R<sup>2</sup> is always larger, and in the case of the CSCTA Model, substantially larger.

As in the Basic Spread Model, the difference between the results obtained using the SUR and CSCTA techniques are quite small in the Basic Turnover Model. This indicates that neither the restriction of beta coefficient equality across portfolios in the CSCTA Model nor first order autocorrelation had a major impact on the results.

### Amortised Spread

#### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \beta_p Rm_t + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta_p Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

#### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \beta Rm_t + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta Rm_t + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

**Table 7.23****Basic Amortised Spread Model SUR Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.058 <sup>***</sup> (0.002)	0.025 <sup>**</sup> (0.012)	-0.063 <sup>***</sup> (0.003)	-0.033 <sup>**</sup> (0.015)	-0.029 <sup>**</sup> (0.013)
Am.Spread	0.326 (0.228)			0.005 (0.276)	0.206 (0.235)
Log(Size)		-0.001 <sup>***</sup> (0.000)		-0.001 <sup>***</sup> (0.000)	-0.001 <sup>***</sup> (0.000)
Rm			1.031 <sup>***</sup> (0.102)	1.028 <sup>***</sup> (0.110)	
N	480	480	480	480	480
R <sup>2</sup>	89.29%	89.48%	90.20%	90.27%	89.49%

**Table 7.24****Basic Amortised Spread Model CSCTA Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.057 <sup>**</sup> (0.002)	-0.027 <sup>**</sup> (0.012)	-0.063 <sup>***</sup> (0.002)	-0.029 <sup>**</sup> (0.011)	-0.027 <sup>**</sup> (0.013)
Am.Spread	0.245 (0.231)			0.067 (0.225)	0.155 (0.234)
Log(Size)		-0.001 <sup>***</sup> (0.000)		-0.001 <sup>***</sup> (0.000)	-0.001 <sup>***</sup> (0.000)
Rm			1.033 <sup>***</sup> (0.065)	1.037 <sup>***</sup> (0.066)	
N	480	480	480	480	480
R <sup>2</sup>	0.02%	1.20%	65.16%	67.75%	1.31%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

The Basic Amortised Spread Model results are very similar to the Basic Spread Model results. The amortised spread variable is not statistically significant, while the size and Rm variables are both statistically significant at the 1% level. These variables have a negative and positive coefficient respectively.

Regressions D and E reveal that the inclusion of the three explanatory variables in the same equation results in only a small change their coefficient and no change in their level of significance. Unlike in the Basic Spread and Turnover Models, the strong significance of the  $R_m$  variable does not obscure the significance the size variable.

Consistent with the Basic Spread and Basic Turnover Models, the trend of substantially higher  $R^2$  values when the  $R_m$  variable is included is also evident in the Basic Amortised Spread Model. Also in line with the Basic Spread and Basic Turnover Models is the similarity of results under the SUR and CSCTA techniques.

The Full Model regression results are now considered. For each liquidity proxy both the SUR and CSCTA techniques were used. As with the Basic Models, the format of presenting the models that were tested and then the results in tabular form is adopted.

### 7.3 Australian Full Model Regression Results

#### Spread

##### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta_p R_{m_t} + \gamma_3 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta_p R_{m_t} + \gamma_3 Jan_{pt} + \gamma_4 Jan Spread_{pt} + \gamma_5 Jan Log(Size)_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 Jan Spread_{pt} + \gamma_5 Jan Log(Size)_{pt} + \eta_{pt}$$

$$(D) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_5 Jan Log(Size)_{pt} + \eta_{pt}$$

$$(E) \quad R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

## CSCTA

$$(A) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta Rm_t + \gamma_3 Jan_{pt} + \eta_{pt}$$

$$(B) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta Rm_t + \gamma_3 Jan_{pt} + \gamma_4 JanSpread_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$$

$$(C) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanSpread_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$$

$$(D) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$$

$$(E) R_{pt} = \alpha + \gamma_1 Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \eta_{pt}$$

( $t = 1, 2, 3, \dots, 48$ , and  $p = 1, 2, 3, \dots, 10$ ).

**Table 7.25**  
**Full Spread Model SUR Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.004 (0.021)	-0.004 (0.021)	-0.114*** (0.016)	-0.114 (0.016)	-0.115*** (0.015)
Spread	-0.027** (0.014)	-0.030** (0.014)	0.027 (0.017)	0.027 (0.017)	0.027 (0.017)
Log(Size)	0.001 (0.001)	0.001 (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)
Rm	1.029*** (0.047)	1.034*** (0.047)			
Jan	0.002 (0.002)	0.001 (0.048)	0.020 (0.054)	0.014 (0.046)	0.002 (0.001)
JanSpread		0.037 (0.483)	-0.015 (0.071)		
JanLog(Size)		-0.000 (0.002)	-0.001 (0.002)	-0.001 (0.002)	
N	480	480	480	480	480
R <sup>2</sup>	96.13%	96.43%	92.47%	92.46%	92.38%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

**Table 7.26**  
**Full Spread Model CSCTA Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.012 (0.012)	-0.013 (0.013)	-0.110*** (0.016)	-0.110*** (0.016)	-0.108*** (0.016)
Spread	-0.017 (0.013)	-0.018 (0.013)	0.026 (0.018)	0.256 (0.017)	0.025 (0.018)
Log(Size)	0.001 (0.01)	0.001 (0.001)	-0.002*** (0.001)	-0.002*** (0.001)	-0.002*** (0.001)
Rm	1.062*** (0.030)	1.063*** (0.030)			
Jan	0.002 (0.002)	0.012 (0.045)	0.035 (0.052)	0.024 (0.044)	0.004 (0.006)
JanSpread		0.023 (0.050)	-0.028 (0.069)		
JanLog(Size)		-0.001 (0.002)	-0.001 (0.024)	-0.001 (0.002)	
N	480	480	480	480	480
R <sup>2</sup>	72.52%	72.54%	2.18%	2.16%	2.13%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

The first regression undertaken in the Full Spread Model includes the four explanatory variables and a dummy variable called Jan which equals one in January months and zero in non-January months. Column A of Tables 7.25 and 7.26 report the results of this regression. It is evident that the Return on Market (Rm) variable is statistically significant (at the 1% level), as was the case in the Basic Spread Model. The spread variable is negative and statistically significant at the 5% level using the SUR technique but is not statistically significant using the CSCTA technique.

A regression, which also included interaction dummy variables for spread and log(size), was then conducted. The Rm and spread variables remain statistically significant at their previous levels. However, no other variables are statistically significant.

As in the Basic Models, the Rm variable was then excluded to determine whether its highly significant nature was obscuring the significance of other variables. This appears to be the case. From column C of Tables 7.25 and 7.26, it is evident that

without the  $R_m$  variable the  $\log(\text{size})$  variable becomes statistically significant at the 1% level. The process of excluding the insignificant variables one at a time is undertaken.  $\log(\text{size})$  remains the only statistically significant variable. None of the January dummy variables are statistically significant.

Consistent with the Basic Spread Model, there is very little difference between the SUR and CSCTA results. The trend of higher  $R^2$  values when  $R_m$  is included is also evident in the Full Spread Model.

The three statistically significant variables are consistently more significant in the SUR Model than the CSCTA Model. This maybe due to the first order autocorrelation.

## Turnover

### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{mt} + \gamma_3 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta_p R_{mt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanTurnover}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanTurnover}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

### CSCTA

$$(A) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta R_{mt} + \gamma_3 \text{Jan}_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \beta R_{mt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanTurnover}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(C) \quad R_{pt} = \alpha + \gamma_1 \text{Turnover}_{pt} + \gamma_2 \text{Log}(\text{Size})_{pt} + \gamma_3 \text{Jan}_{pt} + \gamma_4 \text{JanTurnover}_{pt} + \gamma_5 \text{JanLog}(\text{Size})_{pt} + \eta_{pt}$$

$$(t = 1, 2, 3, \dots, 48, \text{ and } p = 1, 2, 3, \dots, 10).$$

**Table 7.27**  
**Full Turnover Model SUR Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C
Constant	-0.016 (0.022)	-0.010 (0.023)	0.041*** (0.014)
Turnover	-0.115*** (0.038)	-0.109*** (0.042)	-0.431*** (0.000)
Log(Size)	0.001 (0.001)	0.001 (0.001)	-0.004*** (0.001)
Rm	1.057** (0.000)	1.056*** (0.000)	
Jan	0.000 (0.001)	-0.034 (0.042)	-0.119** (0.048)
JanTurnover		0.015 (0.096)	0.462** (0.227)
JanLog(Size)		0.002 (0.002)	0.006** (0.002)
N	480	480	480
R <sup>2</sup>	95.79	96.16	81.45

**Table 7.28**  
**Full Turnover Model CSCTA Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C
Constant	0.021 (0.013)	0.027** (0.014)	0.054*** (0.017)
Turnover	0.034 (0.036)	0.020 (0.040)	-0.368*** (0.072)
Log(Size)	-0.001 (0.001)	-0.001 (0.001)	-0.005*** (0.001)
Rm	1.163*** (0.028)	1.157*** (0.029)	
Jan	0.000 (0.001)	-0.046 (0.040)	-0.134*** (0.042)
JanTurnover		0.065 (0.094)	0.403** (0.196)
JanLog(Size)		0.002 (0.002)	0.006*** (0.002)
N	480	480	480
R <sup>2</sup>	76.74%	77.50%	10.92%

\*\*\* significant at 1% level  
 \*\* significant at 5% level  
 \* significant at 10% level

Like in the Full Spread Model, the first regression conducted in the Full Turnover Model includes the four explanatory variables and the January dummy variable. Consistent with the Basic Turnover Model, the turnover and  $R_m$  variables are both statistically significant when the SUR technique is used. However only  $R_m$  is statistically significant when the CSCTA technique is employed. None of the interaction dummy variables are statistically significant in the presence of  $R_m$ .

However, when  $R_m$  is excluded Jan, JanTurnover, and JanLog(Size) are statistically significant at either the 5% or 1% level. The negative coefficient of 0.119 for Jan using the SUR technique means that returns are 11.9% lower in January months than non-January months, all other factors constant. The positive coefficient of 0.462 for the JanTurnover variable (in the SUR Model) indicates that, in January months, a unit increase in turnover results in an on average 46.2% increase in return. Or, more realistically, a 0.1 unit increase in turnover in January months results in an, on average, 4.62% increase in return. The positive coefficient of 0.006 for the JanLog(Size) variable means that a \$1 increase in the logarithm of size in January months results in a 0.6% increase in return, all other factors held constant.

Interestingly, both turnover and log(size) have statistically significant (at the 1% level) negative coefficients when  $R_m$  is excluded. This indicates that, while positive in January months, the relationship between return and each of these two variables is negative overall.

Consistent with the Basic Turnover Model, there is only a small difference in the results produced by the SUR and CSCTA techniques. A lower  $R^2$  value when the  $R_m$  variable is excluded is also evident.

### **Amortised Spread**

#### SUR

$$(A) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta_p R_{mt} + \gamma_3 Jan_{pt} + \eta_{pt}$$

$$(B) \quad R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta_p R_{mt} + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$$

- (C)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$
- (D)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \eta_{pt}$
- (E)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \eta_{pt}$
- ( $t = 1, 2, 3, \dots, 48$ , and  $p = 1, 2, 3, \dots, 10$ ).

### CSCTA

- (A)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta Rm_t + \gamma_3 Jan_{pt} + \eta_{pt}$
- (B)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \beta Rm_t + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$
- (C)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \gamma_5 JanLog(Size)_{pt} + \eta_{pt}$
- (D)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanAm.Spread_{pt} + \eta_{pt}$
- (E)  $R_{pt} = \alpha + \gamma_1 Am.Spread_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \eta_{pt}$
- ( $t = 1, 2, 3, \dots, 48$ , and  $p = 1, 2, 3, \dots, 10$ ).

**Table 7.29**

### Full Amortised Spread Model SUR Regression Results (Australia)

Standard errors are presented below the coefficients in parentheses. The reported coefficient and standard error of the Rm variable are portfolio averages. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

Variable	A	B	C	D	E
Constant	-0.034** (0.015)	-0.036 (0.016)	-0.030** (0.013)	-0.027** (0.127)	-0.028** (0.023)
Am.Spread	0.006 (0.277)	0.052 (0.276)	0.250 (0.242)	0.240 (0.240)	0.205 (0.235)
Log(Size)	-0.001* (0.001)	-0.001* (0.001)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
Rm	1.025*** (0.011)	1.014*** (0.012)			
Jan	-0.002 (0.007)	0.033 (0.046)	0.029 (0.047)	0.001 (0.009)	-0.002 (0.008)
JanAm.Spread		-1.864 (1.375)	-1.807 (1.409)	-1.545 (1.328)	
JanLog(Size)		-0.001 (0.017)	-0.001 (0.017)		
N	480	480	480	480	480
R <sup>2</sup>	90.22%	92.32%	90.32%	89.48%	89.47%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

**Table 7.30****Full Amortised Spread Model CSCTA Regression Results (Australia)**

Standard errors are presented below the coefficients in parentheses. The number of observations included in each regression, N, pertains to four years of monthly data for ten portfolios.

<b>Variable</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
Constant	-0.029*** (0.011)	-0.031*** (0.012)	-0.030** (0.013)	-0.028** (0.012)	-0.028** (0.012)
Am.Spread	0.068 (0.222)	0.125 (0.224)	0.203 (0.237)	0.193 (0.236)	0.153 (0.234)
Log(Size)	-0.001 (0.001)	-0.001*** (0.000)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
Rm	1.037*** (0.001)	1.036*** (0.007)			
Jan	-0.003 (0.007)	0.026 (0.045)	0.029 (0.046)	-0.000 (0.008)	-0.003 (0.008)
JanAm.Spread		-1.716 (1.325)	-1.787 (1.342)	-1.516 (1.274)	
JanLog(Size)		-0.001 (0.002)	-0.001 (0.007)		
N	480	480	480	480	480
R <sup>2</sup>	67.89%	68.09%	1.75%	1.65%	1.37%

\*\*\* significant at 1% level

\*\* significant at 5% level

\* significant at 10% level

The process explained for the Full Spread and Turnover Models was also used in the Full Amortised Spread Model. Similar to the situation with the Basic Amortised Spread Model, log(size) and Rm are the only statistically significant variables.

Unlike in the Spread and Turnover Models, log(size) is statistically significant in the presence of Rm in the Full Amortised Spread Model. In the Full Amortised Spread Model none of the January dummy variables are statistically significant.

The results are very similar for the Full Amortised Spread Model using the SUR and CSCTA techniques. The trend of higher R<sup>2</sup> values when Rm is included in the regression is also evident.

Comparison of regressions B and C in each of the Full Spread and Turnover Models (see Tables 7.25 – 7.28) reveals that the Rm variable obscures the statistical significance of the other variables. In the Full Spread Model, log(size) becomes statistically significant when Rm is excluded, while in the Full Turnover Model the

variables Jan, JanTurnover, and JanLog(Size) all become statistically significant or more statistically significant when Rm is excluded.

Due to the level of obscurity resulting from the Rm variable it was incorporated into the prediction equation in the following manner:

Return was regressed against Rm using SUR Model as follows:

$$R_{pt} = \alpha_1 + \beta_p Rm_t + \eta_{pt} \quad (7.1)$$

The other variables were then used to model the variation in the error term,  $\eta_{pt}$ , as shown below:

$$\eta_{pt} = \alpha_2 + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanTurnover_{pt} + \gamma_5 JanLog(Size)_{pt} + \xi_{pt} \quad (7.2)$$

Substituting for  $\eta_{pt}$  in equation 7.1 from equation 7.2 results in:

$$R_{pt} = \alpha + \beta_p Rm_t + \gamma_1 Turnover_{pt} + \gamma_2 Log(Size)_{pt} + \gamma_3 Jan_{pt} + \gamma_4 JanTurnover_{pt} + \gamma_5 JanLog(Size)_{pt} + \xi_{pt} \quad (7.3)$$

This method was also applied to the Full Spread Model. It was not applied to the Full Amortised Spread Model because the Rm variable was found not to obscure the significance of the other variables in this model. The results (which are not presented) showed that none of the variables in equation 7.2, or the equivalent variables in the Full Spread Model, were statistically significant at the 10% level. This implies that the variation in the error term from equation one is unexplained by the said variables. Therefore, the predictive power of the Spread and Turnover models cannot be enhanced using this method. While the explanatory variables excluding Rm do not explain any of the variation in return left unexplained by Rm, they are a useful alternative to Rm when it comes to explaining returns in both these models.

## 7.4 Summary of the Australian Results

This section summarises the results presented throughout Chapter Seven. Interpretations are left for Chapter Eight. There is no apparent consistency in the seasonality or time-variation of the liquidity proxies.

In addition, the relationship between return and liquidity is inconsistent across the three liquidity proxies. There is a statistically significant negative relationship between return and spread for the entire year. However, the return-turnover relationship is also statistically significant and negative. There is no statistically significant relationship between return and amortised spread.

There is a strong positive relationship between return and  $R_m$ . A negative statistically significant relationship between return and size for the entire year is found. However, the relationship appears to be positive in January. Interestingly, there is weak evidence that returns are smaller in January, than in other months in the Australian market.

## Chapter Eight Discussion

### 8.1 Do the Results Conflict with the Efficient Market Hypothesis ?

This chapter seeks to consolidate, interpret, and provide explanations for the results presented in Chapters Six and Seven. The results of this research indicate that a number of factors other than beta, influence a security's returns. At first glance, this would seem to be in conflict with the efficient capital market literature, which is at the heart of finance theory. However, closer consideration of this literature reveals that it is possible to reconcile the results of this thesis, and indeed other studies in this area, with the efficient market hypothesis.

The efficient market hypothesis, in its simplest and strongest form, states that security prices fully reflect all available information (Fama, 1991). However, a precondition for this strong version of the hypothesis is that information and trading costs, the costs of getting prices to reflect information, are always zero (Grossman and Stiglitz, 1980). This has led to a weaker and more economically sensible version of the efficient market hypothesis, which proposes that prices reflect information to the point that the marginal benefits of acting on information (the profits to be made) do not exceed the marginal costs (Jensen, 1978).

Consistent with previous asset pricing research, the results of this thesis relate to gross returns (before transaction costs). Any investor who sought to profit based on the existence of a liquidity premium (or any other "effect") would incur transaction costs in doing so. There is no evidence to suggest that the benefits from acting on the knowledge of a liquidity premium (or any other "effect") would outweigh the costs. Therefore, the existence of a liquidity premium (and any other "effect") is

able to be reconciled with the weaker form of the efficient market hypothesis advocated by Jensen (1978).

The regression results from Chapters Six and Seven are summarised in Table 8.2.

**Table 8.1**

**Summary of the New Zealand and Australian Regression Results**

A relationship between return and an explanatory variable is deemed to exist if the regression results indicate that the relationship is statistically significant at the 10% level.

	<b>New Zealand</b>	<b>Australia</b>
<b>Entire Year</b>		
Return-Spread	No Relationship	Negative
Return-Turnover	No Relationship	Negative
Return-Amortised Spread	No Relationship	No Relationship
Return-Size	Negative	Negative
Return-Rm	Positive	Positive
Return-Book-to-market	Positive	No Data
<b>January</b>		
Return-Spread	Negative	No Relationship
Return-Turnover	No Relationship	Positive
Return-Amortised Spread	Positive	No Relationship
Return-Size	Negative	Positive
Return-Book-to-market	Negative	No Data

## 8.2 The Relationship Between Return and Liquidity

It is reasonable to assume that investors are concerned with future rather than present liquidity. The ease with which a stock can be sold in the future is likely to be more important to an investor than the ease with which a stock can be purchased. Here in lies a problem. This study, together with all previous liquidity asset pricing work that the author is aware of, uses observed levels of liquidity as a proxy for future liquidity. Past liquidity levels can only be used as proxies for future liquidity if there is evidence that liquidity is constant over time. The issue of time-variation in each of the three liquidity proxies was considered for both the New Zealand and Australian markets. While there is no clear trend in the three liquidity proxies in either market, there does appear to be moderate variation in each proxy over time. The time

periods studied are reasonably short so it is not possible to reach a strong conclusion. However, there appears to be evidence that present liquidity is not an entirely accurate indicator of future liquidity in either market.

In contrast to the seminal research in this area of Amihud and Mendelson (1986), this study finds evidence of a negative relationship between return and spread. In the New Zealand market this relationship is unique to the month of January, while in the Australian market the relationship exists for the entire year. If spread is accepted as an appropriate measure of liquidity, then such a relationship indicates that there is a negative liquidity effect at work - investors receive higher returns for holding more liquid stocks.

Recent literature has provided the foundation for a negative liquidity premium with papers such as Vayanos (1998), Yu (1998), and Vayanos and Vila (1999) all showing that a negative liquidity premium is a theoretical possibility. However, empirical studies, such as Brennan and Subrahmanyam (1996), have shown that the negative relationship between return and spread is due to spread acting as a proxy for a risk variable that is associated with the reciprocal of price variable. Chen and Kan (1989) pointed out that the spurious relationship between return and spread (or any other variable that is a function of price) occurs due to imprecise beta estimation.

The estimation of betas is a controversial issue in finance literature. The CAPM states that expected asset returns are related to their expected non-diversifiable risk, as measured by their future beta. However, since large-scale systematic data on expectations does not exist, almost all beta estimation is performed using ex-post data.

The methodology employed by this study, the SUR and CSCTA techniques both simultaneously estimate beta and the coefficients of the other explanatory variables. This means that they are not subject to the errors-in-variables problem that is inherent in techniques, such as the one developed by Fama and MacBeth (1973), which first estimate beta and then estimate the coefficients of the other explanatory variables. The SUR and CSCTA techniques do however have a weakness - they both constrain beta to be constant over time. It is therefore possible that the negative

relationship between return and spread is due to this aspect of the beta estimation procedure. However, the evidence from two previous studies suggests otherwise. Both Chen and Kan (1989) and Eleswarapu (1997) employed the Fama and MacBeth (1973) cross-sectional regression technique (which does not constrain beta to be constant over time) and the SUR technique on the same data sets and found no major differences in the return-spread relationship between techniques. It may be that some other aspect of the beta estimation procedure, such as the estimation of portfolio rather than individual stock betas, is the cause of spread acting as proxy for the reciprocal of price variable.

The relationship between return and the other two, theoretically superior, proxies for liquidity (turnover rate and amortised spread) confirm that spread acting as a proxy for the reciprocal of price level (rather than liquidity) is the most likely explanation for the negative return-spread relationship in the New Zealand and Australian markets. This would seem to contradict the Lehman and Modest (1994) proposition that spreads are a better liquidity proxy in order driven markets than they are in hybrid quote driven markets.

There is no apparent relationship between return and amortised spread in the Australian market. However, there is a statistically significant negative relationship between return and turnover. This indicates that there is a liquidity premium in the Australian market. Interestingly, there is evidence of a positive relationship between return and turnover in January. This suggests that while there is a positive liquidity premium overall, there is a negative liquidity premium in January. The theoretical justification for a positive liquidity premium during the entire year is well developed. Investors can reasonably expect to be compensated with larger returns for the risk that they will not be able to sell a stock in a timely fashion without undue loss. However, there is no apparent theoretical justification for a negative liquidity premium in January.

In contrast to the Australian market, there is no statistically significant relationship between return and turnover in the New Zealand market. However, in the month of January there is a positive statistically significant relationship between return and amortised spread. This suggests that there is a liquidity premium in the New Zealand

market in the month of January. However, there is no liquidity premium for the entire year. This is the same result that Eleswarapu and Reinganum (1993) arrived at in their study into liquidity premiums on the NYSE. However, they were unable to provide any theoretical justification for their finding.

Perhaps two behavioural-based arguments can be used to explain the existence of a positive liquidity premium solely in January. Individuals typically have a holiday from work in late December / early January. It is reasonable to assume that during this time they contemplate the year ahead and consider things such as items they wish to purchase. It is also plausible that individuals who have some of their savings invested in the stock market will have to sell some or all of their stock to finance any new purchases. If one also assumes that individuals implement, or at least initiate, a greater proportion of their holiday decisions in January than any other month, it follows that investors will place a higher value on stock market liquidity in January than other months. This means that investors would expect to be compensated with a larger premium for illiquidity in January than other months. An alternative explanation centres on spending before January. Individuals incur many one-off expenses around the festive season. With credit freely available, it is possible that individuals over spend. Consequently, in January when a large proportion of credit repayments is made, it is plausible that stocks have to be sold. Hence, the higher value that is placed on stock market liquidity in January.

These hypotheses also have the potential to explain the existence of abnormal returns in January months, if an additional assumption is allowed in each instance. The first explanation requires the extra assumption that investors initiate a greater proportion of their holiday decisions in early January than any other part of the year. This implies that there is more selling pressure in early January than other times in the year due to investors liquidating their stock holdings to finance their holiday decisions. The second hypothesis requires the additional assumption that individuals begin paying off a greater proportion of their festive season expenditure in early January than the rest of the year. As a result of the increased selling pressure, prices can be expected to decline in early January. In mid to late January, when the selling pressure subsides, prices can be expected to increase. Monthly returns are typically calculated as  $(P_E - P_B) / P_B$ , where  $P_E$  and  $P_B$  are the prices at the end and beginning

of the month respectively. With lower prices at the beginning of January due to the temporary increased selling pressure and prices gradually being restored to their previous levels in mid to late January, it is possible to explain higher returns in January than other months. A detailed analysis of price trends throughout January is needed to determine if there is any substance to the behavioural-based hypothesis regarding liquidity and January returns.

The fact that there is inconsistency in the return-spread, return-turnover, and return-amortised spread relationships between the two markets indicates that one or all of these three measures for liquidity are imperfect. This does not mean that all three measures are inaccurate. It is possible that amortised spread is accurately reflecting the true level of liquidity and spread and turnover are not.

The lack of a consistent, strong relationship between return and liquidity on the pure order driven stock exchanges of New Zealand and Australia was expected based on the findings of previous work in this area. Research has indicated that, in general, order driven stock exchanges tend to be more liquid than their quote driven counterparts. This conclusion is borne out in liquidity asset pricing studies. The return-illiquidity relationship has been found to be strongest on Nasdaq (which was effectively a pure quote driven market at the time of the study). A weaker relationship has been found to exist on both the NYSE (a hybrid quote driven market) and the Tokyo Stock Exchange<sup>1</sup> (an order driven market).

### **8.3 The Relationship Between Return and the Non-Liquidity Explanatory Variables**

The return on market ( $R_m$ ) variable is highly statistically significant in both the New Zealand and Australian markets. This indicates that movements in the market are good predictors of individual stock returns in both markets. In contrast, Bryant and Eleswarapu (1997) and Bartholdy, Fox, Gilbert, Hibbard, McNoe, Potter, Shi, and Watt (1996) both found that beta is a poor predictor of returns in the New Zealand

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<sup>1</sup> The Tokyo Stock Exchange is different to the stock exchanges of both New Zealand and Australia. On the Tokyo Stock Exchange, a *saitori* member monitors trading and calls a halt to trading in certain circumstances. There is no *saitori* equivalent in the New Zealand and Australian stock markets.

market. It is possible that this difference arises due to the different methodologies used. Both Bryant and Eleswarapu (1997) and Bartholody et al. (1996) used the Fama and MacBeth (1973) cross-sectional regression technique, whereas this study employs the SUR and CSCTA techniques. The Fama and MacBeth (1973) approach estimates beta in the first pass using the market model ( $R_{it} = \alpha_i + \beta_i R_{Mt} + e_{it}$ ), then includes beta (along with other explanatory variables) in a second regression equation to assess beta's strength in explaining return. In contrast, the SUR and CSCTA techniques, as they are applied in this research, both simultaneously estimate beta and the coefficients of other non-Rm explanatory variables in a single regression equation.

There is weak evidence that returns are higher in January months than non-January months in the New Zealand market. This is consistent with the findings of Young and Handa (1993), Brailsford (1993), and the majority of studies of return seasonality in other stock markets. In contrast, there is weak evidence that returns are lower in January months in the Australian market. Earlier studies, such as Blume and Stambaugh (1983), have found that the January effect is closely associated with the size effect. Therefore, theoretical justification for the January effect has been linked to the size effect. This thesis follows this convention.

There is strong evidence of a statistically significant negative relationship between return and size in the Australian market. This is consistent with Aitken and Ferris (1991), Lawrance (1998), and the vast majority of size effect studies in other stock markets.

Justifications for the existence of a size effect during the entire year by researchers in the United States are applicable to Australia. One of the first explanations focuses on liquidity. Stoll and Whaley (1983) proposed that the higher returns associated with the stock of smaller firms simply act as compensation for the larger transaction costs associated with smaller firm's stock. Keown, Neustel, and Pinkerton (1984) developed this argument, with the suggestion that firm size serves as a proxy for the availability of information on a firm's stock. Small firms are likely to have fewer analysts following them so there is likely to be less information regarding their performance and prospects in the public arena. With the average investor being less

informed about the prospects of smaller firms than their larger counterparts, the value of any information that insiders have regarding small firms is likely to be greater. This in turn means that adverse selection costs associated with trading a smaller size stock are likely to be larger. Stoll (1989) estimated that adverse selection costs accounted for 43% of the total bid-ask spread. Hence, the link between small firms and larger transaction costs.

More recently, Fama and French (1993) proposed that smaller firms are more likely to suffer financial distress, and the higher returns associated with smaller firms are compensation for higher systematic risk. Alternatively, the Lakonishok, Shleifer, and Vishny (1994) argument that the distress premium identified by Fama and French (1993) is due to investor over-reaction is also plausible. Lakonishok et al. (1994) proposed that the distress premium arises simply because investors dislike distressed stocks and so cause them to be under priced.

Interestingly, there is some evidence of a positive size effect in the month of January in the Australian market. This suggests that while the size effect is negative overall, the returns of larger firms are greater than the returns of their smaller counterparts in January. This is in direct conflict with the substantial body of research (using mostly NYSE data) which has found a strong negative relationship between return and size in January months. There is no apparent theoretical justification for this finding.

There is no consistent relationship between the statistical significance of the return-spread and return-size or the return-amortised spread and return-size relationships in the Australian market. However, both the return-turnover and return-size relationships are negative and statistically significant for the entire year but positive and statistically significant in January. A negative relationship between return and turnover has been proven, both theoretically and empirically, to indicate a positive liquidity premium. This commonality in the return-turnover and return-size relationships therefore indicates that the liquidity based justification for the size effect may be the most appropriate for the Australian market.

There is weak evidence of a negative relationship between return and size in the New Zealand market. However, the evidence points towards the size effect being unique

to January in New Zealand. This is consistent with the findings of research into the size effect for companies listed in the United States. Previous New Zealand research into the size effect has tended not to make the distinction between January months and the rest of the year so it is impossible to ascertain whether the findings of this study are consistent with previous research in this area.

Brown, Keim, Kleidon, and Marsh (1983) proposed the tax-loss selling hypothesis as an explanation for a negative size effect solely in the month of January. They maintained that tax laws influence investors' portfolio decisions by encouraging the sale of securities that have experienced recent price declines so that the (short-term) capital loss can be offset against taxable income.<sup>2</sup> The tax-loss selling effect is said to be larger for small firms because small firms' stock returns are more volatile, and because tax-exempt investors, such as pension funds, have relatively small holdings in small firms' stocks. However, the tax-loss selling hypothesis cannot be used to explain the abnormal returns of small stocks in January in New Zealand for two reasons. Firstly, there is no explicit capital gains tax in New Zealand so it is not generally possible for an investor to offset any capital loss against taxable income.<sup>3</sup> Secondly, the tax year for individuals in New Zealand ends in March not December.

Several of the arguments which have been used by researchers in the United States to explain the abnormal returns of small stocks in January may however be applicable to New Zealand. Ogden (1990) proposed that there is a surge in the cash income of individual investors at year-end due to the payment of annual bonuses. As individual investors are likely to hold small firm stocks this is said to create demand pressure for small firm stocks in late December / early January. In another explanation, Haugen and Lakonishok (1988) argued that "window-dressing" of their portfolios by fund managers at year-end is the cause of the January size effect. Fund managers traditionally disclose the make-up of their portfolios at the end of the calendar year so they are said to sell losing small firm stocks at year-end to avoid the scrutiny and outcry that could accompany a portfolio containing higher risk (small firm) stocks.

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<sup>2</sup> The tax year ends in December for individuals in the United States.

<sup>3</sup> If the New Zealand Inland Revenue Department deems that an individual is in the business of trading shares then it is possible that they will be taxed on any gains (or be able to claim tax on any losses). However, this rarely occurs.

The fund managers are then said to start the new year by investing in higher risk (small firm) stocks in an attempt to realise superior portfolio performance.

Consistent with Chin (1998), Vos and Pepper (1997), and Bryant and Eleswarapu (1997) this research finds evidence of a statistically significant positive relationship between return and book-to-market equity in the New Zealand market. Interestingly, it appears that this relationship is negative in January. This indicates that while value firms tend to earn higher returns than their growth counterparts during the entire year, growth firms outperform value firms in January. Research into the book-to-market equity effect in the United States has, in the main, found a positive relationship between return and book-to-market equity.

Kothari, Shanken, and Sloan (1995a) argued that survivorship bias in the COMPUSTAT database is an important factor in the return-book-to-market equity relationship in the United States. They theorised that the “back-filling-in” procedure COMPUSTAT uses to replace missing data is likely to result in firms with high book-to-market ratios and subsequently high returns being added, and firms with high book-to-market ratios and subsequently low returns being excluded. However, subsequent studies, such as Kim (1997), have suggested that the survivorship bias argument is weak. In any case, the survivorship bias hypothesis cannot be used to explain the relationship between return and book-to-market equity in the New Zealand market. Book value data was collected manually from DATEX year books. Each DATEX publication summarises the balance sheet information of all companies listed on the NZSE during the previous year. Therefore, there is no apparent survivorship bias in this information.

Fama and French (1993) suggested that, as with small size, high book-to-market equity is a proxy for distress. Higher book-to-market equity firms are said to have higher returns as compensation for their greater systematic risk. In contrast, Lakonishok, Shleifer, and Vishny (1994) argued that the distress premium associated with high book-to-market equity firms is due to investor over-reaction. The premium is said to arise simply because investors dislike high book-to-market equity stocks and so cause them to be under priced.

Kothari, Shanken, and Sloan (1995b) found evidence that book-to-market equity is correlated with bid-ask spread. This caused them to suggest that liquidity is a possible explanation of the book-to-market equity effect. Eleswarapu (1997) and Hu (1997b) refuted this argument, using the fact that both book-to-market equity and spread had a statistically significantly positive relationship with return when they were included in the same regression equation as justification. This would seem to be a strong conclusion to reach as it relies on the assumption that spread is a perfect proxy for liquidity. An alternative explanation is that book-to-market equity is acting as a proxy for a different aspect of liquidity to that represented by spread. This scenario is quite plausible given the mounting evidence regarding the inaccuracy of spread as a liquidity proxy.

There is no clear relationship between return and each of the three liquidity proxies, and return and book-to-market equity in the New Zealand market. For the entire year, there is evidence of a positive relationship between book-to-market equity and return but no evidence of a relationship between return and spread, turnover or amortised spread. Although in the month of January, the indications are that book-to-market equity does not act as a liquidity proxy. In January, there is a positive, statistically significant, relationship between amortised spread and return but a negative, statistically significant relationship between book-to-market equity and return. Kothari, Shanken, and Sloan (1995b) proposed that a positive relationship between book-to-market equity and return indicates a positive liquidity premium. Thus, if amortised spread is considered to be an accurate proxy for liquidity (which previous theoretical and empirical research indicates it is) then book-to-market equity cannot be acting as a proxy for liquidity in January. Unfortunately, the necessary data was unavailable so it was not possible to test the relationship between return and book-to-market equity in the Australian market.

It is apparent that  $R_m$  is good at explaining return in both the New Zealand and Australian markets. The  $R_m$  variable is so statistically significant that it obscures the significance of the other explanatory variables in every model other than the Amortised Spread Model for the Australian market. The non- $R_m$  explanatory variables are unable to explain any of the variation in return left unexplained by  $R_m$ . However, they are a useful alternative to  $R_m$  when it comes to explaining return.

## Conclusions

The primary focus of this research is the relationship between liquidity and stock returns on the New Zealand and Australian stock markets for the periods 1993 to 1998 and 1994 to 1998 respectively. There is evidence to suggest that investors are compensated for holding less liquid stocks with higher returns. However, this is the first study, which the author is aware of, to test the relationship in pure order driven exchanges. The combined use of bid-ask spread, turnover rate, and amortised spread as proxies for liquidity, also makes this study unique. Previous studies have investigated the return-liquidity relationship using only one or two of these proxies. In addition to liquidity, other factors that have been found by previous researchers to influence stock returns, such as size, beta, and book-to-market equity are also considered.

The results of this thesis indicate that a number of factors other than beta, influence a security's gross (before transactions costs) returns. This is in conflict with the strongest form of the efficient market hypothesis, which states that security prices fully reflect all available information. However, the results can be reconciled with the weaker, economically more sensible, version of the efficient market hypothesis advocated by Jensen (1978). Jensen proposed that prices reflect information to the point that the marginal benefits of acting on information (the profits to be made) do not exceed the marginal costs. Any investor who sought to profit based on knowledge of the existence of a liquidity premium (or any other "effect") would incur transaction costs in doing so. Therefore, there is no evidence to suggest that the benefits from acting on the knowledge of a liquidity premium (or any other "effect") would outweigh the costs.

In contrast to earlier work on quote driven markets, this study finds evidence of a negative relationship between return and spread. In New Zealand, this relationship is unique to the month of January, while in Australia the relationship persists for the

entire year. There are two possible explanations. The first is that spread is accurately representing liquidity, indicating that there is a negative liquidity premium in New Zealand in January and in Australia for the entire year. While there is some theoretical justification for a negative liquidity premium in the literature, this explanation seems unlikely because neither turnover nor amortised spreads (which have both been proven to be superior proxies for liquidity) provide evidence that is consistent with this. The more likely explanation is that spread is acting as a proxy for a risk variable associated with the reciprocal of price variable due to inaccurate beta estimation. In this study, beta inaccuracies may stem from the fact that the SUR and CSCTA techniques both constrain the beta of each portfolio to be constant over time. However, previous work in this area indicates that it is more likely that another aspect of the beta estimation procedure, such as the estimation of portfolio rather than individual stock betas, is the cause of spread acting as a proxy for the reciprocal of price variable.

The relationship between return and turnover in the Australian market is negative and statistically significant during the entire year but positive and statistically significant during January. This indicates that there is a positive liquidity premium overall but a negative liquidity premium in January. The theoretical justification for the positive liquidity premium overall is well developed. Investors can reasonably expect to be compensated with larger returns for the risk that they will not be able to sell a stock in a timely fashion without undue loss. However, there is no theoretical justification for a negative liquidity premium in January.

There is no statistically significant relationship between return and turnover in the New Zealand market. However, there is a statistically significant relationship between return and amortised spread in January. This suggests that there is a positive liquidity premium in January in New Zealand. While a previous study found a positive liquidity premium to be unique to January on the NYSE, there is no documented explanation for such a finding. This research proposes two behavioural-based explanations. The first is based around future planning during holiday time at the end of the calendar year. It is hypothesised that individuals use their break from work to plan major expenditure for the coming year. It is further hypothesised that individuals have to sell some or all of their stock to finance any purchases.

Individuals are said to implement, or at least initiate a greater proportion of their holiday decisions in January than other months causing them to place a higher value on stock market liquidity in January than the rest of the year. The second explanation centres on festive season spending. It is proposed that part of this abnormal spending is financed with credit that must be repaid in January. Individuals are said to sell down their stock holdings to finance these repayments. Therefore, investors place more importance on stock market liquidity in January than they do in the rest of the year.

The inconsistency in the return-spread, return-turnover, and return-amortised relationships in the two markets indicates that one or all of these three measures of liquidity are imperfect. It does not necessarily imply that all three proxies are inaccurate. For instance, it is possible that amortised spread is a good proxy for liquidity and turnover and spread are not.

The finding of no consistent, strong relationship between return and liquidity in New Zealand and Australia was not unexpected. Studies have indicated that, in general, order driven exchanges tend to be more liquid than their quote driven counterparts. This conclusion is borne out in liquidity asset pricing studies. The return-illiquidity relationship has been found to be strongest on Nasdaq, while a weaker relationship has been found to exist on the NYSE and the Tokyo Stock Exchange.

Consistent with earlier research, there is weak evidence that returns in the New Zealand market are higher in January than non-January months. Interestingly, there is weak evidence of the opposite in the Australian market - returns appear to be larger in non-January months than in January.

There is evidence of a statistically significant negative relationship between return and size in the Australian market. This is in line with the findings of previous research. The theoretical justifications for the existence of a size effect in overseas stock markets appear to be applicable to the Australian market. Of these explanations, the liquidity argument, which has its origins in Stoll and Whaley (1983) is particularly appealing, because there appears to be a relationship between the statistical significance of the return-turnover and return-size relationships. There

is some evidence that larger firms earn higher returns in January in the Australian market. However, there is no apparent theoretical justification for this finding.

There is weak evidence of a negative relationship between return and size for the entire year in the New Zealand market. However, there is much stronger evidence that the return-size relationship is unique to the month of January. Previous studies that have documented the existence of the size effect in January have provided several possible explanations. The most common one – the tax-loss selling hypothesis is not applicable to New Zealand due to differences in New Zealand's tax law. However, the "annual bonus" hypothesis of Ogden (1990) and the "fund manager window-dressing" argument of Haugen and Lakonishok (1988) are potential explanations.

Consistent with earlier studies, this research finds evidence of a statistically significant positive relationship between return and book-to-market equity in the New Zealand market. Interestingly there is evidence that this relationship is negative in January. This indicates that while value firms outperform growth firms during the entire year, growth firms outperform their value firm counterparts in January. The argument of data base "survivorship bias," which has been advanced as an explanation for the positive book-to-market equity effect in the United States, does not apply to this study. There is also evidence that the liquidity based explanation of Kothari, Shanken, and Sloan (1995b) does not apply to New Zealand. However, it is possible that the distress premium argument of Fama and French (1993) and the investor over-reaction argument of Lakonishok, Shleifer, and Vishny (1994) explain the book-to-market equity effect in New Zealand.

The methodologies employed by this study both simultaneously estimate the coefficient of the return on market variable ( $R_m$ ) and the other explanatory variables. For this reason, the  $R_m$  is talked about rather than beta. The  $R_m$  variable is good at explaining variation in return in both the New Zealand and Australian markets. In fact, the  $R_m$  variable is so statistically significant that it obscures the significance of the other explanatory variables. The non- $R_m$  explanatory variables are not able to explain any of the variation in return left unexplained by  $R_m$ . However, they are a useful alternative to  $R_m$  when it comes to explaining return.

## Future Research

There is much scope for further research in this area. An obvious progression is a test of the robustness of these results using a larger data set. Data availability is an issue with both the New Zealand and Australian markets so the choice of a larger pure order driven stock exchange such as Hong Kong is logical.

Future studies in this area could give more consideration to the behavioural-based explanation of liquidity and January returns. Analysis of stock price movements throughout January would be the logical approach.

Since spread is frequently used as a liquidity proxy, it is desirable to investigate further the relationship between return and spread in a pure order driven environment. Future research could consider the relationship between spread and a reciprocal of price variable in pure order driven exchanges, where minimum tick sizes tend to be smaller, to see if the strong correlation which has been documented on quote driven exchanges is evident.

There is no doubt that the most fruitful area for future research into the relationship between liquidity and asset pricing lies in the adoption of new and improved proxies for liquidity. With increased data availability and advances in technology it is becoming possible to test empirically dynamic measures of liquidity, which have previously been restricted to theoretical research.

## References

- Ahn, H.J., Cao, C.Q. & Choe, H. (1996). Tick size, spread, and volume. *Journal of Financial Intermediation*, 5, 2-22.
- Aigner, D.J. (1974). MSE dominance of least squares with errors-of-observation. *Journal of Econometrics*, 2, 365-372.
- Aitken, M.J., Duffy, M. & Frino, A. (1998). *A comparison of the liquidity of open outcry and screen traded systems: Evidence from the Sydney Futures Exchange*. Working Paper, University of Sydney, Sydney, Australia.
- Aitken, M.J. & Ferris, G. (1991). A note on the effect of controlling for transactions costs on the small firm anomaly: Additional Australian evidence. *Journal of Banking and Finance*, 15, 1195-1202.
- Aitken, M.J., Frino, A., Jarnecic, E., McCorry, M., Segara, R., & Winn, R. (1998). *The Micro-structure of the Australian Stock Exchange: An introduction*. Working Paper, Securities Industry Research Centre of Asia Pacific, Sydney, Australia.
- Aitken, M.J. & Frino, A., & McKensy, R. (1993). *The effect of trading mechanisms on market quality: Evidence from the Australian Stock Exchange*. Working Paper, Securities Industry Research Centre of Asia Pacific, Sydney, Australia.
- Aitken, M.J. & Swan, P.L. (1993). Principal and agency trades by stockbrokers are complementary: The welfare effects of deregulating agency trading and banning principal trades. *Journal of Accounting and Finance*, 19-42.
- Amihud, Y. & Mendelson, H. (1980). Dealership market: Market-making with inventory. *Journal of Financial Economics*, 8, 31-53.
- Amihud, Y. & Mendelson, H. (1986). Asset pricing and the bid-ask spread. *Journal of Financial Economics*, 17, 223-249.
- Amihud, Y. & Mendelson, H. (1989). The effects of beta, bid-ask spread, residual risk, and size on stock returns. *Journal of Finance*, 44(2), 479-486.
- Amihud, Y. & Mendelson, H. (1991a). Liquidity, asset prices and financial policy. *Financial Analysts Journal*, N-D, 56-66.
- Amihud, Y. & Mendelson, H. (1991b). Liquidity, maturity, and the yields on U.S. treasury securities. *Journal of Finance*, 46(4), 1411-1425.

- Amihud, Y., Mendelson, H. & Lauterbach, B. (1997). Market microstructure and security values: Evidence from the Tel Aviv Stock Exchange. *Journal of Financial Economics*, 45, 365-390.
- Angel, J.J. (1997). Tick size, share prices, and stock splits. *Journal of Finance*, 52(2), 655-681.
- Anonymous (1998). *Eighths, sixteenths, and market depth: Changes in tick size and liquidity provision on the NYSE*, Working Paper, New York Stock Exchange, New York, U.S.A.
- Atkins, A.B. & Dyl, E.A. (1997). Transactions costs and holding periods for common stocks. *Journal of Finance*, 52(1), 309-325.
- Australian Stock Exchange [Online]. Available: <http://www.asx.com.au> [Retrieved 6.8.99].
- Bacidore, J. (1997). The impact of decimilisation on market quality: An empirical investigation of the Toronto Stock Exchange. *Journal of Financial Intermedaiton*, 92-120.
- Bagehot, W. (1971). The only game in town. *Financial Analysts Journal*, M-A 12-14.
- Baker, H.K. & Eldelman, R.B. (1992). The effects on spread and volume of switching to the NASDAQ National Market System. *Financial Analysts Journal*, 83-86.
- Ball, C.A. & Chordia, T. (1999). *True spreads and equilibrium prices*. Working Paper No. 99-12. Vanderbilt University, Nashville, U.S.A.
- Banz, R.W. (1981). The relationship between return and market value of common stocks. *Journal of Financial Economics*, 9, 3-18.
- Barclay, M.J. (1997). Bid-ask spreads and the avoidance of odd-eighth quotes on Nasdaq: An examination of exchange listings, *Journal of Financial Economics*, 45, 35-60.
- Barclay, M.J., Christie, W.G., Harris, J.H., Kandel, E., & Schultz, P.H. (1999). Effects of market reform on the trading costs and depths of Nasdaq stocks. *Journal of Finance*, 54 (1), 1-34.
- Barclay, M.J., Kandel, E., & Marx, L.M. (1998). The effects of transaction costs on stock prices and trading volume. *Journal of Financial Intermediation*, 7, 130-150.
- Bartholdy, J., Fox, K., Gilbert, C., Hibbard, R., McNoe, W., Potter, M., Jing, S., & Watt, K. (1996). Estimating beta for New Zealand companies. *New Zealand Investment Analyst*, 14-22.

- Bartholdy, J. & Riding, A. (1994). Thin trading and the estimation of betas: The efficacy of alternative techniques. *Journal of Financial Research*, 17, 241-254.
- Basu, S. (1977). Investment performance of common stocks in relation to their price-earnings ratios: A test of the efficient market hypothesis. *Journal of Finance*, 32(3), 663-682.
- Basu, S. (1983). The relationship between earnings yield, market value, and return for NYSE common stocks: Further evidence, *Journal of Financial Economics*, 12, 129-156.
- Battalio, R.H. (1997). Third market broker-dealers: Cost competitors or cream skimmers ? *Journal of Finance*, 52(1), 341-352.
- Benston, G. & Hangerman, R. (1974). Determinants of the bid-ask spreads in the over-the-counter market. *Journal of Financial Economics*, 1, 353-364.
- Benston, G. & Wood, H. (1997). *Spreads and even eighths quotations on Nasdaq*. Unpublished Manuscript, Emory University, U.S.A.
- Berk, J.B. (1995). A critique of size-related anomalies. *Review of Financial Studies*, 8, 275-286.
- Berkman, H. & Eleswarapu, V. (1998). Short-term traders and liquidity: A Test using Bombay Stock Exchange data. *Journal of Financial Economics*, 47, 339-355.
- Berndt, E.R. (1991). *The Practice of Econometrics*. Addison-Wesley, USA.
- Bernstein, P. (1987). Liquidity, stock markets and market-making. *Journal of Financial Management*, 16, 54-62.
- Bessembinder, H. (1997). The degree of price resolution and equity trading costs. *Journal of Financial Economics*, 45, 9-33.
- Bessembinder, H. (1998). *Trading costs and return volatility: Evidence from exchange listings*. Working Paper, Arizona State University, Tempe, AZ, U.S.A.
- Bessembinder, H. (1999). Trade execution costs on Nasdaq and the NYSE: A post-reform comparison. *Journal of Financial Quantitative Analysis* forthcoming.
- Bessembinder, H., Chan, K., & Sequin, P.J. (1996). An empirical examination of information, differences of opinion, and trading activity. *Journal of Financial Economics*, 40, 105-134.
- Bessembinder, H. & Kaufman, H.M. (1997). A comparison of trade execution costs for NYSE and NASDAQ-listed stocks. *Journal of Financial and Quantitative Analysis*, 32(3), 287-310.
- Bhandri, L.D. (1988). Debt / equity ratio and expected common stock returns: Empirical evidence. *Journal of Finance*, 43(2), 507-528.

- Bhide, A. (1993). The hidden costs of stock market liquidity. *Journal of Financial Economics*, 34, 31-52.
- Biais, B., Hillion, P. & Spatt, C. (1995). An empirical analysis of the limit order book and order flow in the Paris Bourse. *Journal of Finance*, 50(5), 1655-1689.
- Black, F. (1972). Capital market equilibrium with restricted borrowing. *Journal of Business*, 444-455.
- Black, F. (1993). Beta and return. *Journal of Portfolio Management*, 20, 8-18.
- Black, F., Jensen, M.C. & Scholes, M. (1972). The capital asset pricing model: Some empirical tests in : Michael C. Jensen ed., *Studies in the theory of capital markets* (Praeger, New York) 79-121.
- Black, F. & Scholes, M. (1974). The effects of dividend yield and dividend policy on common stock returns. *Journal of Financial Economics*, 1, 1-22.
- Blennerhassett, M. & Bowman, R.G. (1998). A change in market microstructure: The switch to electronic screen trading on the New Zealand Stock Exchange. *Journal of International Financial Markets, Institutions and Money*, 8, 261-276.
- Bloomfield, R. & O'Hara, M. (1999). Market transparency: Who wins and who loses? *Review of Financial Studies*, 12(1), 5-35.
- Blume, M.E. & Goldstein, M.A. (1992). *Displayed and effective spreads by market*. Working Paper. University of Pennsylvania, Philadelphia, PA, U.S.A.
- Blume, M.E. & Goldstein, M. A. (1997). Quotes, order flow, and price discovery. *Journal of Finance*, 52(1), 221-244.
- Blume, M.E. & Stambaugh, R.F. (1983). Biases in computing returns: An application to the size effect. *Journal of Financial Economics*, 12, 387-404.
- Bollen, N.P.B. & Whaley, R.E. (1998). Are "teenies" better ? *Journal of Portfolio Management*, 10-24.
- Brailsford, T.J. (1993). Seasonality and institutional factors in the New Zealand equity market. *Pacific Accounting Review*, 5(1), 1-26.
- Brailsford, T.J., Faff, R.W., & Oliver, B.R. (1997). *Research Design Issues in the Estimation of Beta*, Vol 1. McGraw-Hill, Sydney.
- Branch, B. & Freed, W. (1977). Bid-ask spreads on the AMEX and the Big Board. *Journal of Finance*, 32, 159-163.
- Breen, W.J. & Korajczyk, R. (1994). *On selection biases in book-to-market based tests of asset pricing models*. Working Paper, Northwestern University, U.S.A.

- Bremer, M., Hiraki, T. & Sweeney, R.J. (1997). Predictable patterns after large stock price changes on the Tokyo Stock Exchange. *Journal of Finance*, 32(3), 345-365.
- Brennan, M.J. (1975). The optimal number of securities in a risky asset portfolio when there are fixed costs of transacting: Theory and some empirical results. *Journal of Financial and Quantitative Analysis*, 10, 483-496.
- Brennan, M.J., Chordia, T., & Subrahmanyam, A. (1997). *Cross-Sectional Determinants of Expected Returns*. Working Paper.
- Brennan, M.J, Chordia, T., & Subrahmanyam, A. (1998). Alternative factor specifications, security characteristics, and the cross-section of expected stock returns. *Journal of Financial Economics*, 49(3), 345-373.
- Brennan, M.J. & Subrahmanyam, A. (1996). Market microstructure and asset pricing: On the compensation for illiquidity in stock returns. *Journal of Financial Economics*, 41, 441-464.
- Breusch, T.S. & Pagan, A.R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica*, 47, 1287-1294.
- Breusch, T.S. & Pagan, A.R. (1980). The lagrange multiplier test and its applications to model specification in econometrics. *Review of Economic Studies*, 47, 239-254.
- Brockman, P. & Chung, D.Y. (1999a). Bid-ask spread components in an order-driven environment. *Journal Of Financial Research*, 22(2), 227-246.
- Brockman, P. & Chung, D.Y. (1999b). An analysis of depth in an electronic, order-driven environment. *Journal of Banking and Finance* forthcoming.
- Brown, P., Kleidon, A.W., & Marsh, T.A. (1983). New evidence on the nature of size-related anomalies in stock prices. *Journal of Financial Economics*, 12, 33-56.
- Brown, P., Keim, D.B., Kleidon, A.W., & Marsh, T.A. (1983) Stock return seasonalities and the 'tax-loss selling' hypothesis: Analysis of the arguments and Australian evidence. *Journal of Financial Economics*, 12, 105-127.
- Brown, D.P. & Zhang, Z.M. (1997). Market orders and market efficiency. *Journal of Finance*, 52(1), 277-308.
- Bryant, P.S. & Eleswarapu, V. R. (1997). Determinants of the cost of equity in New Zealand. *New Zealand Investment Analyst*, 5-13.
- Buse, A. (1973). Goodness of fit in generalised least squares estimation. *American Statistician*, 27, 106-108.
- Buse, A. (1979). Goodness of fit in the seemingly unrelated regressions model: A generalisation. *Journal of Econometrics*, 10, 109-113.

- Campbell, J.Y. & Shiller, R. (1988). The dividend-price ratio and expectations of future dividends and discount factors. *Review of Financial Studies*, 1, 195-228.
- Cao, C, Choe, H. & Hathaway, F. (1997). Does the specialist matter? Differential execution and inter-security subsidisation on the NYSE. *Journal of Finance*, 52(4), 1615-1640.
- Capaul, C., Rowley, I. & Sharpe, W.F. (1993). International value and growth stock returns. *Financial Analysts Journal*, 27-36.
- Chalmers, J.M.R. & Kadlec, G.B. (1998). An empirical examination of the amortized spread. *Journal of Financial Economics*, 48(2), 159-188.
- Chan, K.C. & Chen, N. (1988). An unconditional asset-pricing test and the role of firm size as an instrumental variable for risk. *Journal of Finance*, 43, 309-325.
- Chan, L.K.C., Hamao, Y., & Lakonishok, J. (1991). Fundamentals and stock returns in Japan. *Journal of Finance*, 46, 1739-1789.
- Chan, L.K.C. & Lakonishok, J. (1997). Institutional equity trading costs: NYSE versus NASDAQ. *Journal of Finance*, 52(2), 713-735.
- Chan, L.K.C., Jegadeesh, N. & Lakonishok, J. (1995). Evaluating the performance of value versus glamour stocks: The impact of selection bias. *Journal of Financial Economics*, 38, 269-296.
- Chen, N-F. & Kan, R. (1989). *Expected return and the bid-ask spread*. Working Paper, University of Chicago, U.S.A.
- Chen, N-F., Grundy, B., & Stambaugh, R. (1990). Changing risk, changing risk premiums, and dividend yield effects. *Journal of Business*, 63, 51-70.
- Chin, J.F.Y. (1998). *Contrarian investment strategies. A test of the New Zealand stock market*. Working Paper, Massey University, New Zealand.
- Christie, W.G. & Huang, R.D. (1994). Market structures and liquidity: A transactions data study of exchange listings. *Journal of Financial Intermediation*, 3(3), 300-326.
- Christie, W.G. & Schultz, P. (1994). Why do NASDAQ market makers avoid odd-eighth quotes ? *Journal of Finance*, 49, 1841-1860.
- Chung, K.H., Van Ness, B.F., & Van Ness, R.A. (1999). Limit orders and the bid-ask spread. *Journal of Financial Economics*, 53(2), 255-288.
- Chung, R., Kryzanowski, L. & Zhang, H. (1997). Decimalisation's winners and losers: The switch to decimal trading was accompanied by many promises, not all of which have come true. *Canadian Investment Review*, 9, 35-39.
- Clark, R., McConnell, J. & Singh, M. (1992). Seasonalities in NYSE bid-ask spreads and stock returns in January. *Journal of Finance*, 47, 1999-2014.

Clyde, P., Schultz, P., & Zaman, M. (1997). Trading costs and exchange delisting. The case of firms that voluntarily move from the American Stock Exchange to Nasdaq. *Journal of Finance*, 52, 2103-2112.

Cohen, R.B. & Polk, C.K. (1995). *COMPUSTAT selection bias in tests of the Sharpe-Litner-Black CAPM*. Working Paper, University of Chicago, U.S.A.

Cook, T.J. & Rozeff, M.S. (1984). Size and earnings / price ratio anomalies: One effect or two ? *Journal of Financial and Quantitative Analysis*, 19(4), 449-466.

Constantinides, G. (1986). Capital market equilibrium with transactions costs. *Journal of Political Economy*, 94, 842-862.

Copeland, T. & Galai, D. (1983). Information effects on the bid-ask spread. *Journal of Finance*, 38, 1457-1469.

Daniel, K. & Titman, S. (1997). Evidence on the characteristics of cross section variation in stock returns. *Journal of Finance*, 52(1), 1-32.

Datar, V.T., Naik, N. & Radcliffe, R. (1998). Liquidity and stock returns: An alternative test. *Journal of Financial Markets*, 1, 203-219.

DATEX Services Ltd. (1995). *New Zealand Investment Year Book (23<sup>rd</sup> ed.)*. Lower Hutt, New Zealand.

DATEX Services Ltd. (1996). *New Zealand Investment Year Book (24<sup>th</sup> ed.)*. Lower Hutt, New Zealand.

DATEX Services Ltd. (1997). *New Zealand Investment Year Book (25<sup>th</sup> ed.)*. Lower Hutt, New Zealand.

DATEX Services Ltd. (1998). *New Zealand Investment Year Book (26<sup>th</sup> ed.)*. Lower Hutt, New Zealand.

DATEX Services Ltd. (1999). *New Zealand Investment Year Book (27<sup>th</sup> ed.)*. Lower Hutt, New Zealand.

Davis, L. (1994). The cross-section of realised stock returns: The pre-COMPUSTAT evidence. *Journal of Finance*, 49(5), 1579-1593.

De Jong, F., Nijman, T. & Roell, A. (1995). The comparison of the cost of trading French shares on the Paris Bourse and on the SEAQ International. *European Economic Review*, 39(7), 1277-1301.

DeLong, J.B., Shleifer, A., Summers, L.H., & Waldmann, R.J. (1990). Noise trader risk in financial markets. *Journal of Political Economy*, 98, 703-738.

Demsetz, H. (1968). The cost of transacting. *Quarterly Journal of Economics*, 82, 33-53.

- Demsetz, H. (1997). Limit orders and the alleged Nasdaq collusion. *Journal of Financial Economics*, 35, 91-96.
- Denis, D. & Kadlec, G. (1994). Corporate events, trading activity, and the estimation of systematic risk: Evidence from equity offerings and share repurchases. *Journal of Finance*, 49, 1787-1811.
- Dennis, P. & Strickland, D. (1998). *The effect of stock splits on liquidity: Evidence from shareholder ownership composition*. Working Paper, Fisher College of Business, Ohio State University, U.S.A.
- Dimson, E. (1979). Risk Measurement when shares are subject to infrequent trading. *Journal of Financial Economics*, 7, 187-226.
- Domowitz, I. (1993). Equally open and competitive: Regulatory approval of automated trade execution in the futures markets. *The Journal of Futures Markets*, 13(1), 93-113.
- Durbin, J. & Watson, G.S. (1950). Testing for serial correlation in least squares regression I. *Biometrika*, 37, 409-428.
- Durbin, J. & Watson, G.S. (1951). Testing for serial correlation in least squares regression II. *Biometrika*, 38, 159-178.
- Durbin, J. & Watson, G.S. (1971). Testing for serial correlation in least squares regression III. *Biometrika*, 58, 1-19.
- Dutta, P.K. & Madhavan, A. (1997). Competition and collusion in dealer markets. *Journal of Finance*, 52(1), 245-276.
- Easley, D., Keifer, N., O'Hara, M. & Paperman, J. (1996). Liquidity, information, and infrequently traded stocks. *Journal of Finance*, 51, 1405-1436.
- Easley, D. & O'Hara, M. (1987). Price, trade size, and information in security markets. *Journal of Financial Economics*, 19, 69-90.
- Easley, D. & O'Hara, M. (1992). Time and the process of security price adjustment. *Journal of Finance*, 47, 577-606.
- Eleswarapu, V.R. (1997). Cost of transacting and expected returns in the Nasdaq market. *Journal of Finance*, 52(5), 2113-2127.
- Eleswarapu, V.R. & Reinganum M. (1993). The seasonal behavior of the liquidity premium in asset pricing. *Journal of Financial Economics*, 34, 373-386.
- Elton, E.J. & Gruber, M.J. (1995). *Modern portfolio theory and investment analysis* (5<sup>th</sup> ed). New York, John Wiley and Sons Inc.

- Engle, R.F. & Lange, J. (1997). *Measuring, forecasting, and explaining time varying liquidity in the stock market*. Working Paper No 6129 National Bureau of Economic Research, Cambridge. M.A.
- Fama, E.F. (1991). Efficient capital markets II. *Journal of Finance*, 46(5), 1575-1617.
- Fama, E.F. & French, K.R. (1992). The cross-section of expected stock returns. *Journal of Finance*, 47, 427-465.
- Fama, E.F. & French, K.R. (1993). Common risk factors in the returns of stocks and bonds. *Journal of Financial Economics*, 33, 3-56.
- Fama, E.F. & French, K.R. (1995). Size and book-to-market factors in earnings and returns. *Journal of Finance*, 50, 131-155.
- Fama, E.F. & French, K.R. (1996a). Multifactor explanations of asset pricing anomalies. *Journal of Finance*, 51, 55-84.
- Fama, E.F. & French, K.R. (1996b) The CAPM is wanted, dead or alive. *Journal of Finance*, 51(5), 1947-1958.
- Fama, E.F. & MacBeth, J. (1973). Risk return and equilibrium: Empirical tests. *Journal of Political Economy*, 81, 607-636.
- Flood, R.P., Hodrick, R.J. & Kaplan, P. (1986). *An evaluation of recent evidence on stock market bubbles*. Unpublished Manuscript, National Bureau of Economic Research, Cambridge, MA.
- Flood, M.D., Huisman, R., Koedijk, K.G. & Lyons, R.K. (1998). *Search costs: The neglected spread component*. Working Paper, Berkeley, U.S.A.
- Fortin, R.D., Grube, C. & Joy, O.M. (1989). Seasonality in the NASDAQ dealer spreads. *Journal of Financial and Quantitative Analysis*, 24, 395-407.
- Franke, G. & Hess, D. (1995). *Anonymous electronic trading versus floor trading*. Working Paper, Universitat Konstanz, Germany.
- Frino, A. & McCorry, M. (1996). Why are spreads tighter on the Australian Stock Exchange than the NYSE ? An electronic open limit order book versus the specialist structure. *ASX Perspective* (1), 43-47.
- Frino, A., McInish, T., & Toner, M. (1998). The liquidity of automated exchanges: New evidence from German bund futures. *Journal of International Financial Markets, Institutions and Money*, 8, 225-241.
- Furbush, D. & Smith, J.W. (1996). *Quoting Behaviour on Nasdaq: The effects of clustering on relative spreads*. Working Paper NASD 96-01, U.S.A.
- Garbade, K.D. (1982). *Securities Markets*. U.S.A, McGraw Hill.

- Garbade, K.D. (1984). *Analysing the structure of treasury yields: Duration, coupon, and liquidity effects*. Topics in Money and Security Markets. Bankers Trust. New York
- Garman, M. (1976). Market microstructure. *Journal of Financial Economics*, 3, 257-275.
- Garvey, G.T., McCorry, M.S. & Swan, P.L. (1995). *Stock market liquidity and optimal management compensation: Theory and evidence*, Working Paper, Securities Industry Research Centre of Asia Pacific, Sydney, Australia.
- George, T.J. & Hwang, C.Y. (1995). Transitory price changes and price-limit rules. Evidence from the Tokyo Stock Exchange. *Journal of Financial and Quantitative Analysis*, 30, 313-327.
- George, T., Kaul, G. & Nimalendran, M. (1991). Estimating the components of the bid-ask spread: A new approach. *Review of Financial Studies*, 4, 623-656.
- Gibbons, M. (1982). Multivariate tests of financial models: A new approach. *Journal of Financial Economics*, 10, 3-27.
- Gillan, S. (1991). An investigation into CAPM anomalies in New Zealand: The small firm and price earnings ratio effects. *Asia Pacific Journal of Management*, 7, 63-78.
- Glosten, L. & Milgrom, P. (1985). Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. *Journal of Financial Economics*, 14, 71-100.
- Godeck, P. (1996). Why Nasdaq market makers avoid odd eight quotes. *Journal of Financial Economics*, 41, 465-474.
- Goldsmith, D. (1976). Transactions costs and the theory of portfolio selection. *Journal of Finance*, 31, 1127-1139.
- Goldstein, M.A. & Kavajecz, K. (1998). *Eights, sixteenths, and market depth: Changes in tick size and liquidity provision on the NYSE*. Working Paper. The Wharton School, Philadelphia, PA, U.S.A.
- Granger, C.W.J. & Morgenstern, O. (1970). *Predictability of stock market prices*. D.C. Heath and Co, Lexington, MA.
- Grauer, R.R. (1999). On the cross-sectional relation between expected returns, betas and size. *Journal of Finance*, 54(2), 773-789.
- Gravelle, T. (1999). *Liquidity of the Government of Canada securities markets: Stylised facts and some market microstructure comparisons to the United States Treasury Market*. Working Paper, Financial Markets Department, Bank of Canada.
- Griffiths, W.E., Hill, R.C., Judge, G.G. (1993). *Learning and practising econometrics*. New York, John Wiley & Sons.

- Grossman, S.J. & Stiglitz, J.E. (1980). On the impossibility of informationally efficient markets. *American Economic Review*, 70, 393-408.
- Hamao, Y. (1991). A standard data base for the analysis of Japanese security markets. *Journal of Business*, 64, 87-102.
- Hamao, Y. & Hasbrouck, J. (1995). Securities trading in the absence of dealers: Trades and quotes on the Tokyo Stock Exchange. *Review of Financial Studies*, 8, 849-878.
- Hamilton, J.L. (1976). Competition, scale economies, and transactions costs in the stock market. *Journal of Financial and Quantitative Analysis*, 11, 779-802.
- Handa, P., Kothari, S.P. & Wasley, C. (1989). The relation between return and betas: Implications for the size effect. *Journal of Financial Economics*, 23, 79-100.
- Hansch, O., Naik, N.Y. & Viswanathan, S. (1998). Do inventories matter in dealer markets? Evidence from the London Stock Exchange. *Journal of Finance*, 53(5), 1623-1656.
- Harris, L. (1994). Minimum price variations, discrete bid-ask spreads, and quotation sizes. *Review of Financial Studies*, 7, 149-178.
- Harris, L. & Hasbrouck, J. (1996). Market vs. limit orders: The SuperDot evidence on order submission strategy. *Journal of Financial and Quantitative Analysis*, 21, 213-231.
- Harris, M. & Raviv, A. (1993). Differences of opinion make a horse race. *Review of Financial Studies*, 6(3), 473-506.
- Hasbrouck, J. & Schwartz, R.A. (1988). Liquidity and execution costs in equity markets. *Journal of Portfolio Management*, 14, 10-16.
- Hasbrouck, J., Sofianos, G. & Sosebee, D. (1993). *New York Stock Exchange Systems and Trading Procedures*. Working Paper, New York Stock Exchange, New York, U.S.A.
- Haugen, R.A. (1995). *The new finance: The case against efficient markets*. Englewood Cliffs, New Jersey, Prentice Hall.
- Haugen, R.A. & Baker, N. (1996). Commonality in the determinants of expected stock returns. *Journal of Financial Economics*, 41, 401-439.
- Haugen, R.A. & Lakonishok, J. (1988). The incredible January effect: The stock market's unsolved mystery. Illinois, Dow-Jones Irwin.
- Hawawini, G. & Keim, D.B. (1998). *The cross section of common stock returns: A review of the evidence and some new findings*. Working Paper, Wharton School, University of Pennsylvania, U.S.A.

- Heidle, H.G. & Huang, R.D. (1999). *Information-based trading in dealer and auction markets: An analysis of exchange listings*. Working Paper, Vanderbilt University, U.S.A.
- Ho, T. & Stoll, H.R. (1981). Optimal dealer pricing under transactions and return uncertainty. *Journal of Financial Economics*, 9, 47-73.
- Ho, T. & Stoll, H.R. (1983). The dynamics of dealer markets under competition. *Journal of Finance*, 38 (4), 1053-1074.
- Hu, S-Y. (1997a). *Trading turnover and expected stock returns: The trading frequency hypothesis and evidence from the Tokyo Stock Exchange*. Working Paper, University of Chicago, U.S.A.
- Hu, S-Y. (1997b). *Trading turnover and expected stock returns: Does it matter and why ?* Working Paper, National Taiwan University. Taiwan.
- Huang, R.D. & Stoll, H.R. (1996a). Competitive trading of NYSE listed stocks: Measurement and interpretation of trading costs. *Journal of Financial Markets, Institutions and Instruments*, 5(1), 1-55.
- Huang, R.D. & Stoll, H.R. (1996b). Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE. *Journal of Financial Economics*, 41, 313-357.
- Huang, R.D. & Stoll, H.R. (1999). *Tick size, bid-ask spreads and market structure*. Working Paper, Vanderbilt University, U.S.A.
- Ibbotson, R.G., Kaplan, P.D. & Peterson, J.D. (1997). Estimates of small-stock betas are much too low. *Journal of Portfolio Management*, 104-111.
- Jaffe, J., Keim, D.B., & Westerfield, R. (1989). Earning yields, market returns, and stock returns. *Journal of Finance*, 44 (1), 135-148.
- Jagannathan, R. & Wang, Z (1996). The conditional CAPM and the cross-section of expected returns. *Journal of Finance*, 51, 3-53.
- Jensen, M.C. (1978). Some anomalous evidence regarding market efficiency. *Journal of Financial Economics*, 6, 95-101.
- Jones, C. & Lipson, M. (1998). *Sixteenths: Direct evidence on institutional trading costs*. Working Paper, University of Georgia, U.S.A.
- Judge, G.G., Griffiths, W.E., Hill, R.C., Lutkrpohl, H., Lee, T-C. (1985). *The theory and practice of econometrics* (2<sup>nd</sup> ed). New York, John Wiley and Sons Inc.
- Judge, G.G., Hill, R.C., Griffiths, W.E., Lutkrpohl, H., Lee, T-C. (1988). *Introduction to the theory and practice of econometrics* (2<sup>nd</sup> ed). New York, John Wiley and Sons Inc.

- Kadlec, G.B. & McConnell, J.J. (1994). The effect of market segmentation and illiquidity on asset prices: Evidence from exchange listings. *Journal of Finance*, 49(2), 611-636.
- Kamara, A. (1990). *Liquidity and short-term treasury yields*. Working Paper, U.S.A.
- Kamara, A. (1994). Liquidity, taxes, and short-term treasury yields. *Journal of Financial Quantitative Analysis*, 29(3), 403-417.
- Kandel, E. & Marx, L.M. (1997). Nasdaq market structure and spread patterns. *Journal of Financial Economics*, 45, 61-89.
- Kandel, E. & Marx, L.M. (1999). Payments for order flow on Nasdaq. *Journal of Finance*, 54(1), 35-42.
- Kandel, E. & Pearson, N.D. (1995). Differential interpretation of public signals and trade in speculative markets. *Journal of Political Economy*, 103(4), 831-872.
- Kandel, S. & Stambaugh, R.F. (1995). Portfolio inefficiency and the cross-section of expected returns. *Journal of Finance*, 50(1), 157-184.
- Kane, J. A. (1994). Trading cost premiums in capital asset returns – A closed form solution. *Journal of Banking and Finance*, 18, 1177-1183.
- Kavajecz, K.A. (1999). A specialist's quoted depth and the limit order book. *Journal of Finance*, 54(2), 747-771.
- Keim, D.B. (1983). Size related anomalies and stock return seasonality: Empirical evidence. *Journal of Financial Economics*, 12, 13-32.
- Keim, D.B. (1990). Trading patterns, bid-ask spreads and estimated security returns: The case of common stocks at the turn of the year. *Journal of Financial Economics*, 25, 75-98.
- Keim, D.B. and Madhavan, A. (1995). Anatomy of the trading process: Empirical evidence on the behaviour of institutional traders. *Journal of Financial Economics*, 37, 371-398.
- Keim, D.B. & Madhavan, A. (1996). The upstairs market for large-block transactions: Analysis and measurement of price effects. *Review of Financial Studies*, 9(1), 1-36.
- Keim, D.B. & Madhavan, A. (1997). Transactions costs and investment style: An inter-exchange analysis of institutional equity trades. *Journal of Financial Economics*, 46, 265-292.
- Keown, A., Neustel, A. & Pinkerton, J. (1986). *Differential information and the small firm effect*. Working Paper, Virginia Polytechnic Institute and State University, U.S.A.

- Keynes, J.M. (1930). *Treatise on Money*. London. Macmillan.
- Kim, D. (1995). The errors in variables problem in the cross section of expected stock returns. *Journal of Finance*, 50(5), 1605-1634.
- Kim, D. (1997). A re-examination of firm size, book-to-market and earnings price in the cross-section of expected stock returns. *Journal of Financial and Quantitative Analysis*, 32(4), 463-489.
- Kim, K.A. & Rhee, S.G. (1997). Price limit performance: Evidence from the Tokyo Stock Exchange. *Journal of Finance*, 52(2), 885-901.
- Kim, S.T., Lin, J-C. & Slovin, M.B. (1997). Market structure, informed trading, and analyst's recommendations. *Journal of Financial and Quantitative Analysis*, 32(4), 507-524.
- Klemkosky, R.C. & Conroy, R.M. (1985). Competition and the cost of liquidity to investors. *Journal of Economics and Business*, 37, 183-195.
- Kmenta, J. (1986). *Elements of Econometrics*. (2<sup>nd</sup> ed). New York, Macmillan.
- Knez, P.J. & Ready, M.J. (1996). Estimating the profits from trading strategies. *Review of Financial Studies*, 9(4), 1121-1163.
- Kofman, P. & Moser, J.T. (1997). Spreads, information flows and transparency across trading systems. *Applied Financial Economics*, 7, 281-294.
- Kothari, S. P. & Shanken, J. (1997). Book-to-market, dividend yield, and expected market returns: A time-series analysis. *Journal of Financial Economics*. 44(2), 169-203.
- Kothari, S.P., Shanken, J. & Sloan, R. (1995a). Another look at the cross section of expected stock returns. *Journal of Finance*, 50, 185-224.
- Kothari, S.P., Shanken, J. & Sloan, R. (1995b). *The CAPM: "Reports of my death have been greatly exaggerated"*. Working Paper, University of Rochester, U.S.A.
- Kyle, A.S. (1984). Market structure, information, futures markets, and price formation: in Gary G Story eds. *International Agricultural Trade: Advanced Readings in Price Formation, Market Structure, and Price Instability*. London. Westview Press, 45-64.
- Kyle, A.S. (1985). Continuous auctions and insider trading. *Econometrica*, 53, 1315-1335.
- Lakonishok, J. & Shapiro, A.C. (1986). Systematic risk, total risk, and size as determinants of stock market returns. *Journal of Banking and Finance*, 10, 115-132.
- Lakonishok, J., Shleifer, A., & Vishny, R.W. (1994). Contrarian investment, extrapolation, and risk. *Journal of Finance*, 49, 1541-1578.

Lamoureux, C.G. & Sanger, G.C. (1989). Firm size and turn-of-the-year effects in the OTC/NASDAQ Market. *Journal of Finance*, 44(5), 1219-1245.

LaPlante, M. & Muscarella, C.J. (1997). Do institutions receive comparable execution costs in the NYSE and Nasdaq markets ? A transactions study of block trades. *Journal of Financial Economics*, 45, 97-134.

Lawrance, G. (1998). *Cross sectional determinants and factor risk premia in the Australasian Markets*. Working Paper, Massey University, New Zealand.

Lee, C.M.C. (1993). Market integration and price execution in NYSE-listed securities. *Journal of Finance*, 1009-1038.

Lee, C.M.C., Mucklow, B. & Ready, M.J. (1993). Spreads, depths, and the impact of earnings information: An intraday analysis. *The Review of Financial Studies*, 6(2), 345-374.

Lehmann, B.N. & Modest, D.M. (1994). Trading and liquidity on the Tokyo Stock Exchange: A bird's eye view. *Journal of Finance*, 49, 951-984.

Levy, H. (1978). Equilibrium in an imperfect market: A constraint on the number of securities in the portfolio. *American Economic Review*, 68, 643-658.

Lindsey, R.R. & Schaede, U. (1992). Specialist vs. satori: Market making in New York and Tokyo. *Financial Analysts Journal*, 48, 48-57.

Lintner, J. (1965). The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, 13-37.

Litzenbeger, R. & Ramaswamy, K. (1979). The effect of personal taxes and dividend on capital asset prices: Theory and empirical evidence. *Journal of Financial Economics*, 7, 163-195.

Lo, A.W. & MacKinlay, A.C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test. *Review of Financial Studies*, 1, 41-66.

London Stock Exchange [Online]. Available: <http://www.londonstockex.co.uk> [Retrieved 25.7.99].

Loughran, T. (1997). Book-to-market across firm size, exchange, and seasonality: Is there an effect? *Journal of Financial and Quantitative Analysis*, 32, 249-268.

McCallum, B.T. (1972). Relative asymptotic bias from errors of omission and measurement. *Econometrica*, 40, 757-758.

McInish, T.H., Van Ness, B.F. & Van Ness, R.A. (1998). The effect of the SEC's Order-Handling Rules on Nasdaq. *The Journal of Financial Research*, 21(3), 247-254.

- McInish, T.H. & Wood, R. (1992). An analysis of intraday patterns in bid / ask spreads for NYSE stocks. *Journal of Finance*, 47, 753-764.
- MacKinlay, A.C. (1995). Multifactor models do not explain deviations from the CAPM. *Journal of Financial Economics*, 38, 3-28.
- MacKinnon, G. & Nemiroff, H. (1999). Liquidity and tick size: Does decimalization matter ? *Journal of Financial Research* forthcoming.
- Madhavan, A. (1992). Trading mechanisms in securities markets. *Journal of Finance*, 47, 607-661.
- Malkiel, B.G. (1995). Returns from investing in equity mutual funds 1971 to 1991. *Journal of Finance*, 50, 549-572.
- Markowitz, H. M. (1952). Portfolio selection. *Journal of Finance*, 17(1), 77-91.
- Martens, M. (1998). Price discovery in high and low volatility periods: Open outcry versus electronic trading. *Journal of International Financial Markets and Money*, 8, 243-260.
- Martin, P.J. & Winn, R. (1996). *Australia's financial markets: Function, structure, and contribution to the economy*. Working Paper, Securities Industry Research Centre of Asia Pacific, Sydney, Australia.
- Mayshar, H.J. (1981). Transactions costs and the pricing of assets. *Journal of Finance*, 36, 583-597.
- Merton, R.C. (1987). Presidential address: A simple model of capital market equilibrium with incomplete information, *Journal of Finance*, 42(3), 483-510.
- Miller, E.D. (1977). Risk, uncertainty, and a divergence of opinion. *Journal of Finance*, 32(4), 1152-1168.
- Milne, F. & Smith, C. (1980). Capital asset pricing with proportional transactions costs. *Journal of Financial and Quantitative Analysis*, 15, 253-266.
- Mossin, J. (1966). Equilibrium in a capital asset market. *Econometrica*, 768-783.
- Muranaga, J. (1999). *Dynamics of market liquidity of Japanese stocks: An analysis of tick-by-tick data of the Tokyo Stock Exchange*. Working Paper, Institute for Monetary and Economic Studies. Bank of Japan.
- Muranaga, J. & Shimizu, T. (1999a). *Market microstructure and market liquidity*. Working Paper, Institute for Monetary and Economic Studies. Bank of Japan, Japan.
- Muranaga, J. & Shimizu, T. (1999b). *Expectations and market microstructure when liquidity is lost*. Working Paper, Institute for Monetary and Economic Studies. Bank of Japan, Japan.

Naik, N.Y. & Yadav, P.K. (1999). *The effects of market reform on trading costs of public investors: Evidence from the London Stock Exchange*. Working Paper No. 296. Institute of Finance and Accounting, London Business School. U.K.

Nasdaq [Online]. Available: <http://www.nasd.com> [Retrieved 7.8.99].

Nelson, C.R. & Kim, M.J. (1993). Predictable stock returns: The role of small sample bias. *Journal of Finance*, 48, 641-661.

New York Stock Exchange [Online]. Available: <http://www.nyse.com> [Retrieved 13.7.99].

New Zealand Stock Exchange (1998). Fact Book.

New Zealand Stock Exchange [Online]. Available: <http://www.nzse.co.nz> [Retrieved 5.9.99].

Ogden, J.P. (1990). Turn-of-month evaluations of liquid profits and stock returns: A common explanation for the monthly and January effects. *Journal of Finance*, 45, 1259-1272.

Pagano, M. & Roell, A. (1990). Trading systems in European stock exchanges: Current performance and policy options. *Economic Policy* April, 65-115.

Pagano, M. & Roell, A. (1996). Transparency and liquidity: A comparison of auction and dealer markets with informed trading. *Journal of Finance*, 51, 579-612.

Peterson, M.A. & Fialkowski, D. (1994). Posted versus effective spreads: Good prices or bad quotes? *Journal of Financial Economics*, 35(3) 269-292.

Pirrong, C. (1996). Market liquidity and depth on computerised open outcry trading systems: A comparison of DTB and LIFFE Bund contracts. *Journal of Futures Markets*, 16(5), 519-543.

Pontiff, J. (1995). Closed-end fund premia and returns: Implications for financial market equilibrium. *Journal of Financial Economics*, 37, 341-370.

Pontiff, J. & Schall, L.D. (1998). Book-to-market ratios as predictors of market returns. *Journal of Financial Economics*, 49, 141-160.

Quandt, R.E. & Newton, W. (1979). *An empirical study of spreads*. Research Memorandum No 30, Financial Research Center. Department of Economics. Princeton University. U.S.A.

Reily, F.K. (1986). *Investments*, New York, Dryden Press.

Reinganum, M.R. (1981). Misspecification of capital asset pricing: Empirical anomalies based on earnings yields and market values. *Journal of Financial Economics*, 9, 19-46.

- Reinganum, M.R. (1983). The anomalous stock market behaviour of small firms in January: Empirical tests for tax-loss selling. *Journal of Financial Economics*, 12, 89-104.
- Richardson, D.H. & Wu, D-M. (1970). Least squares and grouping method estimation in the errors in variable model. *Journal of American Statistical Association*, 65, 724-748.
- Ricker, P. (1998). *Breaking the eighth: Sixteenths on the New York Stock Exchange*. Working Paper, 1730 Filbert Street, #105, San Francisco, CA, U.S.A.
- Ritter, J.R. & Chopra, N. (1989). Portfolio re-balancing and the turn-of-the-year effect. *Journal of Finance*, 44, 149-166.
- Roll, R. (1977). A critique of the asset pricing theory's tests. *Journal of Financial Economics*, 4, 129-176.
- Roll, R. (1983). The turn of the year effect and the return premia of small firms. *Journal of Portfolio Management*, 9, 18-28.
- Roll, R. & Ross, S. (1994). On the cross-sectional relation between expected returns and betas. *Journal of Finance*, 1, 101-121.
- Rosenberg, B., Reid, K., & Lanstein, R. (1985). Persuasive evidence of market inefficiency. *Journal of Portfolio Management*, 11, 9-17.
- Ross, S.A. (1977). The capital asset pricing model (CAPM), short-sale restrictions and related issues. *Journal of Finance*, 32, 177-183.
- Ross, K.D., Shapiro, J.E., & Smith, K.A. (1996). *Price improvement of SuperDot market orders on the NYSE*. Working Paper, New York Stock Exchange, New York, U.S.A.
- Rozeff, M.S. (1984). Dividend yields are equity risk premiums. *Journal of Portfolio Management*, 10, 68-75.
- Rozeff, M.S. & Kinney, W.R. (1976). Capital market seasonality: The case of stock returns. *Journal of Financial Economics*, 3, 379-402.
- Scalia, A. & Vacca, V. (1999). *Does market transparency matter ? A case study*. Working Paper, U.S.A.
- Scholes, M. & Williams, J. (1977). Estimating betas from nonsynchronous data. *Journal of Financial Economics*, 5, 309-327.
- Schwert, G.W. (1983). Size and stock returns, and other empirical regularities. *Journal of Financial Economics*, 12, 3-12.
- Schmidt, P. (1977). Estimation of seemingly unrelated regressions with unequal number of observations. *Journal of Econometrics*, 5, 365-377.

- Seppi, D.J. (1997). Liquidity provision with limit orders and a strategic specialist. *The Review of Financial Studies*, 10(1), 103-150.
- Shanken, J. (1992). On the estimation of beta pricing models. *Review of Financial Studies*, 5, 1-33.
- Sharpe, W.F. (1964). Capital asset prices: A theory of market equilibrium under risk. *Journal of Finance*, 425-442.
- Sheeran, G. (1999, September 5). Brokers ready for on-line share trading. *Sunday Star Times*, Section E, p. 5.
- Shefrin, H. & Statman, M. (1995). Making sense of beta, size and book-to-market. *Journal of Portfolio Management*, 21(2), 26-34.
- Shiller, R.J. (1984). Stock prices and social dynamics. *Brookings Papers on Economic Activity*, 2, 457-498.
- Shyy, G. & Lee, J. (1995). Price transmission and information asymmetry in Bund futures markets: LIFFE vs. DTB. *Journal of Futures Markets*, 15(1), 87-99.
- Smith, J.W., Selway III, J.P. & McCormick, D.T. (1998). *The Nasdaq stock market: Historical background and current operation*. Working Paper, NASD 98-01. U.S.A.
- Sofianos, G. & Werner, I.M. (1997). *The trades of NYSE floor brokers*. Working Paper 97-04, NYSE, New York Stock Exchange, New York.
- Stambaugh, R.F. (1982). On the exclusion of assets from tests of the two-parameter model: A sensitivity analysis. *Journal of Financial Economics*, 10, 237-268.
- Stigler, G.J. (1964). Public regulation of the securities markets. *The Journal of Business*, 37(2), 117-142.
- Stoll, H.R. (1978). The supply of dealer services in security markets. *Journal of Finance*, 33, 1133-1151.
- Stoll, H.R. (1989). Inferring the components of the bid-ask spread: Theory and empirical tests. *Journal of Finance*, 44, 115-134.
- Stoll, H.R. & Whaley, R.E. (1983). Transaction costs and the small firm effect. *Journal of Financial Economics*, 12, 57-79.
- Tinic, S.M. (1972). The economics of liquidity services. *Quarterly Journal of Economics*, 86, 79-83.
- Tinic, S.M. & West, R.R. (1974). Marketability of common stocks in Canada and the USA: A comparison of agent versus dealer dominated markets. *Journal of Finance*, 29, 729-746.

- Tinic, S.M. & West, R.R. (1984). Risk and return: January vs. rest of the year. *Journal of Financial Economics*, 13, 561-574.
- Tinic, S.M. & West, R.R. (1986). Risk, return and equilibrium: A revisit. *Journal of Political Economy*, 94, 126-147.
- Tokyo Stock Exchange [Online]. Available: <http://www.tse.or.jp> [Retrieved 5.7.99].
- Ui, T. (1999). *Transparency and liquidity in securities markets*. Working Paper, Institute for Monetary and Economic Studies. Bank of Japan, Japan.
- Vayanos, D. (1998). Transactions costs and asset prices: A dynamic equilibrium model. *The Review of Financial Studies*, 11(1), 1-58.
- Vayanos, D. & Vila, J-L. (1999). Equilibrium interest rate and liquidity premium with transactions costs. *Journal of Economic Theory*, 13, 509-539.
- Viswanathan, S. & Wang, J.D. (1998). *Market architecture: Limit-order books versus dealership markets*. Working Paper, Duke University, U.S.A.
- Vos, E. & Pepper, B. (1997). The size and book to market effects in New Zealand. *New Zealand Investment Analyst*, 35-45.
- Wahal, S. (1997). Entry, exit, market makers and the bid-ask spread. *Review of Financial Studies*, 10(3), 871-900.
- Wang, J. (1999). Asymmetric information and the bid-ask spread: An empirical comparison between automated order execution and open outcry auction. *Journal of International Financial Markets, Institutions and Money*, 9, 115-128.
- White, K.J. (1997). *Shazam econometrics computer program: User's reference manual version 8.0*. New York, McGraw-Hill Companies.
- Young, M.R. & Handa, H. (1993). *Turn of the month, holiday and January effects on stock returns: The New Zealand experience and Australian comparison*. Working Paper, Massey University.
- Yu, D. (1998). *Equilibrium liquidity premia*. International Finance Discussion Paper Number 615, Board of Governors of the Federal Reserve System, U.S.A.
- Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of American Statistical Association*, 57, 348-368.