The Relationship Between Value and Growth Stock Returns, Monetary Policy and Economic Activity: Evidence From New Zealand, Australia and the US

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Abstract

This thesis examines the relationship between monetary policy, economic activity and value and growth stock returns in New Zealand, Australia and the US for the period 1990 to 1997. There is evidence to suggest that in the short-term, there are periods where value stocks outperform growth stocks and vice versa. This study investigates the role a number of economic variables play in driving the relative performances of these two groups of stocks. The primary focus of this study is on the relationship between value and growth stock returns and monetary policy, however, the following economic variables are also included in the analysis: Short-term interest rates, the exchange rate, GDP, inflation, money supply, and a business confidence index. Vector autoregressions form the methodological basis for this research and provide impulse response functions and forecast error variance decompositions that are used to determine relationships between the variables. The major finding of this study is that value stocks in Australia and the US perform relatively better than growth stocks during periods of loosening monetary policy. On the other hand, value stocks in New Zealand perform relatively better than growth stocks during periods of tightening monetary policy.

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Introduction

In an increasingly competitive funds management industry, investors are constantly searching for new and improved techniques on which to base their investment decisions. Developing a greater understanding of what drives stock returns is therefore of considerable interest to fund managers and investors who wish to improve their ability to accurately select superior performing investments. A substantial portion of finance research, therefore, has been dedicated to determining the factors driving the relative performances of asset returns. Based on Markowitz's (1952) analysis of individuals' investment decisions under conditions of uncertainty using mean-variance analysis, Sharpe (1964) derived the Capital Asset Pricing Model (CAPM). CAPM explains asset returns in terms of individual assets' sensitivity to the market, and has served to provide the basis for subsequent literature concerned with explaining relative asset returns.

An area of study closely related to the problem of explaining asset returns, is concerned with explaining the relative performances of value and growth stock returns. In an effort to explain the different characteristics of assets, there have emerged two main types of equities: value and growth stocks. As their name implies, these stocks differ primarily in the nature of returns they provide their shareholders. Value stocks provide value to their investors through high dividend yields. These stocks are typically smaller than growth stocks, have lower market-to-book equity ratios, and lower price-to-earnings ratios. Conversely, growth stocks are purchased for their recognised potential growth and therefore primarily for capital gains. They are typically larger than value stocks and have higher market-to-book and price-to-earnings ratios. A substantial amount of research has focused on comparing the returns of these two types of stocks, with results consistently showing value stocks outperforming growth stocks in the long-run. However, research has also suggested that in the short-term, there are periods where growth stocks outperform value stocks. Given the obvious disparity in their performances and their different characteristics, a natural progression in the research has been to consider the role the different characteristics of these stocks play in determining their expected returns.

An associated area of study that has been of increasing interest is the impact of macroeconomic factors on asset returns. An obvious external factor that is likely to have an impact on equity returns is monetary policy stance. Monetary policy will have a direct effect on the environment in which companies operate and therefore it is reasonable to expect that monetary policy stance will impact on stock returns. Other factors that are likely to affect stock returns are variables relating to the level of economic activity in the economy. These include variables such as interest rates, GDP, business confidence, inflation and money supply. Therefore, as well as monetary policy, there are a number of closely related factors that could potentially hold a significant relationship with observed equity returns.

Given the obvious disparity in performances of value and growth stocks, and the potential role monetary policy stance and economic activity could play in determining equity returns, it is reasonable to question the role these macroeconomic factors play in explaining the relative performances of value and growth stock returns. This research, therefore, focuses on the following issues. It attempts to determine the relationship between monetary policy stance, economic activity and value and growth stock returns. Understanding the interrelationships between these variables will provide the fund manager with a greater understanding of the different drivers of value and growth stock returns, and enhance their ability to make superior investment decisions.

The primary focus of this study is on the New Zealand market. However, the implementation of monetary policy in New Zealand is fundamentally different from a number of countries, not only in terms of how it is implemented, but also in terms of the characteristics of the market in which it operates. For this reason Australia and the US will be included in this study to serve as comparisons and to assist with the interpretation of results.

Vector Autoregressions (VAR) provide the methodological basis for this research. A recent innovation by Sims (1980), the VAR methodology has played an increasingly important role in much empirical finance literature. VARs provide a method of testing for relationships among a number of economic variables, and form the basis of tests for multivariate cointegration and block Granger causality. For this reason, they are ideally suited to the context of this study and provide the basis for many of the conclusions made in this research.

This thesis is divided into four parts. Part one reviews all literature of relevance to this study and is divided into two chapters. Part two explains the methodology used in this research. This includes regression analysis, cointegration, Granger causality, and Vectors Autoregressions (VARs). Part three provides an introduction to the data and exploratory analysis. Part four presents the results of this thesis. These are divided into three chapters based on the methodology used and variables tested.

Chapter four of the results consolidates, interprets and discusses the results presented in chapters one to three. The thesis then ends with a summary which highlights areas for future research.

Part One

Literature Review

Whilst there have been few studies concerned with the impact of monetary policy stance and economic activity on value and growth stock returns, there is a substantial amount of literature of relevance to this thesis. Chapter one reviews the literature concerned with explaining the relative performances of value and growth stocks, and provides explanations for the consistent superior performance of value stocks. Chapter one also reviews the literature concerned with the relationship between monetary policy and stock returns. This includes the early studies which used money supply as a measure of monetary policy as well as more recent literature based on the discount rate and federal funds rate as measures of monetary policy. Chapter one also considers research that has analysed the impact of monetary policy on different types of stocks. Finally, chapter one considers literature concerned with explaining the relationship between a number of economic variables, monetary policy and stock returns. Chapter two of the literature review explains the monetary policy environments of New Zealand, Australia and the US. This covers the implementation of monetary policy in the respective countries and highlights a number of differences in their monetary policy environments.

Chapter One

Value and Growth Stock Returns, Monetary Policy and Economic Activity

1.1 Explanation of Relative Stock Performances

Value and growth stocks are defined by a number of company specific factors, most often price-to-book ratio, company size and dividend yield. For this reason, literature concerned with the role these factors can play in explaining relative asset returns is of fundamental interest to this research. This section therefore reviews the literature concerned with the role a number of company specific factors could potentially play in driving the relative performances of stock returns.

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

Following the introduction of the capital asset pricing model, subsequent literature has both refuted and supported the model's ability to explain relative asset returns. Supporting the CAPM, Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) provided significant evidence of a positive relationship between average returns and the market beta during the 1926-1969 period. Whilst providing support for the CAPM, Fama and MacBeth's (1973) contribution proved to be significant in terms of their methodology used to test the CAPM. Now commonly referred to as the Fama and MacBeth regression approach, their methodology involved taking a portfolio perspective to testing the CAPM model. This regression approach has served to provide the methodological basis for the majority of subsequent CAPM literature.

Despite widespread acceptance of the CAPM in finance theory, numerous studies throughout the 1980s have provided substantial evidence questioning the ability of CAPM to fully describe the nature of asset returns. These studies offer a number of alternative drivers of equity returns which have predominantly included firm size, leverage, book-to-market equity (B/M), and the earnings-price ratio (E/P).

Company size has proven to be one of the strongest alternatives to beta as a measure of relative asset returns. Banz (1981) and Reinganum (1981) are attributed with providing the first substantial evidence of a size effect present in stock returns. Banz (1981) tested the relationship between company size and stock returns and found evidence of a 'size effect' over the 1936-1975 period, where small firms earned higher risk-adjusted returns than larger firms. During this time, the relationship between size and stock returns was non-linear with there being little difference in the returns of average and large size firms during this period. Similarly, Reinganum (1981) provided evidence of a size effect, while also testing for a relationship between the E/P ratio and stock returns. Whilst finding evidence of both a significant E/P ratio and size effect, when considered together, Reinganum found that the size effect absorbs the E/P effect and therefore concluded size is the relatively more important factor in describing asset returns. Findings of a size effect has been supported in subsequent literature by Lakonishok and Shapiro (1986). Using the Fama and MacBeth (1973) approach, they tested the relative importance of beta and size in explaining asset returns over the 1962-1981 period. They concluded that size is the major factor driving relative asset returns with beta holding an insignificant relationship with stock returns during the period under study.

Evidence of an E/P effect was largely attributable to Basu (1975, 1977). From an efficient market perspective, Basu tested the relationship between the E/P ratio and stock returns and found a significant positive relationship between the two variables during the 1957-1971 period. Given the ability of investors to use E/P data to earn excess returns over this period, Basu suggested the E/P ratio and stock return relationship is inconsistent with the efficient market hypothesis. Given evidence of both an E/P ratio and size effect in stock returns, studies began investigating the relative importance of these two variables in explaining equity returns. Surprised by Reinganum's (1981) finding of the size effect absorbing the E/P effect, Basu (1983) tested the robustness of Reinganum's results by analysing the relationship between firm size, the E/P ratio, and stock returns using a different data set as well as an alternative methodology. Basu's findings provided significant evidence of an E/P effect independent of size. Results for the 1963-1980 period indicated there exists a significant positive relationship between the E/P ratio and stock returns. In relation to the size effect, Basu found that after controlling for size, the E/P effect was still significant in describing equity returns. However, the observed negative relationship between firm size and stock returns virtually disappeared when controlling for differences in risk and E/P ratios.

Research analysing the relative importance of firm size and the E/P ratio continued with Cook and Rozeff (1984) who employed a number of alternative methodologies and tested the conflicting findings of Basu (1983) and Reinganum (1981). Their findings, also conflicted with previous studies, with results showing that both size and the E/P ratio were significant in explaining equity returns, with neither factor absorbing the other. Their evidence "strongly suggests that both effects (at least) are at work" (Cook and Rozeff, 1984, p.464). Jaffe, Keim and Westerfield (1989) tested for a size and E/P effect in stock return data in a attempt to clarify the relative importance of the size effect and E/P ratio. Using a longer time period than both Basu (1983) and Reinganum (1981), they undertook portfolio and seemingly unrelated regression tests while removing perceived survivorship biases from the previously analysed data set. Their results were consistent with the findings of Cook and Rozeff (1984). Specifically, there were significant size and E/P effects for all months throughout the 1951-1986 period. Keim (1990) conducted one of the more recent tests of both a size effect and E/P ratio relationship with stock returns. Testing the 1951-1986 period he found both the E/P ratio and size effects were significant in explaining asset returns when controlling for both size and E/P factors. He therefore reinforced the importance of both factors in explaining equity returns.

Another major beta alternative is the book-to-market equity factor. Rosenberg, Reid and Lanstein (1985) tested the use of book-to-market equity as an investment strategy tool and provided significant evidence of a positive relationship between book-to-market equity and stock returns. Chan, Hamao and Lakanishok (1991) confirmed the significance of the book-to-market factor by finding a significant positive relationship between book-to-market equity and stock returns in the Japanese market. Thus providing further evidence of the importance of the book-to-market factor in explaining equity returns.

Leverage emerged as an alternative to explaining relative asset returns with Bhandari (1988) providing evidence of a positive relationship between a company's debt-to-equity ratio and stock returns. Using the Fama and MacBeth (1973) methodology, he tested the 1948-1949 and 1980-1981 periods. When controlling for both size and beta, he found a higher debt-to-equity ratio led to significantly higher stock returns. Controlling for both beta and size, results suggested that whilst leverage is not a substitute for beta and size factors, it can make a significant contribution to explaining relative asset returns.

Dividend yield has also been considered a factor driving relative asset returns. Following Miller and Modigliani's (1961) dividend irrelevance theory, which stated dividend policy changes had no effect on share value, much financial theory has been dedicated to considering the relationship between dividend yield and share price. Litzenberger and Ramaswamy (1979) extended the CAPM taking into account taxes and included borrowing constraints to derive an after-tax version of the CAPM. Using this model to test the relationship between dividend yield and expected returns they found a "strong positive relationship between before tax expected returns and dividend yields of common stocks" (Litzenberger & Ramaswamy, 1979, p.190). Rozeff (1984) also tested the dividend yield/stock return relationship and found evidence of a positive relationship between dividend yield and stock returns with the dividend yield acting as a measure of equity risk premium. Numerous subsequent literature including Shiller (1984), Flood, Hodrick and Kaplan (1986) and Campbell and Shiller (1988) all provided evidence of a relationship between dividend yield and expected returns.

Whilst literature throughout the 1980s has provided substantial evidence of a number of potential alternatives to CAPM's beta, the relative importance of the different factors is less clear. Substantial conflict exists concerning the relative importance of size and the E/P ratio, and up until this point, the relative importance of dividend yield and leverage had not yet been considered in conjunction with size and the E/P ratio.

Fama and French (1992) provided a comprehensive analysis of the relative importance of size, book-to-market equity, leverage and the E/P ratio in explaining equity returns. Testing the cross-section of average returns on the NYSE, Amex and NASDAQ for the 1963-1990 period they were able to come to a number of conclusions. Using the Fama and Macbeth (1973) approach, they found that beta failed to hold a statistically significant relationship with asset returns. Both size and book-to-market equity proved to be the two most significant factors driving asset returns over this period. Specifically, there was a negative relationship between size and stock returns, and a positive relationship between book-to-market equity and stock returns. In addition to this, these relationships remained significant when both size and book-to-market equity were simultaneously included in the analysis. Both leverage and E/P ratios held a significant relationship to equity returns, however, both factors were rendered redundant with the inclusion of both size and book-to-market equity. Testing the relationship between book-to-market equity and size, Fama and French found a negative relationship exists between the two variables, however, both still remain necessary to explain stock returns. Fama and French (1993) extended their analysis by also considering Government bonds and taking a time-series regression approach. Supporting their previous findings, their results showed both size and book-to-market factors explain equity returns and "proxy for sensitivity to common risk factors in stock returns" (Fama & French, 1993, p.5).

The findings of Fama and French (1992) served to reinforce the importance of size and book-to-market equity in determining asset returns, and highlighted the inadequacy of beta to fully explain asset returns. The debate, however, continued with researchers continuing to search for the ultimate explanation of equity returns. Fama and French's comprehensive analysis put to rest a number of issues concerning the relative importance of size, the E/P ratio, book-to-market equity and leverage factors. More recent literature has attempted to either find new factors driving equity returns, develop alternative methodology, or improve the data set on which earlier analysis had been based. Attempting the latter, Davis (1994) tested the ability of book-to-market equity, cash flow yield and the E/P ratio to explain asset returns. Using an alternative source to compile their sample data set, they analyse stock returns over the 1940-1963 period, and in doing so removed survivorship bias in the previously used COMPUSTAT database. Their results provided evidence of a significant relationship between book-to-market equity, the E/P ratio and cash flow yield, and stock returns. Results on the relative ability of these three factors did not indicate the superiority of one over the other. Davis (1994) also found that the size effect was not present throughout his 1940-1963 sample period.

Chan, Jegadeesh and Lakonishok (1995) conducted an indirect test of the ability of the book-to-market ratio to explain equity returns by examining the extent to which sample selection bias can effect the hypothesised book-to-market effect. Testing a number of sample selection procedures and databases, they concluded that the impact of selection bias is negligible in explaining the book-to-market effect on stock returns.

Kothari and Shanken (1997) and Pontiff and Schall (1998) have provided some of the most recent literature on the factors that drive equity returns. Kothari and Shanken (1997) took a time series approach and used vector autoregressions, bootstrap simulation, and developed a bayesian bootstrap simulation. They found that "both book-to-market (B/M) and dividend yield track time-series variation in expected real stock returns over the period 1926-91" (Kothari & Shanken, 1997, p.169). Pontiff and

Schall (1998) used multivariate regression analysis and found that the "book-to-market ratio contains information about future returns that is not captured by other variables such as interest yield spreads and dividend yields" (Pontiff & Schall, 1998, p.141). These studies serve to further reinforce the significance of the book-to-market ratio in explaining equity returns.

The issue of what factors describe equity returns is still somewhat unresolved. Whilst there appears sufficient evidence to question the validity of the CAPM, the model continues to hold a fundamental place in finance theory with beta remaining the major tool for explaining relative asset returns in practice. Chan and Lakonishok (1993) summed up the role of beta in finance theory by stating that whilst there is mounting evidence suggesting alternative factors are more accurate measures of relative equity returns, there is still insufficient evidence to warrant the total discard of beta as an explanatory variable.

There is substantial evidence indicating the relative importance of a number of company specific factors in explaining stock returns. Evidence regarding the relationship between stock returns and book-to-market equity, company size and dividend yield corresponds to the recent evidence regarding the relative performances of value and growth stock returns. That is, smaller companies with higher book-to-market ratios and higher dividend yields (value stocks) tend to outperform larger stocks with lower book-to-market ratios and lower dividend yields (growth stocks). Recent literature on the relative returns on value and growth stocks is reviewed in the following section.

1.2 Value and Growth Stock Returns

The concept of value and growth investing has been present in finance literature for more than half a century. Value investing was originally promoted by Graham and Dodd (1934) whilst the growth strategy gained popularity in the post World War II period, following support of this strategy by professional investors David Babson (1951) and T. Rowe Price.

The relative performance of value and growth stocks has been well covered in the literature, where there is abundant evidence supporting the superior performance of value stocks in the long-term. Capaul, Rowley and Sharpe (1993) tested the relative performance of value and growth stocks, based on price-to-book (P/B) ratios, in six countries over the 1981-1992 period. A summary of their results are shown in table 1.1 which provides significant evidence of value stocks outperforming growth stocks in all countries on both a total and risk-adjusted basis. They did note, however, that the difference in value and growth returns varied significantly between countries. They therefore suggested that the value/growth investment strategy be used on a global basis rather than within individual countries.

Table 1.1
Annual value-growth spread statistics for international stock markets (1981 – 1992)

Market	Annual spread Value minus growth	Standard Deviation
France	6.41%	13.38%
Germany	1.54%	10.88%
Switzerland	3.71%	10.03%
UK	2.74%	11.50%
Japan	6.04%	13.03%
US	1.35%	6.89%
Europe	2.77%	7.57%
Global	3.44%	5.89%

Source: Capaul, Rowley and Sharpe (1993) p.34.

Capaul, Rowley and Sharpe's (1993) findings have been substantiated by a number of subsequent studies. Bauman, Conover and Miller (1998), Calderwood (1995), Ibbotson and Riepe (1997), Bauman and Miller (1997), and Yeh and Sharaiha (1997) have all tested the relative performance of the value and growth strategies, collectively covering the 1975 – 1997 period and a vast number of markets. Their results are overwhelmingly consistent, with the superiority of the value strategy being evident in all of the studies.

Whilst the long-term superior performance of value stocks is a well established fact supported by a substantial amount of empirical research, the reason behind this international phenomenon is less clear. The literature has provided a number of explanations, the first of which was the overreaction hypothesis. This was developed by DeBondt and Thaler (1985), and was based on an analysis of human behaviour conducted by Kahneman and Tversky (1982). Kahneman and Tversky (1982) performed a psychological test of individuals' reactions to good/bad news and unexpected events and found that people have a tendency to overreact. Applying these findings to finance theory, DeBondt and Thaler (1985) suggested that investors overreact to good and bad news and in doing so overweight the use of recent information when making their investment decisions. In relation to value and growth stocks therefore, DeBondt and Thaler (1985) suggested that "with prices initially biased by either excessive optimism or pessimism, prior 'losers' would be more attractive investments than prior 'winners' " (DeBondt & Thaler, 1987, p.557). That is, value stocks, characterised as being prior losers, outperform the prior winners due to the over-emphasis placed on the recent results of the winning stocks. Evidence of the overreaction hypothesis has been provided through tests of the contrarian investment strategy. This is a strategy where investors invest in stocks that have exhibited poor performances and sell short stocks that have exhibited significant superior performances. Testing their hypothesis, DeBondt and Thaler (1985) identified 'winner' and 'loser' stocks based on past market-adjusted excess returns (the pre-test period), and analysed the returns on these stocks following their winning or losing status (the test period). Results for stock returns over the 1926-1982 period indicated there is overreaction in the market, with stocks that were originally classified as 'loser' stocks outperforming the market in the period following their 'loser' classification. Prior 'winner' stocks significantly underperformed the market in the period following their 'winning' classification.

Support for the overreaction hypothesis was further provided by DeBondt and Thaler (1987) and Chopra, Lakonishok and Ritter (1992). DeBondt and Thaler (1987) conducted a more comprehensive test of the hypothesis by considering firm size, seasonality in returns and company risk. Their results, once again, provided support for the overreaction hypothesis with the overreaction being independent of both firm size and risk. Chopra et al. (1992) tested the overreaction hypothesis adjusting for both firm size and risk. Their approach differed from previous studies in that they didn't use CAPM to measure abnormal returns, and instead used their own estimate of market compensation per unit of beta risk. Despite this different approach, their results still supported the existence of an overreaction effect on stock returns after controlling for both size and risk factors. The overreaction, whilst not explained by a size effect, was more prevalent amongst smaller firms.

Further support for the overreaction hypothesis has been provided through evidence of unrealistic investor expectations leading to the superior performance of value stocks. With investors overreacting to past events, investors expectations of the returns on growth stocks are likely to be too great, therefore leading to disappointed growth investors and the demise of the growth stock. Lakonishok, Shleifer and Vishny (1994) used the contrarian investment strategy to test the hypothesis that "differences in expected future growth rates are linked to past growth and overestimate future growth differences between glamour and value firms" (Lakonishok et al., 1994, p.1543). Their results provided significant support for the role expectations play in the undervaluing of value stocks, with value stocks, characterised by poor prior performance, outperforming growth stocks.

Bauman and Miller (1997) undertook a direct test of the role of expectations in the pricing of value and growth stocks by analysing the difference between the reported earnings per share (EPS) of these stocks, and the consensus forecast of EPS provided by security analysts. Their results showed that the difference between expected EPS and actual EPS became greater and more disappointing for companies with high price-to-earnings (P/E) ratios. They concluded therefore that " investment research analysts systematically overestimate the future EPS of growth stocks relative to value stocks. Therefore, growth stocks appear to experience lower returns subsequently when realised EPS growth rates are disappointingly lower than those that were expected" (Bauman, Conover & Miller, 1998, p.75).

Closely related to the role of expectations and the overreaction hypothesis is the role of mean reversion in explaining the superior performance of value stocks. Calderwood (1995) and Sanders (1995) both suggested mean reversion explains the relative performances of value and growth stocks. Providing evidence of this, Calderwood (1995) compared the average levels of P/B, P/E and yield ratios of a market index to the average levels of these ratios for value and growth indices. He found that the P/B ratio of growth stocks was nearly 68% higher than the average P/B ratio for the market. On the other hand, the average P/B ratio of value stocks was approximately 25% smaller than the market's average P/B ratio. These results suggested that "there is about 2.5 times more regression pressure on growth stocks than on value stocks" (Calderwood, 1995, p.10). These results also suggest that under mean reversion there is upward price pressure on value stocks and downward price pressure on growth stocks, and in relative terms the downward pressure on growth stocks is greater than the upward pressure on value stocks. These results were supported by Sanders (1995) who also found mean reversion in value and growth stocks to be an international phenomenon. Mean reversion was also recognised by Bauman and Miller (1997) and Ibbotson and Riepe (1997) who suggested investors do not take this phenomenon into account when forecasting future earnings.

The research has provided a number of psychological factors for the undervaluing of value stocks by investors who overreact to, or are over optimistic about, the future returns on growth stocks. A number of researchers have suggested that investors have a psychological attachment to shares which leads them to extrapolate past growth rates and therefore undervalue value stocks. (Bauman & Miller 1997, Lakonishok, Schliefer & Vishny 1994). Ibbotson and Riepe (1997) suggested that value stocks are psychologically less desirable to hold in a portfolio. Bauman and Miller (1997) suggested that it is easier for portfolio managers to sell glamour stocks to investors as well as being easier to justify their selection to superiors. They also suggested that analysts may feel pressure not to let their own forecasts differ too significantly from the biased forecasts of company management. Calderwood (1995) suggested a 'mental demons' factor where three 'demons' influence investor behaviour. Firstly, investors place value on the comfort of consensus. That is, they prefer to 'follow the crowd' and buy into stocks with high P/B ratios. Secondly, they fear loss greater than they fear risk. Therefore, investors choose stocks with higher P/B ratios in the belief that low P/B stocks could fall even further. And thirdly, investors tend to exaggerate even remote possibilities leading to the overreaction to stocks with low P/B ratios. That is, they overweight the possibility of further falls in performance. Sanders (1995) also supported the value of comfort to investors who are willing to pay more for stocks which have shown superior performances in the past.

Whatever the psychology underlying investor behaviour, there is substantial evidence suggesting investors overreact which leads to significant expectational errors and the undervaluing of value stocks. There are, however a number of alternative explanations for the superior performance of value stocks. An alternative explanation is that of risk. Ball and Kothari (1989) and Chan (1988) criticised the overreaction hypothesis by providing evidence of risk factors underlying the relative performances of value and growth stocks. They directly challenged DeBondt and Thaler's results by showing that the risk characteristics of 'winning' and 'losing' stocks differ substantially between the test and the ranking period, thus distorting their conclusion that risk factors do not account for the superior performance of value stocks. Using a CAPM approach they tested the stationarity of betas over time and found that "Comparison of the ranking- and postranking-period betas provides compelling evidence that large expected return changes are associated with extreme realized returns" (Ball & Kothari, 1989, p.69). In particular, they found that the risk of 'loser' stocks substantially increased in the period following the abnormal losses, and vice versa for 'winner' stocks. Therefore past betas should not be used when estimating the abnormal returns during the test period. When accounting for the instability in the stocks' betas they found "only weak evidence of price reversals, even though the stocks in our sample have experienced very large abnormal gains or losses prior to the test periods" (Chan, 1988, p.160).

Subsequent support for the risk explanation has been provided by Chan and Chen (1991) and Fama and French (1993). Following Chan, Chen and Hsieh (1985) and Huberman, Kandel and Korolyi (1987), who suggested risk factors underlie the higher performance of small stocks, Chan and Chen (1991) attempted to determine the reason for this by analysing the structural characteristics of small and large firms. From their analysis, they concluded that distress factors underlie the higher risk and return characteristics of small firms. That is, smaller stocks are more likely to be 'distressed' stocks and therefore present higher risk to the investor. Fama and French (1993) analysed the behaviour of value and growth stocks and found that stocks with high book-to-market ratios and small stocks tend to move up and down together, suggesting the existence of an underlying common risk factor. Given this finding, they concluded that the comovement between firm size and book-to-market ratio is due to the fact that these characteristics act as proxies for non-diversifiable risk factors.

Evidence against Fama and French's (1993) risk explanation has been provided by Daniel and Titman (1997). They found that whilst stocks with high book-to-market ratios do covary together, they suggested that this is due more to similarities in firm characteristics than to risk. They also suggested that if a common distress factor was driving the performance of high book-to-market stocks, this covariance should not be present when these firms are not in this distressed or high book-to-market category. They found, however, that the common variation between these stocks was apparent both before and after their periods of distress. They concluded therefore that underlying risk factors do not explain the relative returns of value and growth stocks. They did, however, support Fama and French's (1993) findings that "the market beta has no explanatory power for returns even after controlling for size and book-to-market ratios" (Daniel & Titman, 1997, p.29).

In efforts to more fully understand the value/growth investment strategies a number of alternative explanations have been suggested. While discussing mean reversion and 'mental demons', Calderwood (1995) also suggested that growth stocks are more vulnerable to expectational errors given that growth managers tend to rely more heavily on forecasts of future performance than on existing data. On the other hand, value managers tend to rely more heavily on existing 'hard data' than on forecasts. Therefore, there is greater scope for error in the pricing of growth stocks than for value stocks, with growth stocks more likely to be effected by changes in economic conditions. Another explanation provided by Calderwood concerns the relative dividend yields of value and growth stocks. He suggested that "dividends grow and are much easier to identify and lock in than is capital appreciation" (Calderwood, 1995, p.9). That is, the capital appreciation required by growth stocks to compensate investors for lower dividend yields, is more difficult to achieve than an increase in dividends which is often offered by value stocks.

Another reason suggested for the value premium is due to tax differences on dividends and capital gains. Because value stocks typically provide higher dividend yields, the higher return on value stocks may be required to offset the tax disadvantage associated with these stocks. Suggesting this, Ibbotson and Riepe (1997) recognised that there has been little research in this area and therefore little can be said about the validity of this explanation.

Whilst the literature has focused on the long-run performances of value and growth stocks, little empirical research has been conducted concerning the relative short-run performances of these stocks. In their analysis, however, Bauman and Miller (1998), Ibbotson and Riepe (1997) and Yeh and Sharaiha (1997) have all noted the existence of periods where growth stocks have provided superior returns to value stocks. Table 1.2 provides a summary of the results from Ibbotson and Riepe (1997) which shows the different returns on value and growth stocks in the US during shorter time frames within the 1989-1996 period.

Table 1.2
Value and growth cycles for US stocks over the 1989 – 1996 period

Period	Value stocks Annual returns	Growth stocks Annual returns	Value stocks Standard deviation	Growth stocks Standard deviation
1989 – 1991	12.9%	23.7%	16.8%	21.2%
1992 – 1993	14.5%	3.4%	7.7%	8.7%
1994 – 1996	18.4%	20.9%	12.0%	11.9%

Source: Ibbotson and Riepe (1997) p.69.

Ibbotson and Riepe (1997) also found serial correlation in the difference in returns for value and growth stocks. Finding serial correlation, they suggested that there exists some underlying factors driving the relative performances of value and growth stocks which could assist portfolio managers in their investment decision-making process.

Further research in this area is imminent as, in efforts to earn superior returns, portfolio managers strive to more fully understand the value/growth investment strategies. To date, only one study has considered the role of underlying factors in determining the relative returns of value and growth stocks in the short-run. Jensen, Johnson and Mercer (1997) tested the relationship between monetary policy stance and the relative returns of value and growth stocks. Constructing size and price-to-book portfolios independent of risk, stock returns over the 1965-1994 period were analysed. Finding evidence of the superior performance of value stocks, Jensen, Johnson and Mercer (1997) analysed size and price-to-book portfolios in the context of different monetary policy environments. Based on changes in the Federal Reserve's discount rate, all stock returns were categorised as occurring during restrictive or expansionary monetary policy environments based on the direction of the previous change in the discount rate. Stock returns following an increase in the discount rate were deemed to have occurred during tightening monetary policy and vice versa. Results from their analysis showed that value stocks outperformed growth stocks only during expansive monetary policy. During restrictive monetary policy there was no clear pattern indicating value stocks outperform growth stocks. Given their findings, they suggested that "investors should consider the Federal Reserve's monetary policy stance when attempting to use any investment strategy" (Jensen et al., 1997, p.40).

Theory on the influence of monetary policy on the relative returns of value and growth stocks is currently being developed. Whilst somewhat deficient in empirical testing, there are a number of theories which attempt to explain the relationship between the relative performances of value and growth stock returns and monetary policy. These theories typically involve the consideration of various other macroeconomic factors which could impact on the monetary policy/stock return relationship. Jensen, Johnson and Mercer (1997) suggested their evidence supports Fama and French (1993) and Chan and Chen's (1991) risk explanation of the superior performance of value stocks. Given, value (or distressed) stocks will face higher risk during economic recessions, the expansionary monetary policy that occurs during this time will be associated with higher expected returns for the more risky value stocks.

In a recent study, Young (1998) considered the relationship between monetary policy and the relative performances of value and growth stock returns and suggested a number of reasons underlying the relationship between these variables. Firstly, he suggested that higher interest rates during contractionary monetary policy may have a greater negative effect on value stocks given that these are primarily purchased for their dividend yield. He also suggested that value stocks are 'unexciting stocks' that work on lower margins than growth stocks. Therefore, weaker economic activity resulting from tighter monetary conditions is likely to have a greater negative impact on value stocks than on exciting higher margin growth stocks. Finally, Young (1998) suggested that it is the relationship between monetary policy and economic activity that causes the superior performance of growth stocks to occur during tightening monetary policy. That is, because growth stocks are more likely to perform better during periods of strong economic growth, and it is during these periods that monetary policy is most likely to be firming, tightening monetary policy is associated with higher growth stock returns. This suggests therefore, that the superior performance of growth stocks during tightening monetary policy is more to do with the level of economic activity that occurs during tightening monetary policy, than due to the tightening itself. This explanation is similar to Jensen et al. (1997) who also considered the relationship between economic activity and monetary policy. Their explanation, however, focused on the superior performance of value stocks during economic downturns (due to greater distress) rather than the superior performance of growth stocks during economic upturns. Both, however, result in the same conclusion regarding the relationship between monetary policy, and value and growth stock returns.

NATWEST (1998) provided two suggestions for the channels through which economic conditions can impact differently on value and growth stock returns. Firstly, they suggested that growth stocks should outperform value stocks during periods of decreasing GDP. They suggested that growth is scarcer during periods of decreasing GDP and therefore during this period a premium should be commanded on growth stocks. Conversely, during increasing GDP, growth will be fairly widespread and therefore growth stocks should not command a premium. They also suggested that growth stocks are more sensitive to changes in interest rates given that growth stocks are a longer duration asset than value stocks. That is, growth stock valuations are more dependent on forecasts of future discounted cash flows and therefore will be more affected by changes in the interest rate. It is interesting to note that NATWEST's explanations are in direct conflict to both Young (1998) and Jensen, Johnson and Mercer (1997) who suggested value stocks provide higher returns during economic recessions and growth stocks provide higher returns during strong economic growth. NATWEST (1998), however, suggested that growth stocks perform better during economic recessions and vice versa.

1.3 Monetary Policy and Stock Returns

There have been numerous studies concerned with the influence of monetary policy on stock returns. Section 1.3.1 reviews the early studies primarily concerned with the impact of changes in the money supply on stock returns. Section 1.3.2 reviews the more recent literature which focuses on the relationship between changes in the discount rate or federal funds rate and stock returns. Section 1.3.3 reviews the literature which has analysed the relative impact of monetary policy changes on different types of stocks.

1.3.1 Money Supply as a Measure of Monetary Policy

Early studies analysing the impact of monetary policy changes on stock returns were based on the analysis of money supply variables. Up until 1979, the quantity of money supply played a significant role in the implementation of monetary policy in the US and consequently research throughout this period primarily used changes in money supply as a proxy for monetary policy stance.

Sprinkel (1964) provided the seminal paper investigating the relationship between money supply and stock returns. Taking a graphical approach to analyse the relationship he found a lagged relationship exists between money supply changes and stock returns. Specifically, money supply changes tend to lead changes in stock returns by approximately 2 months for money supply increases, and 15 months for money supply decreases. Sprinkel's study served to be the catalyst in sparking subsequent debate and studies concerned with a money supply/stock return relationship.

Following on from Sprinkel's (1964) study, Palmer (1970) and Homa and Jaffee (1971) attempted to provide further clarification of Sprinkel's results. Like Sprinkel, Palmer adopted a graphical approach and tested money supply and stock return data over the 1959-1969 period. Palmer made a number of observations similar to those made by Sprinkel. In terms of degree, a one per cent change in the growth rate of the money supply leads to a ten per cent change in stock prices.

Like Palmer, Homa and Jaffee (1971) attempted to clarify Sprinkel's result. However, unlike previous studies, Homa and Jaffee conducted a more statistically robust analysis of the data. Both Sprinkel and Palmer relied on observations of a graphical relationship between money supply and stock returns, with no statistical analysis involved. Homa and Jaffee addressed this shortcoming by using regression analysis to provide a substantially more robust measure of a money supply/stock return relationship. Using quarterly data for the 1954-1969 period, results suggested that there is a significantly positive relationship between money supply and stock returns. That is, increases in the money supply leads to increases in stock prices. Homa and Jaffee can therefore be credited with providing the first substantial statistical evidence in support of Sprinkel's (1964) findings. Having established that this relationship exists, Homa and Jaffee considered whether it could be used as an effective forecasting tool from which an investment strategy could be determined that provides superior returns compared to a naïve buy-and-hold strategy. Using the regression equation formulated to test the relationship between stock returns and money supply changes, Homa and Jaffee tested this equation in terms of its ability to forecast future stock returns. Using estimates[1] of expected money supply growth, they used simulation to test a number of different investment strategies. In cases where the future level of the money supply was predicted correctly it was possible to earn superior returns. However, in cases where less accurate money supply estimates were obtained, the success of the investment strategies was less clear.

Keran (1971) extended the earlier studies by considering the channels through which money supply changes may have an impact on stock returns. Keran (1971) found stock prices were primarily determined by a weighted average of current and past earnings, and long-term interest rates. Interest rates were found to be influenced by inflation expectations, the growth rate of real income and the percentage change in real money balances. Given this, he concluded that "changes in the nominal money stock have little direct impact on the stock price, but a major indirect influence on stock prices through their effect on inflation and corporate earnings expectations" (Keran, 1971, p.31).

Hamburger and Kochin (1972) attempted to obtain a greater understanding of the channel through which money supply affects stock prices by examining the short-run impacts of money supply changes on equity returns. Hamburger and Kochin provided evidence that "money has *both* direct and indirect effects on the stock market" (Hamburger & Kochin, 1972, p.238). That is, "changes in money supply play an important role in the determination of equity prices even when the paths through interest rates and through expected corporate earnings – as conventionally measured – are excluded" (Hamburger & Kochin, 1972, p.240). Hamburger and Kochin also examined the impact of money growth on the level of interest rates. Results suggested that money growth has a greater effect on stock returns than on interest rates. This result "conflicts sharply with the conventional view on how money influences the stock market and suggests that changes in money have a direct impact on the market" (Hamburger & Kochin, 1972, p.242).

Literature up to this point has established the notion of a positive relationship between money supply changes and equity returns, considered the implications of this for portfolio management, and analysed the channels through which this relationship is transferred. Cooper (1974) altered the focus of subsequent studies by introducing efficient market theory into the money supply/stock return literature. Analysing the effects of money supply changes on stock returns, he paid particular attention to the implications of this relationship on the efficient market hypothesis. Previous studies suggesting a

[1] To assess the ability of any forecasting technique it is necessary to ensure that only the information known to the investor at the time of forecasting is included in the forecasting equation.

lagged relationship exists between stock returns and money supply changes imply that investors can use trading strategies based on past information to earn superior returns and are therefore inconsistent with an efficient market. Using regression and spectral analysis Cooper (1974) analysed the 1947-1970 period and found that money supply changes did not lead stock returns but instead stock returns lead money supply changes, on average, by approximately 3 months.

Following on from Cooper (1974), Rozeff (1974) presented a comprehensive analysis of the money supply/stock return relationship in the context of market efficiency. In doing this, Rozeff (1974) distinguished between a predictive and non-predictive monetary policy model. The predictive monetary policy model was defined as a model in which "stock returns are materially affected *by only lagged* monetary variables" (Rozeff, 1974, p.248). The non-predictive monetary policy model was a model where "current stock returns are related to current monetary data or to current and future monetary data" (Rozeff, 1974, p.248). From these definitions, the inconsistency of the predictive monetary policy model with efficient markets is apparent. Performing a number of regressions to test these models for the 1947-1970 period, Rozeff (1974) found no significant relationship between stock returns and past available monetary data. Testing the non-predictive monetary policy model, results showed "current stock returns bear a significant relationship to current monetary growth rates, but excess profits cannot be earned on the basis of the relation unless one has advance knowledge of growth rates of the money supply" (Rozeff, 1974, p.300). These findings are consistent with the efficient market hypothesis. As a final test, Rozeff analysed the relationship between current stock prices and future expected money supply changes. This acted as a further test of the efficient market hypothesis where, in an efficient market, current stock prices should reflect all available information and therefore may accurately anticipate future money supply changes. Testing this, Rozeff found evidence that a positive relationship exists between current stock prices and future money supply changes. This lends further support to the existence of an efficient market where it is unlikely that money supply changes lead stock price changes.

Following Cooper (1974) and Rozeff (1974), Pesando (1974) and Rolgaski and Vinso (1977) also placed the money supply/stock return relationship in an efficient market context. Upholding the efficient market view, Pesando (1974) provided evidence suggesting little relationship exists between money supply changes and future stock returns. Analysing the 1970-1972 period and using Canadian and US data, his results suggested that, in fact, little relationship exists between money supply changes and stock returns and therefore "one should not attach undue importance to their quantitative estimates of changes in the money supply on common stock prices" (Pesando, 1974, p.909).

Rolgaski and Vinso (1977) also considered the implications of a money supply/stock return relationship on market efficiency by testing for causality between the two variables. Analysing the 1963-1974 period, they tested for causality and found "causality does not appear to go from money supply to stock prices but rather from stock prices to money supply and back again" (Rolgaski & Vinso, 1977, p.1029).

Following the introduction of efficient market theory into the money supply/stock return analysis, a number of subsequent studies considered market efficiency by distinguishing between anticipated and unanticipated money supply changes. It was hypothesised that only unanticipated money supply changes should have an impact on stock returns given that in an efficient market stock prices should reflect all currently available information. Therefore, distinguishing between anticipated and unanticipated changes, one can test the level of market efficiency. One of the first to do this was Berkman (1978) who analysed weekly changes in the money supply over the June 1975-July 1977 period to determine their relationship with unexpected changes in money supply. Using regressions to distinguish between expected and unexpected money supply changes, he found a significantly negative, yet small, relationship exists between stock returns and unexpected changes in the money supply. However, when failing to distinguish between expected and unexpected changes, only a weak relationship was found to exist. These results are in direct conflict to earlier studies that predominantly found a positive relationship between stock returns and money supply changes. These findings, however, have been reinforced by subsequent literature.

Lynge (1981), Pearce and Roley (1983) and Cornell (1983) all distinguished between anticipated and unanticipated changes in the money supply and, like Berkman (1978), have found a negative relationship exists between unanticipated changes in money supply and stock returns. Lynge (1981) analysed the impact of money supply changes on stock returns in an efficient market context and found a significant negative relationship exists between stock returns immediately following a money supply change announcement and the time of the announced change. Given this, Lynge suggested that the market does not fully anticipate the announced money supply change. He therefore concluded that investors' forecasts of money supply changes must be sufficiently inaccurate that the actual announcement provides new information to which stock prices react.

While Lynge (1981) was one of the first to follow Berkman (1978) and distinguish between anticipated and unanticipated changes in money supply, his study did not involve categorising past money supply changes as either anticipated or unanticipated. He merely analysed the data and interpreted the results with respect to the implications it held for anticipated versus unanticipated changes. Pearce and Roley (1983) presented a more in depth analysis by categorising all money supply changes in their study as either anticipated or unanticipated. Using weekly data for September 1977-January 1982, they tested the relationship between changes in stock prices and anticipated and unanticipated changes in money stock. To determine anticipated changes, a weekly survey of market participants was undertaken with the anticipated change being the median forecast of the participants. Analysing the stock price changes on the day following the announcement, Pearce and Roley found that only unanticipated changes in money stock resulted in a significant change in stock prices. Specifically, an unanticipated increase in money supply led to a decrease in stock prices. This result therefore supports the efficient market hypothesis. Testing for the persistence of the impact of money supply changes on stock prices, Pearce and Roley found the impact on stock prices is completed in the day following the money supply announcement.

Cornell (1983) also found a negative relationship between unanticipated money supply changes and stock returns. Studying the 1978-1981 period, Cornell investigated the relationship between a number of economic variables and changes in the money supply. Like Pearce and Roley they used the median forecasts of expected money supply changes to distinguish between anticipated and unanticipated changes. Using regression analysis, they found a significant negative relationship between money supply changes and stock prices after 1979.

A number of contributions have been made to the theory of a money supply/stock return relationship. Sprinkel (1964) provided the seminal paper with numerous subsequent literature serving to add support to the existence of a relationship between money supply changes and stock returns. The direction of the relationship, however, is somewhat less clear. Sprinkel (1964) and Palmer's (1970) studies, though significantly lacking in statistical power, provided the earliest evidence of a positive relationship between money supply changes and stock returns. Following these initial studies, a number of attempts have been made to improve on the methodology used to establish a money supply/stock return relationship, with results from these studies providing further statistical evidence of a positive stock return/money supply relationship. That is, an increase in money supply leads to higher stock returns. However, following the introduction of the efficient market hypothesis into the money supply literature, more recent analysis has provided significant evidence of a negative relationship between unanticipated money supply changes and stock returns. In terms of the lead-lag relationship between these two variables, substantial evidence has supported the notion that stock returns are more likely to lead money supply changes, than money supply changes are to lead stock returns.

1.3.2 Changes in the Discount Rate and Federal Funds Rate as a Measure of Monetary Policy

Literature in the 1980s began to take alternative approach to testing the impact of monetary policy on stock returns. Unlike the early studies, which were primarily concerned with the influence of money supply changes on equity returns, more recent literature has emphasised the use of the federal funds rate and the discount rate in influencing monetary policy. The reason behind this new focus was largely caused by the Federal Reserve's change in their operating procedure for implementing monetary policy in 1979. Prior to 1979, the quantity of money supply was a significant tool in the implementation of monetary policy. Consequently, research throughout this period was predominantly concerned with explaining a stock return/money supply relationship. However, with the discount rate and federal funds rate emerging as major money policy tools, studies concerned with establishing a relationship between these tools and stock returns have become increasingly common in the finance literature.

Whilst Sprinkel (1964) was the first to formally assess the relationship between money supply and stock returns, Waud (1970) was the first to analyse the impact of discount rate changes on stock returns. Although at the time of Waud's study money supply was the primary monetary policy tool, Waud was concerned with discount rate changes due to the general perception that these changes had a psychological impact on investors' expectations of the future course of the economy. Given the stock market is a market in which prices should reflect investors' expectations of the future course of the economy, Waud tested the impact of discount rate changes on stock returns. Using regression analysis, Waud analysed stock returns on the day following the 25 discount rate changes that occurred over the 1952-1967 period. Results from this analysis suggested a significant negative relationship exists between discount rate changes and stock returns. That is, an increase in the discount rate (tightening monetary policy) leads to a decrease in stock returns. From these findings, Waud concluded that "there is an effect on expectations associated with discount rate changes and that there seems to be a consensus as to what the inferred information content of such changes portends for future economic conditions, that opinion being different depending on whether there is a discount rate increase or a discount rate decrease" (Waud, 1970, p.248). Waud also considered the relative impact of technical[2] and non-technical changes on stock returns, suggesting that only non-technical changes in the discount rate should impact on stock returns. Results showed a significant impact of both technical and non-technical changes on stock returns. Therefore, Waud concluded that all discount rate changes, irrespective of their purpose, provide the public with information regarding the future economic prosperity of the economy.

Following Waud's seminal paper, a number of years lapsed before there were any subsequent tests of Waud's findings. However, interest in the relationship between monetary policy changes and stock returns resurfaced in the 1980s following changes in the Federal Reserve's monetary policy implementation procedures. The literature has developed in three main areas. The majority has begun by establishing the basic relationship between discount rate or federal funds rate changes and stock returns. Following this, many studies have extended the research by placing the monetary policy/stock return relationship in an efficient market context. Further to this, the literature has also considered the channels through which the monetary policy/stock return relationship is transmitted.

Numerous studies have provided evidence of a negative relationship between discount rate changes and stock returns. Smirlock and Yawitz (1985) provided one of the first studies, subsequent to Waud's, which attempted to establish a discount rate/stock return relationship. Smirlock and Yawitz were concerned with the implications of technical and non-technical discount rate changes on market efficiency. Using event study methodology, they tested the hypothesis that only non-technical changes in the discount rate should have an impact on stock prices in an efficient market. In testing this hypothesis they analysed stock returns on the day following the 36 discount rate changes that occurred over the 1975-1982 period, using the NYSE value-weighted index as a measure of stock returns. Their results showed that prior to 1979 there was no significant relationship between discount rate changes and stock prices. However, a negative relationship existed between stock prices and discount rate changes after 1979. Considering the impact of this on market efficiency, Smirlock and Yawitz suggested that "If the discount rate is endogenous, as available evidence indicates, then the market may be inefficient since it significantly reacts to an event that should contain no new information"

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[2]A technical discount rate change is defined by Jensen and Johnson (1995) as where the Federal Reserve's motive for the discount rate change is merely to align the discount rate with market rates. Non-technical changes is where the rate change represents a change in the Federal Reserve's monetary policy stance.

(Smirlock & Yawitz, 1985, p.1147). Testing this hypothesis, Smirlock and Yawitz used two different approaches to distinguish between technical and non-technical discount rate changes. The first approach was based on the use of a statistical model, the second was based on statements made by the Federal Reserve Bank stating the intentions of the discount rate change. Despite fundamental differences between the two approaches, results from these two methods provided fairly consistent results. The evidence suggested that for discount rate changes prior to 1979 (of the 18, 11 were deemed to be non-technical) there appeared to be no significant relationship between non-technical discount rate changes and stock prices. Results, however, from the post 1979 data showed a negative relationship existed between stock prices and non-technical changes in the discount rate. They therefore concluded that these results "provide strong support for the hypothesis that the market responds differently to discount rate changes, depending on whether they are viewed as technical or non-technical" (Smirlock & Yawitz, 1985, p.1154). These results were inconsistent with Waud's finding of a significant impact of both technical and non-technical discount rate changes for the period prior to 1979, however, Waud did not specify his method for distinguishing between technical and non-technical discount rate changes and therefore a direct comparison is difficult. Smirlock and Yawitz also tested the speed at which the impact on stock returns is transmitted. To test this, they determined the response of asset prices to discount rate changes for the 5 day period following the announcement day. They asserted that there should be no impact in this post-announcement period in an efficient market. Results showed "strong support for the rapid price adjustment associated with market efficiency and indicated that, to the extent that markets react to discount rate changes, the reaction is largely complete by the end of the announcement day" (Smirlock & Yawitz, 1985, p.1157).

Following Smirlock and Yawitz (1985), Thorbecke and Alami (1994) investigated the relationship between stock returns and changes in the federal funds rate for the 1974-1979 period in a test of the expected interest rate and expected inflation rate hypotheses put forward by Hardouvelis (1987)[3]. These hypotheses suggest two alternative channels through which monetary policy influences stock returns. A negative relationship between stock prices and the federal funds rate is evidence of an expected interest rate hypothesis but inconsistent with an expected inflation rate hypothesis. Using event study methodology, they tested the impact of changes in the federal funds rate on stock prices, with changes being determined by analysing price movements for the 24-hour period surrounding the

[3] The expected inflation rate hypothesis suggests that an unanticipated increase in money supply leads the market to expect higher inflation rates, thus lowering after-tax real profits and therefore lowering stock prices.

rate change announcement. Results showed that increases in the federal funds rate (tightening monetary conditions) caused a significant negative impact on stock prices, therefore lending support to the interest rate hypothesis.

Like previous studies, Jensen and Johnson (1995) used event study methodology to test the discount rate/stock return relationship. Their study, however, differed from previous studies in that they were concerned with analysing the longer term impacts of monetary policy changes on stock returns. These longer term effects were analysed by examining stock returns 15 days prior to the announcement of a discount rate change, and stock returns 15 days after a two day announcement period. Stock prices were measured using the CRSP equal weighted index, the CRSP value-weighted index, and a financial index constructed by Jensen and Johnson. Over the 1962-1991 period there were 39 increases and 32 decreases in the discount rate. Non-parametric tests were also undertaken by Jensen and Johnson to confirm the significance of their results. Combining the results from the above analysis, results suggested that the market anticipates future changes in the discount rate with a negative relationship existing between discount rate changes and stock returns. That is, when the market anticipates an increase in the discount rate, stock prices will go down. Results showed that the opposite relationship held true for discount rate decreases. In terms of the market reaction after the discount rate change, results showed that the same negative relationship existed. That is, following a discount rate decrease, the market experienced positive excess returns with negative returns being experienced following a discount rate increase. Like previous studies, Jensen and Johnson also considered the nature of the discount rate change. Whilst not explaining their procedure for distinguishing between technical and non-technical changes, Jensen and Johnson found that a negative relationship existed between stock returns and both technical and non-technical discount rate changes. Therefore, like Waud (1970), they concluded that the relationship between discount rate changes and stock returns is independent of the motive behind the discount rate change. Additionally, they asserted that the relationship is also independent of the style of monetary policy implementation with the pre-1979 and post-1979 data giving the same results. Jensen and Johnson also considered the channel through which monetary policy affects stock returns by analysing the impact of discount rate changes on long-term interest rates. Results showed that there was no significant relationship between discount rate changes and long-term interest rates. Jensen and Johnson concluded therefore that "stock performance patterns cannot be explained by interest rate movements" (Jensen & Johnson, 1995, p.93). This result presented a direct

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The expected interest rate hypothesis is where following an increase in money supply, the market may expect the interest rates to fall, thereby increasing stock prices.

conflict to Thorbecke and Alami's (1994) interpretation of the channel through which the negative relationship exists between discount rate changes and stock returns. However, given that Thorbecke and Alami did not conduct a direct test of the interest rate hypothesis, their conclusions were somewhat tentative.

Thorbecke (1997) conducted one of the most recent and comprehensive analyses of the proposed relationship between stock returns and monetary policy over the 1967-1990 period. Unlike previous studies which used the event study methodology, Thorbecke used a variety of approaches to test the monetary policy/stock return relationship. The techniques used to test the monetary policy/stock return relationship are similar to the approach that will be undertaken in this thesis, and therefore his study warrants close attention. Three methodologies were used by Thorbecke. Firstly, Vector Autoregressions (VAR) were used to assess the impact of changes in the Federal Funds rate (FFR) (or nonborrowed reserves (NBR) for the 1979 –1982 period) on stock returns. Using monthly data the vector autoregression equation included the variables: growth rate of industrial production, the inflation rate, the log of total reserves, a stock price index, the federal funds rate, the log of nonborrowed reserves, the log of total reserves, stock returns, a constant and six lags. Changes in monetary policy were measured by orthogonalised innovations in the federal funds rate (or the nonborrowed reserves over 1979-1982). Results from the vector autoregression showed that a tightening of monetary policy, as measured by changes in the federal funds rate and nonborrowed reserves, had a significant negative impact on stock returns. Testing also for the level of forecasting error resulting from using the FFR or NBR to forecast stock returns, results further indicated that NBR and FFR explained substantial and significant portions of stock return data. Changing the lag structure or the ordering of the variables in the VAR did not significantly alter the results. The second approach taken to testing the monetary policy/stock return relationship was a narrative one. Recognising that monetary policy changes can be difficult to quantify and that there can be alternative qualitative measures of monetary conditions, Thorbecke used Federal Reserve statements and other historical documents to determine exogeneous changes in monetary policy. Following the approach taken by Boschen and Mills (1995), he constructed an index which classified monetary policy into five categories. These were strongly anti-inflationary, anti-inflationary, neutral, pro-growth, and strongly pro-growth. In doing this, stock return data in the different periods was analysed. Under this approach stock return data was regressed both on the Boschen and Mills index and on the following variables: T-Bond/T-Bill spread, the corporate bond/T-Bond spread, the monthly growth rate in industrial production, unexpected inflation and the change in expected inflation. Results indicated that as monetary policy moves from a neutral to pro-growth stance, stock returns increase. These results supported Thorbecke's previous findings and therefore he concluded that "expansionary monetary policy, whether measured by innovations in the FFR and NBR or by narrative indicators, exerts a large and statistically significant positive effect on monthly stock returns" (Thorbecke, 1997, p.645). The third method used by Thorbecke is an event study approach. Excluding technical changes in the FFR, changes in the stock market over the 24 hours of the announced change were analysed. Results reconfirm Thorbecke's previous findings that there is a negative relationship between stock returns and monetary policy changes. Thorbecke (1997) therefore provided substantial evidence supporting a negative relationship between monetary policy and stock returns regardless of the methodology employed, and concluded that "monetary policy has real effects, and that these effects are quantitatively important" (Thorbecke, 1997, p.651).

In a related study, Patelis (1997) assessed the impact of monetary policy on the predictability of stock returns. That is, his study was "NOT concerned with the contemporanious relation between monetary policy and stock returns, rather in the relation between monetary shock and future expected stock returns" (Patelis, 1997, p.1953). A number of measures were used to determine the level of desired monetary conditions. They were, the federal funds rate, the spread between the federal funds rate and the yield on the 10 year Treasury note, the spread between the yield on 6 month commercial paper and 6 month T-bills, the quantity of non-borrowed reserves, and the portion of non-borrowed reserve growth orthogonal to total reserve growth. To determine expected stock returns, Patelis used the dividend yield, the spread between the yield on the 10 year Government bond and the yield on the one month T Bill, and the one month real interest rate. To assess the role of monetary policy in predicting stock returns Patelis firstly conducted a number of long-run multivariate regressions. Following this, he used short-run vector autoregressions to verify the long-run regression results by obtaining alternative estimates of the coefficient of the long-horizon regressions. In addition to this, Patelis undertook return variance decompositions to "examine the relative importance of the various forecasting variables in causing unexpected stock returns" (Patelis, 1997, p.1951). Monthly and quarterly data for the period 1962-1994 was used to conduct the analysis. Results from the regressions provided evidence that monetary policy variables are significant predictors of stock returns across different time horizons. Results from the variance decompositions indicated that the greatest impact of monetary policy is felt by the future expected dividend growth factor. In contrast, monetary policy had little effect on future expected interest rates.

The evidence to date has provided overwhelming support for a negative relationship between stock returns and monetary policy changes using either the discount rate or the federal funds rate as a measure of monetary policy. That is, an increase in the discount rate or federal funds rate, leads to a decrease in stock returns. Distinguishing between the motives behind changes in the discount rate, there are some conflicting results. Whilst some studies have shown that only non-technical changes have a significant impact on stock returns, other studies have provided evidence suggesting that both technical and non-technical discount rate changes significantly affect stock returns. Regardless, it is apparent that monetary policy changes, as proxied by discount rate and federal funds rate changes, play a significant role in the determination of stock returns.

1.3.3 The Relative Impact of Monetary Policy on Different Types of Stocks

A number of recent studies have extended the literature by considering the role company specific factors play in determining the relationship between monetary policy and stock returns. Gertler and Gilchrest (1994), Thorbecke and Coppock (1996) and Thorbecke (1997) considered the impact of company size on the relationship between monetary policy and stock returns. Gertler and Gilchrest (1994) tested the impact of changes in the federal funds rate on small and large manufacturing firms over the 1960:1-1991:4 period in an attempt to obtain evidence on the transmission theories of monetary policy. Using vector autoregressions, they found evidence of asymmetries in the reactions of small and large manufacturing firms to changes in the federal funds rate. Specifically, they found that "small firms contract substantially relative to large firms after tight money and that they account for a significantly disproportionate amount of the ensuing decline in manufacturing" (Gertler & Gilchrest, 1994, p.338). Gertler et al. (1994) used this as evidence of the balance sheet channel and credit lending channel of monetary policy transmission which suggests a greater negative effect of tightening monetary policy on small companies. As the name implies, the balance sheet channel suggests that monetary policy transmission is effective through the impact of changes in monetary policy on companies' balance sheets. This is achieved both directly and indirectly. Tightening monetary policy can directly weaken a companies' balance sheet through the effect of interest rate changes on the companies' outstanding debt and interest payments. Increased costs weakens the balance sheet through reductions in net cash flows. The balance sheet is also directly weakened through tightening monetary policy due to the impact of increased interest rates on asset prices. Asset prices typically fall with increasing interest rates and therefore the value of the companies' borrowing collateral falls. The balance sheet is also indirectly affected by monetary policy changes through the impact of these changes on consumer spending behaviour. Tightening monetary policy may result in decreased spending by customers and therefore adversely affect the balance sheet of the company whose revenues decrease while fixed costs cannot alter in the short-run. This explanation supports Gertler and Gilchrest's findings with small companies more likely to have limited access to other sources of credit, and scale down their production in the face of higher interest costs. The credit channel is based on the assumption that bank lending activities are significantly constrained by tightening monetary policy. Tightening monetary policy will increase the cost of funds to banks and therefore will "shift the supply of loans inward, squeezing out bank-dependent borrowers and raising the external finance premium" (Bernanke & Gertler, 1995, p.41). In these circumstances, companies who are largely dependent on banks as a source of funding, are adversely affected by contractions in bank lending.

Thorbecke and Coppock (1996) tested the relationship between stock returns and monetary policy over the 1974-1987 period using a nonlinear seemingly unrelated regression (NLSUR) technique. Taking into account firm size, Thorbecke and Coppock analysed the stock returns on ten value-weighted common stock portfolios. Taking into account the different operating procedures of the Federal Reserve Bank during the time period considered, the data sample was broken into three groups according to the operating procedure that was in place at that time. The resulting sample periods tested were 1974-1979 and 1982-1987, where the Federal Reserve used the federal funds rate to implement monetary policy, and the 1979-1982 period, where the level of nonborrowed reserves were used to implement monetary policy. Distinguishing between expected and unexpected changes, a number of regressions were performed to explain expected monetary policy. Variables included in the regressions were industrial production growth, the inflation rate, an index of commodity prices, the federal funds rate, nonborrowed reserves and total reserves. Initial results supported previous studies which had showed unanticipated changes in monetary policy were negatively related to stock returns. That is, a tightening in monetary policy caused a decrease in stock returns and vice versa. When testing this relationship for large and small firms, Thorbecke and Coppock found results similar to Gertler and Gilchrest (1994). They found that small firms are significantly adversely affected by tightening monetary policy, however, they are not significantly positively affected by loosening monetary policy. "Thus small firms appear to bear a disproportionate burden from changes in monetary policy" (Thorbecke & Coppock, 1996, p.997).

Thorbecke (1997), whilst considering the general relationship between stock returns and monetary policy, also considered company size in their analysis. Their results supported previous findings of asymmetry in the response of small firms to changes in monetary policy. That is, small firms were more affected by changes in monetary policy than large firms.

Jensen, Johnson and Bauman (1997) considered the impact of company related factors that may effect the relationship between stock prices and monetary policy. Specifically, they considered the stock return/monetary policy relationship and how this differs across industries. Using changes in the discount rate as a measure of monetary policy, they analysed the long and short-run impacts of these changes on stock returns. They asserted that short-run changes can be used to measure investors' reactions based on their expectations of how the change will affect future returns, with long-run returns being used to measure the actual effect of the discount rate change on the industry. Jensen, Johnson and Bauman (1997) believed there was significant evidence to expect different industries will react differently to news of monetary policy changes due to a significant amount of evidence showing industry returns differ in terms of their sensitivity to interest rate changes[4]. To test this hypothesis, 16 industry portfolios were constructed with results suggesting there exists a negative relationship between discount rate changes and stock returns for all industries except the oil industry. The industries with the greatest apparent negative relationship were the retail, construction and finance industries. In terms of testing the long-term impacts of monetary policy changes, Jensen, Johnson and Bauman analysed the mean daily annualised returns and the mean market-adjusted daily returns investors would have earned if they had invested in the industry index following the discount rate change. Like the short-term results, the evidence suggested that a negative relationship also exists between stock returns and discount rate changes in the long-term. However, it appears that, unlike the short-term results, the long-term impact of discount rate changes varies more significantly across industries. In particular they found that the largest impact was felt by the apparel, retail, durables, construction and business equipment, and durable industries, with the food, utility, metal and oil industries experiencing the smallest impact of discount rate changes. Non-parametric tests were also undertaken with results confirming the previous findings indicating that "the persistence of the relationship confirms that the identified patterns relate to a systematic cause and not simply a chance observation" (Jensen, Johnson, & Bauman, 1997, p.640). Explaining the greater sensitivity of the finance, retail and construction industries to discount rate changes, they suggested that this results from the greater sensitivity of these

[4] See for example, Christie (1981), Flannery and James (1984), Saunders and Yourougou (1990), Ma and Ellis (1989), Bernard and Frecka (1983).

industries to interest rate changes. That is, the finance industry is highly sensitive as its cost of funds tend to adjust more rapidly than its return from its assets to interest rate changes, therefore significantly affecting its profit margins. The construction industry was thought to be more sensitive as many of its projects are financed by debt, and changes in the interest rate will significantly affect the individuals' desire to borrow. Finally, the retail industry will be highly sensitive to interest rate changes due to the impact interest rates have on their cost of credit and cost of holding inventory. The results from the long-term analysis suggested that industries reliant on export or imports are more likely to be affected by monetary policy changes in terms of the impact of these changes on the exchange rate. They noted that the apparel, retail, durables and business equipment industries all showed a significant relationship with discount rate changes, and "each of these industries is heavily influenced by export/import conditions" (Jensen, Johnson & Bauman, 1997, p.638). Overall, Jensen, Johnson and Bauman (1997) presented significant evidence supporting previous studies that have shown a significant relationship between monetary policy and stock returns with the level of impact being different dependent on the stocks' industry classification.

While these studies hold implications for the effect of monetary policy changes on value and growth stock returns, to date, there is only one study that has explicitly analysed the impact of monetary policy on value and growth stock returns. As shown in section 1.2, Jensen, Johnson and Mercer (1997), whilst providing support for the negative relationship between monetary policy and stock returns, also distinguished between value and growth stocks and considered the relative impacts of monetary policy changes on these two types of stocks. Results from their analysis indicates that size and price-to-book effects only occur during expansive monetary policy conditions. That is, only during expansive monetary conditions do small stocks with low price-to-book ratios, irrespective of their level of systematic risk, provide significantly higher returns than large stocks with high price-to-book ratios. These results therefore suggest that "the substantially greater returns from value investing occur primarily during periods of expansive monetary policy" (Jensen, Johnson & Mercer, 1997, p.40).

1.4 Economic Series and Stock Returns

Because this study considers the relationship between a number of economic variables, and value and growth stock returns, literature concerning these relationships is of interest to this research. There have, in fact, been numerous studies concerned with the relationship between economic activity, interest rates, inflation, liquidity, and exchange rates. However, this research is primarily interested in the relationship these variables hold to stock returns and monetary policy. This section therefore reviews the main contributions made to the literature.

There has been a substantial amount of literature concerned with determining the relationship between economic activity and stock returns. In attempts to determine the interrelationships between stock returns, inflation and economic activity, Fama (1981), Geske and Roll (1983) and Kaul (1987) have provided significant evidence of a strong relationship between real activity and stock returns. Fama (1981) and Kaul (1987) used GNP and industrial production as measures of economic activity, while Geske and Roll (1983) also used company earnings and unemployment. Based on multivariate regression analysis, these studies found a positive relationship exists between stock returns and future real activity. James, Koreisha and Partch (1985) also provided evidence of a significant relationship between economic activity and stock returns. Using a Vector Autoregressive Moving Average (VARMA) model, they tested for causality between stock returns and the growth rate in industrial production. Their results supported previous findings of a strong relationship between stock returns and real activity.

More recent evidence of a positive relationship between economic activity and stock returns has been provided by Fama (1990) and Schwert (1990). Fama (1990) attempted to judge the efficiency of stock prices by determining the total return variation of stocks explained by expected cashflows, time-varying expected returns and shocks to expected returns. In doing so, he provided further evidence of a positive relationship between stock returns and economic activity. Using multiple regression analysis, he found stock returns were highly correlated with future growth rates of industrial production for the 1953-1987 period. Testing the robustness of Fama's result, Schwert (1990) tested the relationship between stock returns and future rates of industrial production over the longer 1889-1988 period. Results supported Fama's findings of a strong positive relationship between stock returns and future production growth rates.

More recently, Lee (1992) has used VARs to examine the relationship between stock returns, interest rates, real activity and inflation. Unlike James et al. (1985) who focused only on multivariate causality tests, Lee used Forecast Error Variance (FEV) decompositions and Impulse Response Functions (IRF) to determine the relationship between the variables. Results from the FEVs indicate that stock returns lead changes in real activity, with the IRFs showing that the relationship between these two variables is positive.

In addition to the aforementioned literature, there has also been a substantial amount of research providing indirect evidence of a relationship between economic activity and stock returns. Rozeff (1984), Campbell and Shiller (1988), Fama and French (1989), Fama (1990) and Schwert (1990) have all used the dividend yield as a proxy for business conditions and provided evidence of a positive relationship between dividend yields and stock returns. If stock prices increase with improving economic conditions, dividend yields should be expected to decrease. Therefore, a positive relationship between dividend yields and stock returns is evidence of a positive relationship between economic activity and stock returns. The default spread (spread between lower and higher grade bond yields) has also been used as a measure of business conditions, as it tends to be high when conditions are weak and low when conditions are strong (Chen, 1991). Evidence of a strong relationship between the default spread and stock returns has been provided by Keim and Stambaugh (1986), Fama and French (1989), Fama (1990) and Schwert (1990). The term spread (measure of forward interest rates) has also been used to proxy economic activity, as it tends to fall during strong economic activity and increases during weak economic activity. This is because of a greater increase in short-term interest rates (in relation to long-term interest rates) during strong economic growth, and a greater decrease in short-term interest rates during a weak economy. Evidence of a negative relationship between the term spread and stock returns has been provided by Campbell (1987), Fama and French (1989), Fama (1990), Schwert (1990) and Chen (1991).

The literature has also considered the relationship between economic activity and monetary policy. Friedman and Schwartz (1963) provided the earliest evidence of a relationship between monetary policy, as measured by the money supply, and economic activity. Specifically, they found that monetary policy actions are followed by movements in real output that may last for two or more years. This was later confirmed by Sims (1972) who tested for Granger causality between money supply and economic activity, and found that the money supply Granger-causes nominal GNP. This has been confirmed by Christiano and Ljungqvist (1988) who also undertook bivariate tests for Granger causality between money supply and economic activity. They found significant causality between the variables and therefore provided evidence in support of the results of previous research.

More recent studies by Bernanke and Blinder (1992), Romer and Romer (1989) and Gali (1992) have reinforced the earlier findings of a relationship between monetary policy and economic activity. Bernanke and Blinder (1992) used the VAR methodology to determine the relationship between monetary policy, as measured by the federal funds rate, and a number of economic variables. Results from the Granger causality tests and variance decompositions showed that the federal funds rate has forecasted industrial production over the 1959:7-1989:12 period. Romer and Romer (1989) undertook a narrative approach to measuring monetary policy and found that over the post-war period there were six periods where anti-inflationary monetary policy was followed by decreases in industrial production. Gali (1992) further reinforced these findings by using the VAR methodology to show that money supply shocks over the 1955:Q1-1987:Q3 period explained 13 percent of the forecast error variance of economic activity over a 5 to 10 quarter horizon.

Given the overwhelming evidence of a relationship between both business conditions and stock returns, and monetary policy and stock returns, Jensen, Mercer and Johnson (1996) investigated "the joint role of the monetary sector and business conditions in tracking expected security returns" (Jensen, Mercer & Johnson, 1996, p.214). Using regression analysis, Jensen et al. (1996) tested the relationship between business cycle proxies and stock returns and how this changes across different monetary environments. Using the discount rate as a measure of monetary conditions, and the dividend yield, term spread, and default premium as business conditions proxies, they found that "the behaviour of the business-conditions proxies and their influence on expected security returns is significantly affected by the monetary sector" (Jensen et al., 1996, p.213). Specifically, they found that business conditions only explain future stock returns during periods of loosening monetary policy.

To summarise, there is overwhelming evidence suggesting a positive relationship between economic activity and stock returns. That is, stock returns are higher during periods of higher economic growth, with this finding being robust to different measures of business conditions. In terms of monetary policy, evidence suggests a strong relationship also exists between monetary policy and economic activity. Specifically, monetary policy leads changes in economic activity, with tightening monetary policy causing falls in future economic activity and vice versa. Recent evidence has also highlighted the inter-related role monetary policy and economic activity can play in explaining future stock returns.

As with the business cycle literature, there have been substantial efforts made to establish a relationship between interest rates, inflation and stock returns. Kessel (1956), Bach and Ando (1957), Alchian and Kessel (1959), Kessel and Alchian (1960), Bach and Stephsen (1974) and Hong (1977) provided some of the earliest evidence of a negative relationship between inflation and stock returns. These studies, whilst somewhat lacking in statistical power, laid the foundations for the perceived negative inflation/stock return relationship. Further evidence of a negative relationship between expected and unexpected inflation, and stock returns has been provided by Bodie (1976), Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1977) and Schwert (1981). These studies used more powerful tests to conduct their analysis, and have therefore firmly established the notion of a negative stock return/ inflation relationship in the finance literature.

French, Ruback and Schwert (1983) tested the relationship between inflation and stock returns in the context of the nominal contracting hypothesis. This concerns the impact of inflation on the stock returns of companies with different nominal contracting positions. With nominal assets and nominal liabilities defined as assets or liabilities with cash flows that are fixed in nominal terms, these studies hypothesised that inflation should have a greater negative impact on firms with higher nominal assets than nominal liabilities (net creditor companies). Earlier studies (Kessel 1956, Bach & Ando 1957, Alchian & Kessel 1959 and Hong 1977) had considered the effect of companies' nominal contracting positions on their relationship with inflation, however, they had not distinguished between expected and unexpected inflation. French et al. (1983) provided further evidence of a negative relationship between inflation and stock returns, and in terms of the nominal contracting hypothesis, found no evidence supporting this hypothesis. That is, net debtor companies do not benefit by unexpected inflation relative to net creditor companies.

The negative relationship between stock returns and inflation has continued to be supported in the literature with studies by Fama (1981), Geske and Roll (1983), James, Koreisha and Partch (1985), Kaul (1987) and Campbell and Ammer (1993). These studies attempted to determine the reason underlying the inflation/stock return relationship and in doing so provided even further evidence of its significance. Fama (1981) suggested that the relationship is due to a negative relationship between real activity and inflation, and therefore the inflation/stock return relationship is in fact spurious. In a similar study, Geske and Roll (1983) suggested that the inflation/stock return relationship is due more to the relationship between real activity, money supply and inflation, than it is to do with a direct relationship between stock returns and inflation. James et al. (1985) provided evidence supporting

Geske's theory by showing the negative inflation/stock return relationship is due to a negative relationship between money supply and real activity. Kaul (1987) supported these results and further strengthened the empirical evidence of a negative relationship between inflation and stock returns. Campbell and Ammer (1993) tested the relationship between stock returns and inflation using the Vector Autoregressive (VAR) methodology. Results suggested that inflation plays an important role in determining future stock returns.

In a more recent analysis of the stock return/inflation relationship, Boudoukh and Richardson (1993) examined the longer term relationship between these two variables. Studies up until this point had focused only on the short-term relationship between stock returns and inflation. Using a 5 year horizon, evidence suggested that over the long-term, there is a positive relationship between inflation and stock returns.

The literature has also considered the influence of monetary policy on the relationship between inflation and stock returns. Geske and Roll's (1983) study provided the initial evidence of a significant role played by monetary policy in determining the inflation/stock return relationship. As already mentioned, his study suggested that stock returns are related to inflation only through the relationship between money supply and real activity. Hence the significant influence of monetary policy in the inflation/stock return relationship. The role of monetary policy was more formally tested by Kaul (1987) who provided evidence suggesting the inflation rate/stock return relationship is heavily dependent on monetary policy. Specifically, he found that during a counter-cyclical monetary policy stance there is a strong negative relationship between stock returns and inflation. During pro-cyclical monetary policy the relationship was insignificant. In a recent study by Graham (1996), evidence suggested that monetary policy exerted a significant influence over the inflation rate/stock return relationship. Specifically, only during counter-cyclical monetary policy was the relationship between inflation and stock returns strongly negative. During pro-cyclical monetary policy, the relationship was in fact positive.

There is substantial evidence indicating a significant negative relationship exists between stock returns and inflation. There is, however, some debate surrounding the channels through which this relationship is transmitted. Whilst, the evidence is not yet clear, the numerous attempts to more fully understand the relationship between inflation and stock returns has lead to a well-established empirically tested fact. That is, stock returns are negatively related to inflation.

It appears to be widely accepted that interest rates hold a negative relationship to stock returns, with changes in interest rates often quoted as the underlying reason for movements in the stock market. This belief is backed up substantial academic research which has provided significant evidence of a negative relationship between interest rates and stock returns. Fama and Schwert (1977) provided the basis for future study in this area. Using regression analysis, they showed a negative relationship exists between stock returns and short-term interest rates. Keim and Stambaugh (1986), Campbell (1987) and Ferson (1989) followed on from Fama and Schwert (1977) and also showed that interest rates provide a degree of forecasting power for excess stock returns. These studies covered data for the majority of the 20^{th} century and, primarily using regression analysis, showed a negative relationship exists between interest rates and stock returns. As with the inflation literature, studies have also considered this relationship in the context of the nominal contracting hypothesis. Flannery and James (1984) and Tarhan (1987) tested the relationship between interest rates and the stock returns on financial institutions, as a test of the nominal contracting hypothesis. These studies reaffirmed the negative interest rate/stock return relationship, however, they presented conflicting evidence concerning the nominal contracting hypothesis. Flannery and James (1984) found evidence suggesting the negative relationship between interest rates and stock returns was significantly affected by the nominal contracting positions of the companies. Tarhan (1987), however, did not find evidence to support the nominal contracting hypothesis. More recent evidence of the role of interest rates in predicting stock returns has been provided by Lee (1997) who also found a negative relationship between interest rates and stock returns, however, this was not stable over the entire period being tested.

The relationship between interest rates and monetary policy has also been the subject of much empirical research. This has traditionally focused on the effect of money supply growth and interest rate movements. There are two schools of thought on this issue. Originally, the impact of an increase in money supply, due to supply/demand factors, was believed to lead to falling interest rates. However, there has been a number of studies which dispute this. One of the first to question this was Friedman (1968) who suggested that a positive relationship exists between money supply and interest rates. That is, an increase in money supply leads to expectations of higher inflation and therefore interest rates increase. Subsequent studies have shown this to be true with much empirical research casting doubt on the suggested negative relationship between money supply and interest rates. Studies by Mishkin (1981), Melvin (1983), Reichenstein (1987), Sims (1992) and Hardouvelis (1987), to name a few, have all provided substantial evidence that there is no significant negative relationship between money supply and interest rates. A recent study, however, by Grier and Perry (1993) suggested that these results are due to these studies not taking into account heteroscedasiticity in interest rates. Grier and Perry (1993) found that when taking in account heteroscedasticity there was a significant negative relationship between money supply and interest rates.

When measuring monetary policy using variables other than money supply, it is apparent that there is a significant relationship between interest rates and monetary policy. The central banks of New Zealand, Australia and the US maintain a monetary policy system that allows significant influence to be exercised over short-term interest rates. In this way a tightening monetary policy stance is associated with increasing short-term interest rates, and a loosening monetary policy stance is associated with falling short-term interest rates.

The literature has also provided evidence concerning the relationship between liquidity and stock returns. With liquidity most often measured by money supply variables, much of the evidence of the relationship between stock returns and liquidity is the result of studies concerned with the relationship between stock returns and monetary policy. As already indicated in section 1.3, research has provided mixed results regarding the relationship between money supply and stock returns. Studies by Homa and Jaffee (1971), Hamburger and Kochin (1971) and Keran (1971) indicated a positive relationship existed, however, subsequent studies by Berkman (1978), Pearce and Roley (1983) and Cornell (1983) showed a negative relationship existed. The literature is therefore inconclusive regarding the nature of the relationship between liquidity and stock returns.

The final macroeconomic variable of interest is the exchange rate. Evidence of a relationship between exchange rates and stock returns is mixed, with literature providing evidence of both a positive and negative relationship between these two variables. For example, Fang and Loo (1996) and Soenen and Hennigar (1988) provided evidence of a significant negative relationship between exchange rates and stock returns. On the other hand, studies by Aggarwal (1981) and Ajayi and Mougoue (1996) have suggested a positive relationship exists between exchange rates and stock returns.

The literature has also considered the relationship between exchange rates and the stock returns of different industries. Jorion (1991) found that, overall, stock prices were not sensitive to changes in exchange rate, however, significant results were found when categorising stocks according to their industry. Jorion found that the stock returns of industries which are largely export-based or have significant foreign operations, were negatively related to the exchange rate. The stock returns of import-based industries were positively related to the exchange rate. Bodnar and Gentry (1993) found that the stock returns of 20 – 30 percent of industries were significantly related to movements in the exchange rate. Some studies, however, have questioned the existence of any relationship between stock returns and the exchange rate. Aldaib, Zoubi and Thornton (1994) suggested that stock prices of multinational companies are not significantly affected by movements in the exchange rate. They found the relationship was only significant where there were large fluctuations in the exchange rate.

In terms of monetary policy, recent literature has attempted to provide evidence linking exchange rates to monetary policy. Using a number of alternative measures of monetary policy, Evans (1994) and Eichenbaum and Evans (1995) used the VAR methodology and suggested a positive relationship exists between exchange rates and monetary policy. They note, however, that this relationship was insignificant in the short-term with monetary policy only having a significant impact on exchange rates over the longer term. This finding was also supported by Lewis (1995) who concluded that, in the short-term, there was an insignificant relationship between monetary policy and the exchange rate. Roley and Sellon (1998) undertook a study of the relationship between these two variables using an event study methodology and found that there was a significant immediate response of the exchange rate to monetary policy. Whether the relationship between the two variables exists more in the short-term or long-term, the literature has been consistent in showing a positive relationship exists between monetary policy and the exchange rate.

The recent resurgence of interest in the role of monetary policy in the economy has been largely driven by the introduction of Sim's (1980) VAR methodology. This has provided an alternative approach to testing the relationship between a number of economic variables and has provided the methodological basis for much of the recent empirical research. Therefore, these studies not only provide information regarding the nature of the relationship between common stock returns and a number of economic variables, they are also of interest due to their application of the VAR methodology.

Chapter Two

Monetary Policy in New Zealand, Australia and the United States of America

2.1 Monetary Policy in New Zealand

Monetary policy in New Zealand is currently operated under the Reserve Bank Act 1989. The sole objective of monetary policy in New Zealand, as stated in the Act, is to maintain price stability. An inflation target is set in a Policy Target Agreement (PTA) which is agreed on and signed between the Minister of Finance and the Governor of the Reserve Bank. The current inflation target for the Reserve Bank of New Zealand (RBNZ) is between 0-3 per cent.

With the single objective of price stability, the Reserve Bank Act allows the RBNZ freedom in their method of implementing monetary policy. The Reserve Bank has a number of tools to implement monetary policy. In order to achieve price stability their use of tools is directed towards affecting short-term interest rates in order to indirectly influence inflation rates. Monetary policy changes can be implemented by affecting the level of primary liquidity in the banking sector. Primary liquidity is defined as being all settlement cash balances held at the Reserve Bank plus Reserve Bank Bills with 28 days or less to maturity. Altering the level of primary liquidity enables the RBNZ to implement monetary policy.

Primary liquidity can be altered through changes in the supply or cost of holding settlement cash balances. Settlement cash is held by banks in order to cover banknote and coin transactions, Government revenue, and inter-bank settlements. These settlement accounts must always be kept in credit and therefore banks must ensure they keep appropriate cash balances to meet their settlement requirements. These requirements on the settlement account balances give the Reserve Bank the ability to alter banks' cost of funds and consequently influence the level of short-term interest rates. The supply of, or cost of holding settlement cash is influenced through the cash target, discount margin, supply of Reserve Bank Bills and the interest paid on the settlement account balances. Increases in the target level of settlement cash balances leads to easier monetary conditions as "banks tend not to compete as aggressively for the expected supply of settlement cash or Reserve Bank bills" (Huxford & Reddell, 1996, p.313). The discount margin refers to the cost of selling Reserve Bank Bills back to RBNZ prior to their maturity. Changes in the discount margin therefore, alters banks' willingness to run the risk of not having sufficient settlement account funds. An increase in the cost of discounting discourages banks from running the risk of not having sufficient settlement funds and therefore encourages banks to compete more aggressively for funds and therefore pushes up interest rates. Changing the supply of Reserve Bank bills directly impacts on the amount of settlement funds available. An increase in the supply of Reserve Bank bills results in easier money conditions as Reserve Bank bills act as a potential substitute for settlement cash. The interest rate paid on settlement account balances provides an alternative tool for influencing settlement account balances. Decreasing the interest rate paid on settlement account balances discourages banks from holding surplus settlement funds and therefore leads to easier monetary conditions as banks have less incentive to compete for funds.

Whilst history has shown changes in the cash target to be a major tool in implementing monetary policy, there has been a recent move away from the use of settlement accounts to implement monetary policy changes. Two alternative, and more frequently used, informal tools of monetary policy are open market and 'open mouth' operations. Open market operations involves the buying and selling of Government securities which affects the amount of money in the economy and therefore the level of interest rates. These Government securities are typically in the form of repurchase agreements which means the securities are sold or bought with the view to reversing the sale or purchase at an agreed upon later date and price. An open market purchase of Government securities increases the money supply and leads to lower interest rates, and vice versa. Open market operations are conducted on a daily basis and serve mainly to control the level of money supply in the economy in order to maintain the desired settlement cash target. 'Open mouth' operations also play a significant role in influencing monetary conditions in New Zealand. This involves the interpretation of statements made by the Governor of the Reserve Bank in terms of the desired level of monetary conditions. That is, a statement made by the Governor indicating a desire to tighten monetary conditions, leads to banks increasing their interest rates given the power the RBNZ has shown to have over enforcing their desired monetary policy changes.

The Reserve Bank maintains relative independence from the New Zealand Government. Whilst the objective of monetary policy is decided by the Government, the Reserve bank has relative freedom in its method of achieving its price stability goal. The implementation of monetary policy in New Zealand is transparent in that any monetary policy changes or significant events are "widely and transparently available to all in the markets and in the media" (Huxford & Reddell, 1996, p.317). In some respects, however, the transparency of New Zealand's monetary policy implementation is somewhat limited given the Reserve Bank does not use explicit targets (eg. Interest rates) to direct monetary policy changes.

In an attempt to help quantify New Zealand's monetary policy stance, a recent innovation in the New Zealand market has been the monetary conditions index (MCI)[5]. This is a ratio of interest rates to exchange rates in a 2:1 framework. Now, statements made by the Reserve Bank Governor can be made more transparent in terms of stating his desired monetary conditions in terms of the monetary conditions index.

2.2 Monetary Policy in Australia

Monetary policy in Australia is currently regulated by the Reserve Bank Act 1959. The Reserve Bank Act spells out the objectives of monetary policy as being:

1. "The stability of the currency of Australia;
2. The maintenance of full employment in Australia; and
3. The economic prosperity and welfare of the people of Australia" (Reserve Bank of Act of Australia, 1959, section 10(2)).

Given these objectives, the Reserve Bank of Australia (RBA) has relative freedom in the operational approach they take to achieving these objectives. Recognising the conflicting nature of objectives one and two, the RBA currently accords higher priority to their first objective of achieving price stability. Whilst the Act sets down the broad objectives of monetary policy, the 'Statement of the conduct of monetary policy, 1996' provides an agreement between the RBA and the Government as to the target inflation rate to be maintained by the RBA. It is currently a medium average of between 2-3 per cent.

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[5] Refer to section 5.2 of chapter 5 for details of the MCI.

The operational approach taken by the RBA to achieve their inflation objective is the use of the overnight cash rate. The overnight cash rate is the interest rate on overnight loans made between institutions (primarily banks) in the money market and is determined by the supply and demand of overnight funds. The RBA is able to exercise control over the overnight cash rate through their control over the supply of funds banks have to settle transactions amongst themselves (exchange settlement funds). The RBA can alter the supply of exchange settlement funds (ESF) and consequently influence the demand/supply of funds in the money market. For example, if the RBA wanted to increase the cash rate, they would decrease the amount of ESF's available and therefore put pressure on banks to borrow money from the money market in order to meet their settlement obligations. The increased demand for funds in the money market puts upward pressure on the cash rate. Conversely, if the RBA wished to decrease the cash rate, they could increase the supply of ESF's therefore encouraging banks to lend surplus funds in the money market, thus putting downward pressure on the cash rate. The process of changing the supply of ESF's is referred to as the RBA's domestic market operations. Similar to New Zealand, these domestic market operations involve the buying and selling of Government securities usually in the form of repurchase agreements.

The RBA's rationale for the use of the cash rate lies in the direct link between changes in the cash rate and other short-term money market rates, especially the 90 day bank bill rate. The cash rate is therefore able to affect banks' cost of funds and lead to changes in banks' commercial interest rates. Therefore, if the RBA wanted to tighten monetary conditions they would act to increase the overnight cash rate, thereby pushing up the cost of funds and forcing banks to increase their commercial interest rates. Conversely, looser monetary conditions would be achieved through a lowering of the overnight cash rate.

Although the Reserve Bank of Australia operates directly under the Reserve Bank Act 1959, the Bank enjoys relative freedom in choosing the approach it takes to implement monetary policy and achieve the stated objectives. However, whilst providing a certain degree of central bank independence, the legislation permits consultation between the Government and the Reserve Bank, with the Act recognising the importance of macroeconomic policy co-ordination. The Reserve Bank therefore implements monetary policy with a certain degree of consultation with the Australian Government.

The current system of monetary policy operation in Australia has provided a greater level of transparency and accountability in their actions. That is, the actions and intentions of the Reserve Bank are less open to ambiguous interpretation with regards to the Reserve Bank's current monetary policy stance. This is assisted not only by the use of an explicit cash rate target, but also by clear and public statements made by the Reserve Bank at the time when changes are made to the targeted cash rate.

2.3 Monetary Policy in the United States of America

The Federal Reserve is the Central Bank of the US and is charged with implementing monetary policy. It was established by the Congress Act 1913 and is made up of 12 Federal Reserve District Banks throughout the US. The objective of US monetary policy is to achieve maximum employment, stable prices, and moderate long-term interest rates.

In order to achieve these goals, the Federal Reserve implements monetary policy by targeting short-term interest rates via open market operations and changes in the discount rate. The effect of open market operations and changes in the discount rate are felt through their impact on a banks' reserves. Banks in the US have a legal requirement to hold 3-10% of their funds in interest-bearing and noninterest-bearing chequing accounts as reserves. Given this requirement, banks lend or borrow funds amongst themselves to ensure they meet the 3-10% reserve requirement. The rate of interest charged on the funds being borrowed/lent between banks is called the federal funds rate. This rate has a direct influence on short-term interest rates and therefore provides the means through which the Federal Reserve is able to implement monetary policy. The federal funds rate, like any interest rate, is affected by the supply and demand for funds. Therefore the Federal Reserve is able to use open market operations to alter the supply of federal funds and therefore influence the federal funds rate. For example, if the Federal Reserve wanted to tighten monetary policy, they could increase the federal funds rate by buying Government securities thereby decreasing the amount of funds available to banks to meet their reserve requirements. This would force banks to borrow money in the federal funds market thereby pushing up the demand for federal funds and consequently the federal funds rate.

An alternative tool of monetary policy implementation is the discount rate. This works through the Federal Reserve's ability to lend money to banks through what is referred to as the 'discount window'. The interest rate charged on these funds is the discount rate. For example, if the Federal Reserve wanted to loosen monetary policy, they would decrease the discount rate thereby making it cheaper for banks to borrow money through this facility. This, in turn, would encourage banks to compete less aggressively for funds and put downward pressure on commercial interest rates. In practice, however, the amount of funds which can be lent through the 'discount window' is relatively small, with the Federal Reserve discouraging use of this facility altogether. Despite this, the discount rate plays a significant role in signaling the monetary policy stance of the Federal Reserve Bank. That is, although changes in the discount rate in practice are not hugely significant due to the infrequent use of the discount window facility, the role of the discount rate is largely seen through the informational content of any rate changes. Increases in the discount rate are seen as a signal of tightening monetary policy, with discount rate decreases being a signal of loosening monetary policy.

Whether using open market operations to influence the federal funds rate or making changes in the discount rate, an increase in the cost of borrowing funds puts upward pressure on short-term interest rates. This discourages banks from borrowing in the federal funds market or from the discount window, and they are therefore forced to compete more aggressively for funds.

The Federal Reserve Bank enjoys relative freedom from the US Government. The Congress Act 1911 designed the Federal Reserve system in order to achieve this independence and is based on the rationale that the people who control the country's money supply should be independent of the people in charge of making the government's spending decisions. Despite this level of independence, the bank is required to report regularly to the Government on monetary policy and other such economic issues.

2.4 Comparison of Monetary Policy in New Zealand, Australia and the United States of America

Despite there being a number of similar characteristics between the monetary policy environments in New Zealand, Australia and the US, there are still a number of key differences that distinguish their respective monetary policy systems.

In terms of monetary policy implementation, the Reserve Bank of New Zealand, unlike the Federal Reserve and the Reserve Bank of Australia, uses no stated or explicit target for the interest rate on overnight funds used in bank settlements. This fundamental difference in the implementation of monetary policy leads to more subtle differences in terms of the level of transparency and measurement of monetary policy conditions in Australia and the US, compared to New Zealand. Due to the use of an explicit target, the monetary conditions of Australia and the US are substantially easier to measure and more transparent in nature. That is, any actions taken by the Reserve Bank of Australia or the Federal Reserve provide less ambiguous signals of the current monetary policy stance. This does not mean that monetary policy implementation in New Zealand is entirely unclear. The use of monetary policy statements by the Governor of the Reserve Bank of New Zealand are designed to increase the level of transparency in the New Zealand monetary policy environment by clearly indicating the desired levels of monetary conditions. Efforts to increase the transparency of monetary policy has also led to the use of a monetary conditions index which has attempted to achieve a monetary environment more transparent and in line with the monetary policy environments of Australia and the US.

Despite New Zealand, Australia and the US being similar in their objective of achieving stable prices, the New Zealand market is once again different in that stable prices is the sole objective of monetary policy in New Zealand. Both Australia and the US take a multiple objectives approach with full employment and economic growth also being objectives of Australian and US monetary policy.

Differences also relate to the legislative environment in which the Central Bank operates. New Zealand once again differs from the US in that no there is no explicit reserve requirement placed on banks. That is, it is up to individual banks to decide on the appropriate levels of reserves to be held.

In terms of the level of central bank independence, the central banks in all three countries operate relatively independent of the Government. All central banks operate under an Act of Parliament, however, are relatively free to implement monetary policy as they see fit, in order to achieve their stated objectives. However, in relative terms, the Australian Reserve Bank appears to have a lower degree of independence than the Reserve Bank of New Zealand and the US Federal Reserve. Australian legislation requires the Australian Reserve Bank to implement its monetary policy "in close consultation with the government" (Holmes, 1994, p.33). This legislative inclusion of the Government in monetary policy implementation arguably decreases the relative independence of the Reserve Bank of Australia.

The literature review has examined a number of studies of relevance to this research. Chapter one began with a review of the literature concerned with explaining the relative performances of stock returns. Testing the ability of a number of factors to explain relative stock performances, size and book-to-market factors have emerged as the primary drivers of relative stock returns. That is, smaller stocks with high book-to-market ratios tend to provide higher returns than larger stocks with lower book-to-market ratios. This finding is consistent with the more recent literature on the relative performances of value and growth stocks which has consistently shown value stocks outperform growth stocks in the long-term. Chapter one examines the theories which attempt to explain the long-term superior performance of value stocks and also reviews the more recently developed theories to explain why growth stocks may provide superior returns in the shorter term. Given this thesis is concerned with the relationship between value and growth stock returns, and monetary policy, chapter one examined literature concerned with explaining the relationship between monetary policy and stock returns. This included the early literature which used money supply as a proxy for monetary policy, and the more recent literature which used the discount rate or federal funds rate as a measure of monetary policy. The impact of monetary policy on different types of stocks was also considered. From the evidence presented, it is concluded that tightening monetary policy has a negative impact on stock returns, while loosening monetary policy has a positive impact on stock returns. Because this research considers the relationship between value and stock returns and a number of economic variables in addition to monetary policy, chapter one also considered the relationship between these economic variables and stock returns. Chapter two explained the nature of monetary policy implementation in New Zealand, Australia and the US. This chapter covered the respective goals of monetary policy in the three countries, their methods of achieving these goals, and presented a number of comparisons between the monetary policy environments of New Zealand, Australia and the US.

Part Two

Methodology

This research utilises a number of methodologies. Before taking a multivariate approach to analysing the relationship between value and growth stock returns, monetary policy and economic activity, an initial bivariate analysis will be undertaken. This will include regression analysis, cointegration and Granger causality tests. Chapter three therefore explains these methodologies. These form the basis for much of the early data analysis and serve to provide an indication of any simple bivariate relationships that may exist between the variables. Following this, the Vector Autoregression (VAR) methodology will be used to provide a multivariate framework for analysing the relationship between value and growth stock returns, monetary policy and economic activity. The major byproducts of the VAR are Impulse Response (IR) functions and Forecast Error Variance (FEV) decompositions. These provide information regarding the nature of the relationship between the variables, and the relative importance of the variables in explaining future values of each other. VARs also provide the framework for multivariate cointegration and block Granger causality tests. Chapter Four provides an explanation of the VAR methodology.

Chapter Three

Regression Analysis, Bivariate Cointegration and Granger Causality

3.1 Regression Analysis

Regression analysis provides a means of testing the relationship between a number of economic variables and is well established in the finance literature. In terms of this research, regression analysis provides a method of testing the relationship between value and growth stock returns and monetary policy. In this way the strength and nature of the relationship between these variables can be tested. There are, however, a number of limitations with the use of regression analysis. Ordinary Least Squares (OLS) regression is only an appropriate methodology if the following four assumptions are satisfied.

1. The relationship between the variables is based on a linear regression model.
2. The error term, e, is normally distributed with a mean of zero, and a constant variance, σ^2. That is, the error terms are homoscedastic, not heteroscedastic. In notation, $e_i \sim N(0, \sigma^2)$.
3. Zero covariance between the pairs of error terms. That is, the successive error terms are independent of each other, cov $e_i ej = 0$. When the error terms are independent of each other, they are said to be non-autocorrelated.
4. The independent variable is non-stochastic.

(Watsham & Parramore, 1997)

Only when these assumptions are satisfied is OLS regression an appropriate methodology for testing the relationship between variables. In reality, however, it is unlikely that all of these assumptions will be satisfied. Lagrange Multiplier (LM) tests for serial correlation in the residuals are often undertaken as a check on the accuracy of the regression analysis. This test follows the form of equation (3.1).

$$u_t = \sum_{i=s}^{r} a_i u_{t-i} + e_t \quad \text{for } 0 \leq s \leq r \leq 12, \text{ with } e \sim \text{IID}(0, \sigma^2) \qquad (3.1)$$

where u_t represents the error terms from the OLS regression. Chi^2 and F-statistics are provided by the LM test and serve to reinforce any significant results found using regression analysis. In terms of this research, LM tests for serial correlation in the residuals will be undertaken to reinforce the validity of any significant findings.

When undertaking regression analysis it is important to be aware of spurious regression. This most often occurs when analysing data which tends to increase or decrease over time. This creates "a degree of correlation that overstates any underlying causal relationship" (Watsham & Parramore, 1997, p.201). This is most likely to arise when the variables in the regression are non-stationary[6]. Granger and Newbold (1974) highlighted the potential for spurious regression, and therefore suggested that only stationary variables should be used in regression analysis. In financial time series analysis this most often means that differencing of the data is required.

Whilst regression analysis provides an indication of the nature and strength of the relationship between a number of variables, it has been somewhat superceded in the literature by a number of more complex statistical methodologies. In the context of this research, it forms the basis of the initial, yet somewhat unsophisticated, analysis of the data.

Early analysis of the data also involves what is referred to in this thesis as 'return difference' analysis. This involves comparing the returns of value and growth stocks during different monetary policy or economic environments. As with regression analysis, this is a fairly simple approach to gaining an understanding of the nature of the relationship between the variables.

3.2 The Unit Root Test

Tests for cointegration and Granger causality in a bivariate context will be undertaken. This will serve to provide further evidence of any significant relationships between the variables that may have been indicated by return difference and regression analysis. The unit root test is a test for stationarity in a data series and forms the basis of cointegration and Granger causality tests, and in fact many time series methodologies.

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[6] Refer to section 3.2 for information on stationary time series

A series is considered stationary if it has a "constant mean, a constant variance and a covariance which depends only on the time between lagged observations" (Watsham & Parramore, 1997, p.230). If a series is non-stationary it is said to contain a unit root. Because the majority of time series methodologies are based on the assumption of a stationary series, it is of considerable importance to establish the degree of stationarity in any time series being analysed. From much empirical testing, it has become generally accepted that the majority of financial time series are in fact non-stationary. (Watsham & Parramore, 1997). Therefore, to ensure the accurate use of time series models it is necessary to identify a non-stationary series and transform it into a stationary one.

Creating a stationary series involves 'differencing'. Differencing is a process whereby one measures the change in value of successive observations. A series that is differenced once is illustrated by the equation, $\Delta Y_t = Y_t - Y_{t-1}$. Integration is a term used to describe the level of differencing necessary for a series to become stationary. If a series is differenced once in order to become stationary, the series is said to be integrated of order one, I(1). A series which is differenced twice in order to become stationary, is said to be integrated of order two, I(2). Any series differenced of order d to reach stationarity, is referred to as an I(d) process.

A test for a unit root was provided by Dickey and Fuller (1979) and is now commonly referred to as the Dickey-Fuller test for stationarity. From the following equation, one is better able to understand the concept of stationarity and how it can be tested.

$$Y_t = a_1 Y_{t-1} + \varepsilon_t \qquad (3.2)$$

If a_1 equals one, we are able to say that the series Y_t contains a unit root and is non-stationary. However, if a_1 is less than one, then the series is said to be stationary, and therefore integrated of order zero, I(0). If a series is found to be non-stationary it should be differenced, with the resulting differenced series then being tested for stationarity. Transforming equation (3.2) into a test for a unit root of an I(1) series, we obtain the following equation:

$$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t, \quad \text{where } \gamma = (a_1 - 1) \qquad (3.3)$$

If γ equals zero (a_1=1) , the series is said to contain a unit root and is therefore non-stationary. In this case, further differencing is necessary to achieve stationarity. If γ is greater than zero, the series is said to be integrated of order one, I(1). The Dickey-Fuller test statistic is therefore used to determine if γ is significantly different from zero. The null hypothesis of the Dickey-Fuller unit root test is that of a unit root. That is, the series is non-stationary. Using the Dickey-Fuller table of critical values, a significant finding is where the test statistic, $\gamma/SE(\gamma)$, is greater than the Dickey-Fuller critical value. An insignificant result is where the test statistic is less than Dickey-Fuller critical value, and this indicates the series is non-stationary.

Equation (3.3) does not include a constant or a time trend which can sometimes be appropriate when modeling financial time series. For example, when modeling stock prices it may be appropriate to include a constant mean, given these are expected to generate positive rates of return. Equations (3.4) and (3.5) illustrate a unit root test with a constant, and with a constant and a time trend. Note that the critical values of the Dickey-Fuller test, as given in Dickey and Fuller (1979), differ according to whether a constant and/or trend is included in the regression equation.

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + \varepsilon_t \tag{3.4}$$

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + a_2 t + \varepsilon_t \tag{3.5}$$

where a_0 is the constant and t is the trend. A problem with using the above equations to test for a unit root is that not all series are best represented by an autoregressive, AR(1) process. This is problematic, as the Dickey-Fuller test is based on an AR(1) process which relies on the assumption that the errors are independent and have a constant variance. (Enders, 1995). Taking autocorrelation in the residuals into account, Dickey and Fuller (1981) developed the Augmented Dickey-Fuller test for a unit root. Still using the original Dickey-Fuller test statistic, equations (3.3), (3.4) and (3.5) are rewritten to incorporate more than one lag in the regression equation sufficient to rid the residuals of autocorrelation. The rewritten equations, (3.3a), (3.4a) and (3.5a) are shown below.

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t, \tag{3.3a}$$

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t, \tag{3.4a}$$

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + a_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t, \tag{3.5a}$$

The Augmented Dickey-Fuller statistic (ADF), therefore, provides an alternative test for stationarity. γ remains the variable of interest and the test is still whether it is significantly different from zero. The ADF statistic, if significant, rejects the null hypothesis of a unit root and the series is said to be stationary.

When introducing lags into the unit root test, it is important to ensure the appropriate number of lags are used in the regression. Whilst including sufficient lags to ensure no serial correlation exists in the residuals, it is not advisable to use too many lags. Including too many lags greatly reduces the power of the test due to losses in the degrees of freedom, and therefore increases the likelihood of not finding stationarity. Enders (1995) suggested beginning with a large number of lags and reducing the number of lags until the highest lag is significant. Whilst a somewhat time-consuming task, Enders (1995) suggested it is better than starting with a minimum amount of lags and adding lags until significance is attained. This method is believed to bias the regression equation towards including a smaller number of lags than necessary to accurately capture the true nature of the series. Using this approach to choose a lag length, diagnostic tests should then be undertaken to check for serial correlation in the residuals.

Lagrange Multiplier (LM) tests are used to detect serial correlation in the residuals. This test was provided by Godfrey (1987a, 1987b) and is applicable for models with or without lags.[7] The LM statistic tests the null hypothesis of no serial correlation against the alternative hypothesis of serial correlation. Therefore, a significant LM statistic is evidence of serial correlation. The LM χ^2 test statistic is illustrated by equation (3.6).

$$\chi^2_{SC}(p)=\left(\frac{e'_{OLS}W(W'M_xW)^{-1}W'e_{OLS}}{e'_{OLS}e_{OLS}}\right)\overset{a}{\sim}\chi^2_p \qquad (3.6)$$

where,

$$M_x = I_n - X(X'X)^{-1}X'$$

$$e_{OLS} = y - X\hat{\beta}_{OLS} = (e_1, e_2, \ldots, e_n)'$$

$$W = \begin{bmatrix} 0 & 0 & \ldots & 0 \\ e_1 & 0 & \ldots & 0 \\ e_2 & e_1 & \ldots & 0 \\ . & e_2 & . & . \\ . & . & . & e_{n-p-1} \\ e_{n-1} & e_{n-2} & \ldots & e_{n-p} \end{bmatrix} \qquad (3.7)$$

and p is the order of the error process. Finding no serial correlation, reinforces the validity of using the chosen number of lags in the unit root test. The process of determining an appropriate lag length should be undertaken each time a series is tested for a unit root.

[7] The Durbin-Watson statistic applies only to models with a single one-period lag and therefore the LM test is of more practical use. (Hendry & Doornik, 1996).

The Akaike Information Criteria (AIC), proposed by Akaike (1973, 1974), and the Schwarz Bayesian Criteria (SBC), proposed by Schwarz (1978), can also be used to determine the appropriate lag length to use in the ADF test. These two selection criteria trade-off between the 'fit' and 'parsimony' of the model. Both measure the fit of the model by its maximised log-likelihood function with each applying different penalties for the inclusion of additional parameters. The AIC is defined as follows. Let $l_n(\tilde{\theta})$ be the maximised value of the log-likelihood function of an econometric model, where $\tilde{\theta}$ is the maximum likelihood estimator of $\tilde{\theta}$, based on a sample size of n. The AIC model is therefore defined as

$$\text{AIC}_l = l_n(\tilde{\theta}) - p \qquad (3.8)$$

where $p \equiv$ dimension $(\theta) \equiv$ the number of freely estimated parameters. Using this version of the AIC, the model with the highest AIC_l is chosen. The SBC is defined by equation (3.9).

$$\text{SBC} = l_n(\tilde{\theta}) - \frac{1}{2} p \log n \qquad (3.9)$$

As with the AIC, the model with the highest SBC will be chosen. The main difference between the two models lies with the penalties they impose for the inclusion of additional parameters. The SBC imposes greater penalties and therefore leads to a more parsimonious model than the AIC (Pesaran & Pesaran, 1997).

In testing for a unit root it is also necessary to consider the inclusion of a trend or a constant term. The majority of tests for unit roots include a constant term and therefore that is the approach taken here. The decision of whether or not to include a trend will be based on the significance of the trend variable. If a trend is found to be significant, it will be included in the unit root test. If not significant, it will be excluded from the equation.

A further point to note with the unit root tests is the issue of structural breaks. If there are structural breaks in the series, the ADF tests will be biased towards finding non-stationarity. Graphing a series, one may be able to detect the presence of a structural break. Perron (1989) introduced a structural break component into the unit root test, however, his analysis requires knowledge of the date of the structural change. Caution must also be exercised as it would be possible to argue that structural changes have occurred when in fact it is likely that each year will contain some small new element different to the previous year. In the context of this study, the data will be graphed to detect any observable structural changes. Given the relatively short time period under study and general knowledge of this period, it is unlikely that any structural changes will need to be incorporated in the unit root tests. However, if for example 1987 was included in the sample period, one may expect to include a structural break in the test for a unit root.

Providing an alternative to the Dickey-Fuller test for a unit root, Phillips and Perron (1988) generalised the Dickey-Fuller test and derived a test that imposed less strict assumptions on the distribution of the error terms in the regression. In particular, the Phillips-Perron test allows the error term to be "weakly dependent and heterogeneously distributed" (Enders, 1995, p.239). This means it is more likely to reject the null hypothesis of a unit root.

Whilst unit root tests are fairly well established in the finance literature, it is necessary to note a number of shortcomings in the current methodologies. Both the ADF and the Phillips-Perron tests have difficulties in distinguishing between a non-stationary and a near non-stationary series. "A trend stationary process, can be arbitrarily well approximated by a unit root process, and a unit root process can be arbitrarily well approximated by a trend stationary process" (Enders, 1995, p.261). In addition to this, testing for a unit root requires considerable care to be taken to ensure the appropriate number of variables are included. That is, how many lags to include, and is a trend and/or constant required in the regression. The number of variables in the equation has a direct bearing on the power of the unit root tests, with too few, or too many, significantly reducing its power.

Whilst the Phillips-Perron test carries the advantage of weaker assumptions of the nature of the error terms, it is problematic when modeling a series with a negative moving average. For these series, the Phillips-Perron tests are more likely to reject the null hypothesis of a unit root despite the possible existence of a negative unit root. (Enders, 1995). This study has chosen to adopt the Augmented Dickey-Fuller test which has been extensively used in numerous empirical studies, and which is therefore well established in time series methodology.

3.3 Cointegration

Bivariate cointegration is used to test for a long-run relationship between two variables. First introduced by Granger (1981) and developed by Engle and Granger (1987), cointegration is best described as follows. Two variables X_t and Y_t are both integrated of order *d*. These variables are said to be cointegrated if the residuals, z_t, from a linear combination of these two variables are integrated of an order less than *d*. Cointegration therefore implies a long-run equilibrium relationship exists between X_t and Y_t. This means that while in the short-run X_t and Y_t may substantially deviate from each other, in the long-run they will tend to revert to their long-run equilibrium relationship. (Watsham & Parramore, 1997).

There have been three major methods developed to test for cointegration. The Engle-Granger two-step method (1987), the Johanson Maximum Likelihood method (1988) and the Stock-Watson Procedures (1988). The Engle-Granger method is the simplest approach to test for cointegration between two variables and involves a two step process.

Step one involves testing the two individual series for stationarity. From this, one is able to determine the level of integration in the two series. For example, testing X_t and Y_t we may find that both series are integrated of order one, I(1). Knowing this is fundamental to the tests for cointegration where it is necessary to compare the level of integration in the two individual series with the level of integration in the residual series. Step one is also of considerable importance as only series that are integrated of the same order can be cointegrated. That is, if X_t is an I(1), and Y_t is an I(2), it is possible to conclude that no cointegration exists between these two variables. (Enders, 1995)

Step two involves running an OLS regression of the two original (non-stationary) X_t and Y_t series. That is, running the regression illustrated by equation (3.10).

$$Y_t = a_0 + X_t + \varepsilon_t \qquad (3.10)$$

This is called the cointegrating regression. From this regression, the residuals, ε_t, are isolated and tested for stationarity. The null hypothesis is that of non-cointegration. That is, there is a unit root in the residual series.

The Augmented Dickey-Fuller critical values, however, are no longer appropriate for a unit root test of the residuals from the cointegrating regression. This is because the residual series is based on *estimates* of the actual residuals, not the actual residual series. This creates a natural bias in the ADF test to find stationarity in the residual series. (Engle & Granger, 1991). Therefore, Engle and Granger developed their own critical values from which to test the residuals for stationarity. These values can be found in

MacKinnon (1990). The unit root test is applied to the residual series in a similar manner to testing the original X_t and Y_t series. However, it is not necessary for the unit root regression to include a constant. The unit root test of the residual series is as follows.

$$\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \varepsilon_t \qquad (3.11)$$

The parameter of significance in the unit root test is still the value of a_1, and whether or not it is significantly different from zero. As detailed in section 3.2, the unit root test should include a sufficient number of lags to remove serial correlation. Given the above example, if ε_t was found to be an I(0) series, X_t and Y_t are said to cointegrated.

As can be seen from this two-step method, when testing for cointegration between two variables, one of the variables has to be assigned the dependent variable. That is, put on the left side of the regression equation. Whilst equation (3.10) was used as the cointegrating regression to test for cointegration between X_t and Y_t, cointegration could similarly have been tested using X_t as the dependent variable. Theory suggests that it should not influence the outcome of the test, with a test for a unit root in the error terms from the two alternative cointegrating regressions being equivalent when dealing with large samples. (Enders, 1995). However, it is also recognised that it is not always possible to obtain a sample size large enough to remove this problem. Therefore, "whilst the test is asymptotically invariant to this so-called direction normalisation rule, the test results may be very sensitive to it in finite samples" (Rao, 1994, p.28). That is, the ordering of the two variables in the cointegrating regression may in fact have an impact on the cointegration results.

Another issue arising from the Engle-Granger procedure is their use of estimated residuals to test for a unit root. As already mentioned, these residuals are not actual residuals and are based on an OLS method to minimise their sum of squared residuals. Addressing these limitations, Johansen (1988) and Stock and Watson (1988) developed a maximum likelihood method which solves this shortcoming of the two-step Engle-Granger procedure. Both tests use multiple cointegrating vectors in their methodologies and in general terms Johansen's (1988) method is a multivariate generalisation of the Dickey-Fuller test.

In the context of this research, the Engle-Granger methodology will be used to test for bivariate cointegration. Noting the potential for the order of the regression variables to effect the result, cointegration tests will be conducted using both variables as the dependent and independent variable.

3.4 Error Correction and Granger Causality

Error correction follows as a direct consequence of cointegration between two variables. Engle and Granger (1987) showed that if X_t and Y_t hold a long-run relationship with each other ie. are cointegrated, while they deviate from each other in the short-term, they will tend to revert to their long-run equilibrium relationship. It is this process of returning to an equilibrium position that is referred to as 'error correction'. The error correction model is therefore a representation of that process.

Granger causality was developed by Granger (1969) and is a test for the presence of causality between two variables. Granger (1969) explains causality using the following notation. If $P_t(X \mid \overline{X})$ represents the optimal predictor of X given past values of X, the errors from these predictions will be represented as $\varepsilon_t(X \mid \overline{X}) = X_t - P_t(X \mid \overline{X})$. Using $\sigma^2(X \mid \overline{X})$ to represent the variance of $\varepsilon_t(X \mid \overline{X})$, and U_t to represent all possible information, we can define causality as follows. If $\sigma^2(X \mid U) < \sigma^2(X \mid \overline{U - Y})$, we can say that Y is causing X.

From the above definition it will be apparent that Granger causality is based on the unrealistic assumption of being able to use all available information to predict X. In reality not all information will have an impact on the predicted series and therefore Granger modifies the above definition in recognition of this. Using two series X and Y, and assuming that all other information is irrelevant, Y is said to cause X if $\sigma^2(X \mid \overline{X}) > \sigma^2(X \mid \overline{X}, \overline{Y})$, where $\sigma^2(X \mid \overline{X}, \overline{Y})$ represents the minimum variance of X when both X and Y are used to predict X. It is in this form that Granger is able to test for causality between two variables.

The testable form of Granger causality is best represented by equations (3.12) and (3.13) where two series, X_t and Y_t, are being tested for causality.

$$X_t = \sum_{j=1}^{p} a_j X_{t-j} + \sum_{j=1}^{q} b_j Y_{t-j} + \varepsilon_t \tag{3.12}$$

$$Y_t = \sum_{j=1}^{q} c_j X_{t-j} + \sum_{j=1}^{p} d_j Y_{t-j} + n_t \tag{3.13}$$

Using a linear relationship framework, these two equations form the basis of Granger tests for causality. From these equations we can determine whether lagged values of the Y_t series in equation (3.10) significantly improve the prediction of X_t. If they do, we can say that Y_t causes X_t. Using equation (3.13), we can determine whether including X_t significantly improves the prediction of Y_t. If it does, we can say that X_t causes Y_t. It is interesting to note that if a series can be predicted exactly from past values of itself, it "cannot be said to have any causal influences other than its own past" (Granger, 1969, p.430).

In testing the contribution one series makes to the prediction of another, the significance of the coefficients of the two lagged series are assessed. If X_t does not cause Y_t, the sum of the coefficients of the lagged X_t series are equal to zero. Conversely, if X_t does cause Y_t, the sum of the coefficients would be significantly different from zero. The Wald F-statistic provides a test for the significance of omitting the lagged X_t values from (3.13). The Wald F-statistic is given by,

$$F_c = \frac{(ESSR - ESSU)/q}{ESSU/(T-p-q)} \qquad (3.14)$$

where ESSU is the error sum of squares for equation (3.13), and ESSR is the error sum of squares for the restricted equation ,

$$Y_t = \sum_{j=1}^{p} d_j Y_{t-j} + v_t \qquad (3.15)$$

T is the number of observations used in equation (3.13). The Wald statistic, F_c, has the F-distribution with q degrees of freedom in the numerator and $T - p - q$ degrees of freedom in the denominator. A significant Wald F-statistic indicates that the lagged values of X_t were significant in the prediction Y_t and therefore X_t can be said to cause Y_t.

It is important to note that both the X_t and Y_t series must be stationary in the Granger tests for causality. The above example has assumed that they are stationary, however, in reality they are likely to be I(1) series. If X_t and Y_t were I(1) series, equations (3.12) and (3.13) would be rewritten as follows:

$$\Delta X_t = \sum_{j=1}^{p} a_j \Delta X_{t-j} + \sum_{j=1}^{q} b_j \Delta Y_{t-j} + \varepsilon_t \qquad (3.12a)$$

$$\Delta Y_t = \sum_{j=1}^{q} c_j \Delta X_{t-j} + \sum_{j=1}^{p} d_j \Delta Y_{t-j} + \varepsilon_t \qquad (3.13a)$$

When cointegration has been found to exist between two variables, it follows that Granger causality must also exist. That is, if two variables hold a long-run relationship with each other, then by necessity, one will cause the other. (Engle & Granger, 1991). When testing for Granger causality between two cointegrated variables, the Granger causality equation must include an error-correction component taking into account their long-run equilibrium relationship. If X_t and Y_t were found to be cointegrated, equations (3.12) and (3.13) would be rewritten as follows:

$$\Delta X_t = c_1 z_{t-1} + \sum_{j=1}^{p} a_j \Delta X_{t-j} + \sum_{j=1}^{q} b_j \Delta Y_{t-j} + \varepsilon_t \qquad (3.12b)$$

$$\Delta Y_t = c_2 z_{t-1} + \sum_{j=1}^{q} c_j \Delta X_{t-j} + \sum_{j=1}^{p} d_j \Delta Y_{t-j} + \varepsilon_t \qquad (3.13b)$$

where z_{t-1} represents the error correction term. The same process of testing for causality is carried out whether an error correction component is included in the equations or not. From this we can see the necessity of running cointegration tests before tests for causation are conducted.

There are a number of important issues to consider that result from the above description of Granger causality. Firstly, the above method of testing for Granger causality requires consideration of the number of lags to include in equations (3.12) and (3.13). Results from Granger causality tests have been shown to be sensitive to the number of lags included and therefore care needs to be taken when choosing the number of lags to test for causality. (Enders, 1995). As with any statistical test, including too many lags reduces the power of the test, with Granger causality more likely to be found. However, too few could also bias the results towards finding no causality when there is in fact causality present. As with unit root tests, the significance of the lags in the regression provides the greatest indication of the appropriate number of lags to include in the Granger causality tests. Secondly, the above analysis has assumed that the only relevant variables in predicting X_t are lagged values of X_t and Y_t. However, it may be likely that there are other relevant variables that are significant in the prediction of X_t. In circumstances where relevant data is not included, spurious causality could arise. For example, the above analysis assumed X_t and Y_t were the only relevant variables to include when testing for causality. However, if there was a third series, Z_t, which had a causal relationship with both X_t and Y_t, spurious causality between the two series may be found. That is, X_t could appear to cause Y_t (and vice versa) when it is in fact the Z_t series causing both X_t and Y_t. Thirdly, Granger causality explicitly assumes a linear relationship exists between all variables being tested and does not consider the potential for the existence of non-linear relationships. (Enders, 1995).

Granger Causality, however, has served to provide a means by which the relationship between two series can be tested. Consideration of the appropriate lag lengths, and the potential for spurious causality serve merely to reduce the likelihood of incorrect interpretations based on the use of the aforementioned analysis of causality between two variables.

Chapter Four

Vector Autoregressions and Multivariate Cointegration Analysis

4.1 The Vector Autoregression (VAR)

The Vector Autoregression (VAR) methodology was developed by Sims (1980) in response to the need for a multivariate model which required no a priori knowledge of the relationship between the variables included in the system. In this way VARs have provided the means of estimating a number of relationships among jointly endogenous variables without having to impose any a priori restrictions on the variables. The VAR approach therefore removed the need for theorists to reach a consensus regarding the nature of structural relationships underlying the variables contained in the VAR. Essentially, the VAR is a "system of dynamic linear equations in which each variable is written as a function of serially uncorrelated error and an equal number of lags of all variables in the system" (Keating, 1990, p.455). In other words, each variable within the VAR depends on past values of itself as well as past values of all the other variables included in the VAR. VARs have been primarily used by researchers interested in gaining a greater understanding of relationships between a group economic variables. Impulse response functions and forecast error variance decompositions are the two major by-products of the VAR methodology which provide interpretable information with regards to the various relationships encompassed within the VAR.

The theory underlying the VAR is somewhat complex. Pesaran and Pesaran (1997) provide a detailed explanation of the VAR methodology as follows.

Equation (4.1) is a representation of the VAR model.

$$\begin{aligned} z_t &= \mathbf{a}_0 + \mathbf{a}_1 t + \sum_{i=1}^{p} \Phi_i z_{t-i} + \Psi \boldsymbol{w}_t + \boldsymbol{u}_t, \quad t = 1,2,\ldots,n \qquad (4.1) \\ &= \mathbf{A}' \boldsymbol{g}_t + \boldsymbol{u}_t \end{aligned}$$

where z_t is an $m \times 1$ vector of jointly determined dependent variables and w_t is a $q \times 1$ vector of deterministic or exogenous variables. The VAR model presented in equation (4.1) relies on seven assumptions. These are as follows.

1. **Zero mean assumption**. The $m \times 1$ vector of disturbances, u_t, has zero means:
   $E(u_t) = 0$, for $t = 1,2, \ldots, n$
2. **Homoscedasticity Assumption.** The $m \times 1$ vector of disturbances, u_t, has a time-invariant conditional variance matrix.
   $E(u_t u'_t \mid z_{t-1}, z_{t-2}, \ldots, w_t, w_{t-1}, \ldots) = \Sigma$,
   where $\Sigma = (\sigma_{i,j})$ is an a $m \times m$ symmetric positive definite matrix.
3. **Non-autocorrelated Error Assumption.** The $m \times 1$ vector of disturbances, u_t, is serially uncorrelated:
   $E(u_t u'_s) = 0$ for all $t \neq s$.
4. **Orthogonality Assumption**. The $m \times 1$ vector of disturbances, u_t, and the regressors, w_t, are uncorrelated
   $E(u_t \mid w_t) = 0$ for all t
5. **Stability Assumption**. The augmented VAR(p) model (4.1) is stable. That is, all the roots of the following determinantal equation fall outside the unit circle.
   $$| \mathbf{I}_m - \Phi_1 \lambda - \Phi_2 \lambda^2 - \ldots - \Phi_p \lambda^p | = 0 \qquad (4.2)$$
6. **Normality Assumption.** The $m \times 1$ vector of disturbances has a multivariate normal distribution. This assumption is required for the use of a maximum likelihood function.
7. The observations $g_t = (1, t, z_{t-1}, z_{t-2}, \ldots, z_{t-p}, w_t)$, for all $t = 1,2, .., n$ are not perfectly collinear.

(Pesaran & Pesaran, 1997, p.121)

Maximum likelihood estimators of the coefficients of the variables in the VAR can be determined using OLS regressions. OLS regression provides efficient estimates of each equation within the VAR because all the regressors in the equations are identical. OLS also assumes that all error terms contain no serial correlation (Enders, 1995).

There are a number of issues to consider when applying the VAR methodology. Firstly, one must decide on the number of variables to include in the VAR. This is a somewhat arbitrary choice based on economic theory and judgement as to which variables are most likely to hold relationships with each other. Having decided on the variables to include in the VAR, the first step in VAR modeling is to test the data for stationarity. There is, however, debate concerning the need to ensure the variables in the VAR are stationary. Both Sims (1980) and Doan (1982) have argued against differencing non-stationary series, suggesting that it "is the goal of VAR analysis to determine the interrelationships among the variables, *not* the parameter estimates" (Enders, 1995, p.301). They believe that differencing throws away too much information, and reduces the possibility of observing any cointegrating relationships. There is, however, support for the differencing of non-stationary variables. Granger and Newbold (1974) highlighted the potential for spurious regression to arise when modeling non-stationary variables, and Pesaran and Pesaran (1997) recommend differencing non-stationary data in the context of VAR modeling.

Having tested the data for the presence of a unit root, the next step in VAR modeling is choosing the optimal number of lags to include in the system. As when choosing the number of variables to include in the VAR, the researcher must consider the impact of increasing the number of parameter estimates on the degrees of freedom. Using too many lags significantly decreases the degrees of freedom, however, too few lags may lead to mispecification of the VAR model. Three statistics can be used as a guideline to determining the optimal lag length. These are the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and log-likelihood ratios. The AIC and SBC values are given by

$$\text{AIC}_p = \frac{-nm}{2}(1+\log 2\pi) - \frac{n}{2}\log\left|\tilde{\Sigma}_p\right| - ms \tag{4.3}$$

$$\text{SBC}_p = \frac{-nm}{2}(1+\log 2\pi) - \frac{n}{2}\log\left|\tilde{\Sigma}_p\right| - \frac{ms}{2}\log(n) \tag{4.4}$$

where $s = mp + q + 2$. The AIC and SBC values are given for the maximum order of p chosen by the user. The researcher chooses the lag length that maximises the AIC and SBC values. The log-likelihood ratio statistic tests the hypothesis that the order of the VAR is p, against the alternative that the order of the VAR is P(P>p) using the following formula

$$\text{LR}_{P,p} = n\left(\log\left|\tilde{\Sigma}_p\right| - \log\left|\tilde{\Sigma}_P\right|\right) \tag{4.5}$$

for $p = 0,1,2, \ldots, P-1$, where P is the maximum order of the VAR model selected by the user. Under the null hypothesis, the LR statistic in (4.5) is asymptotically distributed as a chi-squared variate with $m^2(P-p)$ degrees of freedom. A limitation of the LR statistic calculated above is, when used in small samples, it tends to be biased towards the over-rejection of the null hypothesis. Therefore an adjusted LR statistic has been developed to take this into account. The adjusted LR statistic is as follows.

$$LR^*_{P,p} = (n-q-2-mP)\left(\log\left|\tilde{\Sigma}_p\right| - \log\left|\tilde{\Sigma}_P\right|\right) \qquad (4.6)$$

for $p = 0,1,2, \ldots,$ P-1. The distribution of the adjusted LR statistic is the same as the asymptotic distribution of the unadjusted LR statistic in equation (4.5). Like the AIC and SBC critieria, the lag length with the maximum adjusted log likelihood ratio should be chosen. It is unlikely that all three statistics will give consistent results. Consideration of all three criterion, combined with sound economic judgement, is advised when determining the optimal lag length. Essentially, the inclusion of lags acts to rid the regressions within the VAR from any serial correlation. Testing for serial correlation can also serve as a check on the number of lags chosen. Consideration should also be paid to the sample size and therefore the risk of over-parameterisation of the VAR.

The researcher must also choose whether to include trends and intercepts in the VAR system. As with the debate concerning the use of levels or differenced variables in the VAR, similar controversy surrounds the inclusion of trends in the VAR. To assist in this decision, log-likelihood ratios can be used to test for the deletion of variables (ie. trends, intercepts etc) from the VAR. In the following description of the deletion test, the intercept and trend term will be subsumed under the variable $\boldsymbol{w}_t$. Let,

$$\underset{q\times 1}{w_t} = \begin{pmatrix} w_t, & q_1\times 1 \\ w_2, & q_2\times 1 \end{pmatrix} \quad \text{and} \quad \underset{m\times q}{\Psi} = \begin{pmatrix} \Psi_1, & \Psi_2 \\ m\times q_1, & m\times q2 \end{pmatrix} \qquad (4.7)$$

where $q = q_1 + q_2$. The Log-likelihood ratio statistic for testing the null hypothesis of

$$H_0 : \psi_1 = 0, \text{ against } H_1 : \psi_1 \neq 0$$

is computed as

$$LR(\psi_1 = 0) = 2\{LL_U - LL(\psi_1 = 0)\} \qquad (4.8)$$

where LL_U is the unrestricted maximized value of the log-likelihood function, and $LL(\psi_1 = 0)$ is the maximized value of the log-likelihood function obtained under $\psi_1 = 0$. Asymptotically $LR(\psi_1 = 0)$ is distributed as a chi-squared variate with mq_1 degrees of freedom.

Having established a number of fundamental issues relating to the optimal structure of the VAR model, the researcher is now able to use the model to provide information regarding the nature of the relationship between the variables within the VAR. Impulse response functions and forecast error variance decompositions are the two major tools of the VAR methodology.

4.2 Impulse Response Analysis

The impulse response function "measures the time profile of the effect of shocks on the future states of a dynamical system" (Pesaran & Pesaran, 1997, p.423). That is, we are able to determine the reaction of the variables in the VAR for a one standard deviation shock to a given variable. Two types of impulse response functions have evolved. The orthogonalized IR function advocated by Sims (1980), and the generalized IR function more recently proposed by Koop, Pesaran and Potter (1996) and Pesaran and Shin (1997). The difference between the two lies with the relative importance they place on the ordering of the variables in the VAR. Sim's (1980) orthogonalised impulse response functions are highly dependent on the order of the variables in the VAR and are therefore normally analysed in the context of different VAR orderings. However, this approach is not practical when dealing with a large number of variables. The orthogonalised approach is also problematic when the researcher has little knowledge of the correct order of the variables. Responding to the limitations of the orthogonalised approach, Koop et al. (1996) and Pesaran and Shin (1997) developed the generalised IR functions. Generalised IR functions provide results that are independent of the ordering of the variables in the VAR. Pesaran and Pesaran (1997) provide a detailed explanation of the two approaches.

Both generalised and orthogonalised IR functions rely on the $m \times m$ coefficient matrices, $\mathbf{A}_j$, in the infinite moving average representation of equation (4.1).

$$z_t = \sum_{j=0}^{\infty} \mathbf{A}_j \boldsymbol{u}_{t-j} + \sum_{j=0}^{\infty} \boldsymbol{B}_j w_{t-j} \quad (4.9)$$

where the matrices, $\mathbf{A}_j$, are computed using the recursive relations

$$\mathbf{A}_j = \Phi_1 \mathbf{A}_{j-1} + \Phi_2 \mathbf{A}_{j-2} + \ldots + \Phi_p \mathbf{A}_{j-p}, \quad j = 1,2, \ldots \quad (4.10)$$

with $\mathbf{A}_0 = \mathbf{I}_m$, and $\mathbf{A}_j = 0$, for $j < 0$, and $\mathbf{B}_j = \mathbf{A}_j \psi$, for $j = 1,2,\ldots$

The orthogonalized approach taken by Sim's is based on the following Cholesky decomposition of Σ (the covariance matrix of the shocks, $\boldsymbol{u}_t$):

$$\Sigma = \mathbf{TT}' \quad (4.11)$$

where $\mathbf{T}$ is a lower triangular matrix. The moving average presentation (4.9) is then rewritten as:

$$z_t = \sum_{j=0}^{\infty} (\mathbf{A}_j \mathbf{T})(\mathbf{T}^{-1} \boldsymbol{u}_{t-j}) + \sum_{j=0}^{\infty} \mathbf{B}_j w_{t-j}$$

$$= \sum_{j=0}^{\infty} \mathbf{A}^*_j \varepsilon_{t-j} + \sum_{j=0}^{\infty} \mathbf{B}_j w_{t-j} \qquad (4.12)$$

where

$$\mathbf{A}^*_j = \mathbf{A}_j\mathbf{T}, \text{ and } \varepsilon_t = \mathbf{T}^{-1}\boldsymbol{u}_t$$

From this we can see that,

$$E(\varepsilon_t \varepsilon^{`}_t) = \mathbf{T}^{-1}E(\boldsymbol{u}_t \boldsymbol{u}^{`}_t)\,\mathbf{T}^{`-1} = \mathbf{T}^{-1}\,\Sigma\mathbf{T}^{`-1} = \mathbf{I}_m,$$

and the new errors, ε_t, obtained using the transformation matrix, **T**, are now contemporaneously uncorrelated and have unit standard errors. That is, the shocks, $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t} \ldots \varepsilon_{mt})^{`}$ are orthogonal to each other. The orthogonalised IR function of a unit shock (equal to one standard error) at time t to the ith orthogonalised error, namely ε_{it}, on the jth variable at time $t + N$ is given by the jth element of

$$\text{orthogonalized IR function} = \mathbf{A}^*_N\, \boldsymbol{e}_i = \boldsymbol{A}_N \boldsymbol{T} \boldsymbol{e}_I \qquad (4.13)$$

to the i^{th} variable (eqtn)

where e_i is the m * 1 selection vector,

$$\boldsymbol{e}_i = (0, 0, \ldots\ 0, 1, 0, \ldots 0)' \qquad (4.14)$$

↑
ith element

This can be written more compactly as,

$$\mathrm{OI}_{ij,N} = \boldsymbol{e}^{`}_j \boldsymbol{A}_N \mathbf{T} \boldsymbol{e}_i, \quad i,j, = 1,2, \ldots, m \qquad (4.15)$$

As already mentioned, the order of the variables directly impact on the resultant orthogonalized IR functions. This is because the non-uniqueness of the orthogonalized responses is also related to the non-uniqueness of the matrix **T** in the Cholesky decomposition of Σ in (4.11).

The generalized IR function for a system-wide shock, $\boldsymbol{u}^0_t$, is defined by

$$GI_z(N, \boldsymbol{u}^0_t, \Omega^0_{t-1}) = E(z_{t+N} \,|\, \boldsymbol{u}_t = \boldsymbol{u}^0_t, \Omega^0_{t-1}) - E(z_{t+N} \,|\, \Omega^0_{t-1}) \qquad (4.16)$$

where $E(\cdot\,|\,\cdot)$ is the conditional mathematical expectation taken with respect to the VAR model presented in equation (4.1), and Ω^0_{t-1} is a particular historical realization of the process at time t-1. In relation to the infinite moving average representation given in equation (4.9), we have

$$GI_z(N, \boldsymbol{u}^0_t\ \Omega^0_{t-1}) = \mathbf{A}_N \boldsymbol{u}^0_t \qquad (4.17)$$

which is dependent on the history of the process. In practice the choice of the vector of shocks, $\boldsymbol{u}_t^0$, is arbitrary. In the case where $\boldsymbol{u}_t^0$ is drawn from the same distribution as $\boldsymbol{u}_t$, namely a multivariate normal with zero means and a constant covariance matrix Σ, we have the analytical result that

$$GI_z(N, \boldsymbol{u}_t^0\ \Omega_{t-1}^0) \sim N(0, \mathbf{A}_N \Sigma \mathbf{A}'_N) \qquad (4.18)$$

The above is an analysis of the generalized IR functions in the context of a system-wide shock to the VAR. We can now apply this to the case of a variable specific shock on the evolution of $z_{t+1}, z_{t+2}, \ldots, z_{t+N}$. Assuming that for a given $\boldsymbol{w}_t$, the VAR model is perturbed by a shock of size $\delta_i = \sqrt{\sigma_{ii}}$ to its i^{th} equation at time t. By the definition of the generalized IR we have

$$GI_z(N, \delta_i, \Omega_{t-1}^0) = E(z_t \mid u_{it} = \delta_i, \Omega_{t-1}^0) - E(z_t \mid \Omega_{t-1}^0) \qquad (4.19)$$

Putting this into an infinite moving average process as shown in equation (4.9), we obtain

$$GI_z(N, \delta_i, \Omega_{t-1}^0) \sim \mathbf{A}_N E(\boldsymbol{u}_t \mid u_{it} = \delta_i) \qquad (4.20)$$

which is history invariant, that is, not dependent on Ω_{t-1}^0. The computation of the conditional expectations, $E(\boldsymbol{u}_t \mid u_{it} = \delta_i)$, depends on the nature of the multivariate distribution assumed for the disturbances, $\boldsymbol{u}_t$. In the case where $\boldsymbol{u}_t \sim N(0,\Sigma)$, we have

$$E(\boldsymbol{u}_t \mid u_{it} = \delta_i) = \begin{pmatrix} \sigma_{1i}/\sigma_{2i} \\ \sigma_{2i}/\sigma_{ii} \\ \cdot \\ \cdot \\ \cdot \\ \sigma_{mi}/\sigma_{ii} \end{pmatrix} \delta_i \qquad (4.21)$$

where, as before, $(\Sigma = \sigma_{ij})$. Hence for a unit shock defined by $\delta_i = \sqrt{\sigma_{ii}}$, we have,

$$GI_z(N, \delta_i = \sqrt{\sigma_{ii}}, \Omega_{t-1}^0) = \frac{A_N \sum e_i}{\sqrt{\sigma_{ii}}}, \quad i,j, = 1,2, \ldots, m \qquad (4.22)$$

where $\boldsymbol{e}_i$ is a selection vector given by (4.14). The generalized impulse response function of a unit shock to the i^{th} equation in the VAR model (4.1), on the j^{th} variable at horizon N is given by the j^{th} element of (4.22) , or expressed more compactly as

$$GI_{ij,N} = \frac{e'_j A_N \sum e_i}{\sqrt{\sigma_{ii}}}, \quad i,j, = 1,2, \ldots, m \qquad (4.23)$$

Unlike the orthogonalized impulse responses in (4.13), the generalized impulse responses in (4.22) are invariant to the ordering of the variables in the VAR. However, the two impulse responses will be the same for the first variable in the VAR or in situations where the Σ (system covariance matrix of errors) is a diagonal matrix. It is interesting to note that the ordering of the variables in the VAR is only important when the error terms of the various regression equations in the VAR system are correlated. When they are not, the orthogonalised and generalised methods will give similar results.

4.3 Forecast Error Variance Decompositions

The second major analysis tool provided by VAR modeling is Forecast Error Variance (FEV) decompositions. The FEV decomposition is used to give an indication as to the "proportion of the movements in a sequence due to its 'own' shocks versus shocks to another variable" (Enders, 1995, p.311). In other words, they show the proportion of FEV for each variable due to innovations in other variables within the system. If a shock to one variable, x, explains none of the FEV of variable, y, series y is said to be exogeneous. If, at the other extreme, shocks to the x series explains all of the FEV of series y, series y is said to be endogenous. Therefore, in terms of this research, they provide an indication of the relative importance of the variables in the VAR in explaining future value and growth stock returns. Like the IR functions, there are orthogonalised and generalised versions of the FEV decompositions. These are explained in Pesaran and Pesaran (1997) as follows.

From the infinite moving average process of the VAR model (4.12), the orthogonalised forecast error variance decomposition of the i^{th} variable in the VAR is given by

$$\theta_{ij,N} \quad = \quad \frac{\sum_{l=1}^{N} (e_i' A_l T e_j)^2}{\sum_{l}^{N} e_i' A_l \Sigma A_l' e_i}, \quad i,j = 1,2, \ldots, m \tag{4.23}$$

where $\mathbf{T}$ is defined by the Cholesky decomposition of Σ, (4.11); $\boldsymbol{e}_i$ is the selection vector defined by (4.14); and $\mathbf{A}_l$, $l = 0,1,2,\ldots$ are the coefficient matrices in the moving average representation, (4.9). $\theta_{ij,N}$ measures the proportion of the N-step ahead forecast error variance of variance i, which is accounted for by the orthogonalized innovations in variable j. Like the orthogonalised IR functions, the orthogonalized forecast error variance decompositions are dependent of the ordering of the variables in the VAR.

The generalised approach to FEV decompositions involves considering the variance of N-step forecast errors of z_t which is explained by conditioning on the non-orthogonalized shocks, $u_{it}, u_{i,t+1}, \ldots, u_{i,t+N}$, while allowing for contemporaneous correlations between these shocks and the shocks to the other equations in the system. Using equation (4.9), the moving average representation of the VAR, the forecast error of predicting the z_{t+N} conditional on the information at time $t-1$ is given by

$$\underset{m\times 1}{\xi_t(N)} = \sum_{l=0}^{N} A_l u_{t+N-l} \qquad (4.24)$$

with the total forecast error covariance matrix

$$\text{Cov}(\xi_t(N)) = \sum_{l=0}^{N} A_l \Sigma A_l' \qquad (4.25)$$

Consider now the forecast error covariance matrix of predicting z_{t+N} conditional on the information at time $t-1$, and the given values of the shocks to the i^{th} equation, $u_{it}, u_{i,t+1}, \ldots, u_{i,t+N}$. Using equation (4.9), we have

$$\underset{m\times 1}{\xi_t^{(i)}(N)} = \sum_{l=0}^{N} \mathbf{A}_l \left(\boldsymbol{u}_{t+N-l} - E\left(\boldsymbol{u}_{t+N-l} \mid u_{i,t+N-l}\right) \right) \qquad (4.26)$$

As in the case of the generalised IR functions, assuming $\boldsymbol{u}_t \sim N(0,\Sigma)$, we have

$$E(\boldsymbol{u}_{t+N-l} \mid u_{i,t+N-l}) = (\sigma_{ii}^{-1}\Sigma e_i)u_{i,t+N-l} \qquad \text{for} \quad l = 0,1,2,\ldots,N$$

$$i = 1,2,\ldots,m$$

Substituting this result back into (4.26)

$$\xi_t^{(i)} = \sum_{l=0}^{N} A_l \left(u_{t+N-l} - \sigma_{ii}^{-1}\Sigma e_i u_{i,t+N-l}\right)$$

and taking unconditional expectations, yields

$$Cov(\xi_t^{(i)}(N)) = \sum_{l=0}^{N} A_l \Sigma A_l' - \sigma_{ii}^{-1}\left(\sum_{l=0}^{N} A_l \Sigma e_i e_i' \Sigma A_l'\right) \qquad (4.27)$$

Therefore, using (4.25) and (4.27), it follows that the decline in the N-step forecast error variance of z_t, obtained as a result of conditioning on the future shocks to the i^{th} equation, is given by

$$\Delta_{iN} = Cov[\xi_t(N)] - Cov[\xi_t^{(i)}(N)]$$

$$= \sigma_{ii}^{-1}\sum_{l=0}^{N} A_l \Sigma e_i e_i' \Sigma A_l' \qquad (4.28)$$

Scaling the j^{th} diagonal element of Δ_{iN}, namely $e_j'\Delta_{iN}e_j$, by the N-step ahead forecast error variance of the i^{th} variable in z_t, we have the following generalised forecast error variance decomposition.

$$\Psi_{ij,N} = \frac{\sigma_{ii}^{-1}\sum_{l=0}^{N}\left(e_j' A_l \Sigma e_i\right)^2}{\sum_{l=0}^{N} e_j' A_l \Sigma A_l' e_i} \qquad (4.29)$$

Note that the denominator of this measure is the i^{th} diagonal element of the total forecast error variance formula in (4.25), and is the same as the denominator of the orthogonalized forecast error variance decomposition formula (4.23). Also, $\theta_{ij,N} = \psi_{ij,N}$ when z_{it} is the first variable in the VAR. However, in general the two decompositions differ.

4.4 Unrestricted VARs vs Structural and Cointegrating VARs

Sim's (1980) VAR provided researchers with an innovative method of determining the relationship between a number of jointly endogenous variables. Sim's contribution marked a significant turning point in multivariate modeling by providing a method "largely free of the spurious specification assumptions and consequent specification errors necessitated by traditional macroeconometric procedures" (Spencer, 1989, p.442). However, from their inception, VAR methodology has received considerable criticism directly relating to their non-restrictive nature. The major criticism of the VAR relates to its interpretation. It is argued that the mechanical nature of VAR modeling, combined with the lack of economic theory required in formulating the VAR, allows for little economic interpretation from the VAR result. Specifically, "unless the underlying structural model can be identified from the reduced-form VAR model, the innovations in a Choleski decomposition do not have a direct economic interpretation" (Enders, 1995, p.321). Providing a solution to the traditional VAR, Bernanke (1986), Sims (1986) and Blanchard and Watson (1986) developed the structural VAR (SVAR). The purpose of the SVAR was to use "economic theory (rather than Choleski decomposition) to recover the structural innovations from the residuals" (Enders, 1995, p.322). Implementing a structural VAR involves imposing a number of restrictions on the VAR based on economic theory. The traditional VAR is based on Choleski decomposition retrictions which, proponents of the structural approach argue, makes strong assumptions about the underlying structure of the VAR, leading to inaccurate IR functions and FEV decompositions.

Structural VARs therefore introduced economic theory into the traditional VAR framework, essentially imposing an "economic model on the contemporaneous movements of the variables" (Enders, 1995, p.343). It is interesting to note, however, that the structural VAR to some extent is taking away what Sim's traditional VAR was trying to achieve. That is, a multivariate model which requires no a priori information and therefore restrictions on the relationships between the variables within the VAR. Therefore, whilst some argue that the structural VAR is more conducive to economic interpretation, its use may be limited to situations only where sound economic theory enables restrictions to be used in the context of VAR modeling. Therefore, given the nature of this research and the lack of economic theory regarding the relationship between value and growth stocks returns and a number of economic variables, the unrestricted VAR approach is preferable to the structural VAR.

A recent innovation in VAR modeling is that of the cointegrating VAR. Park and Phillips (1988) and Sims, Stock, and Watson (1990) have shown that traditional VAR modeling is inappropriate when modeling variables that are cointegrated. That is, conventional asymptotic theory, on which VAR modeling is based, is not applicable for a system of cointegrated variables. The cointegrating VAR is essentially a restricted version of the traditional VAR approach, and as with bivariate cointegration, an error correction component is required in a VAR containing cointegrated variables. Engle and Granger (1987) provided the theoretical justification of this by showing that a VAR containing cointegrated variables can be written as a vector error correction model. Essentially, a "vector autoregression can be interpreted as a vector error correction in which there are no cross equation constraints" (Naka & Tufte, 1997, p.1594). The cointegrating VAR, or the Vector Error Correction Model (VECM), is described by Pesaran and Pesaran (1997) and is represented by equation (4.30).

$$\Delta \mathbf{y}_t = \mathbf{a}_{1y} + \mathbf{a}_{1y}t - \Pi_y z_{t-1} + \sum_{i=1}^{p-1} \Gamma_{iy}\Delta z_{t-1} + \Psi_y \mathbf{w}_t + \varepsilon_t,\ t = 1,2,\ldots,n \qquad (4.30)$$

where

- $z_t = (\mathbf{y}'_t, \mathbf{x}'_t)'$, $\mathbf{y}_t$ is an $m_y \times 1$ vector of jointly determined (endogenous) I(1) variables,
- $\mathbf{x}_t$ is an $m_x \times 1$ vector of exogenous I(1) variables

$$\Delta \mathbf{x}_t = \mathbf{a}_{0x} + \sum_{i=1}^{p-1} \Gamma_{ix}\Delta z_{t-i} + \Psi_x \mathbf{w}_t + \mathbf{v}_t \qquad (4.31)$$

- $\mathbf{w}_t$ is a $q \times 1$ vector of exogenous/deterministic I(0) variables, excluding the intercepts and/or trends
- the disturbance vectors ε_t and $\mathbf{v}_t$ satisfy the following assumptions:

$$\mathbf{u}_t = \begin{pmatrix} \varepsilon_t \\ \nu_t \end{pmatrix} \sim iid(0,\Sigma) \qquad (4.32)$$

where Σ is a symmetric positive-definite matrix

- the disturbances in the combined model, $\boldsymbol{u}_t$, are distributed independently of $\boldsymbol{w}_t$:

$$E(\boldsymbol{u}_t \mid \boldsymbol{w}_t) = 0 \qquad (4.33)$$

The intercept and the trend coefficients, $\mathbf{a}_{0y}$ and $\mathbf{a}_{1y}$, are $m \times 1$ vectors; Π_y is the long-run multiplier matrix of order $m_y \times m$, where $m = m_x \times m_y$; $\Gamma_{1y}, \Gamma_{2y}, \ldots, \Gamma_{p-1,y}$ are $m_y \times m$ matrices capturing the short-run dynamic effects; and Ψ_y is the $m_y \times q$ matrix of coefficients of the I(0) exogenous variables. $\boldsymbol{x}_t$ is referred to as the long-run forcing variables of the system. As in traditional VARs, cointegrating VARs can include intercepts and trends.

Given that the cointegrating VAR was developed in response to the inability of the traditional VAR to take into account cointegration among variables, it is argued that the vector error correction approach to VAR modeling is in fact a more efficient methodology. Despite this, the traditional unrestricted VAR is still being widely used in the finance literature. A number of reasons for the continued usage of the traditional VAR have been provided by Naka and Tufte (1997). Firstly, the VAR is a simpler approach to take to that of the cointegrating VAR. Secondly, the traditional VAR has continued to be advocated specifically due to its unrestricted nature. As already mentioned, the major advantage with the VAR lies in its unrestricted nature. Therefore, cointegrating VARs, to some extent, take away this advantage by applying error correction restrictions. Thirdly, limitations to a number of computer packages in implementing the cointegrating VAR acts as a deterrent to using the cointegrating VAR approach. The fourth reason is that there is no clear-cut evidence that the cointegrating VAR approach yields superior results. Naka and Tufte (1997), Clements and Hendry (1995), Hoffman and Rasche (1996) and Lin and Tsay (1996) suggest that when analysing long-run horizons, the cointegrating VAR yields more efficient results, however, in the short-run "loss of efficiency from vector autoregression estimation is not critical" (Naka & Tufte, 1997, p.1593). Finally, given the uncertainty inherent in determining cointegrating relations, imposing any restrictions based on cointegrating relations may be both unnecessary and unwise. These reasons, therefore, have to a large extent led the unrestricted VAR to remain a methodology commonly used to determine the relationship between a number of variables in much empirical research.

Given the uncertainty surrounding the added benefits of the cointegrated VAR approach, this research will conduct a multivariate analysis using the traditional unrestricted VAR. The cointegrating VAR, however, is still of interest as it provides a framework for testing for multivariate cointegration and block Granger causality between the variables in the VAR.

4.5 Multivariate Cointegration

As indicated in section 4.4, the cointegrating VAR forms the basis of tests for multivariate cointegration. Tests for cointegration within the VAR framework provides an indication of the number of cointegrating relations between the variables in the VAR. However, results from these tests provide very little economic interpretation. When finding a number of cointegrating relations, all that can be concluded is that there is a statistically significant long-term relationship between the variables in the VAR. Therefore, this study uses multivariate cointegration to provide evidence of any statistically significant long-term relationships between a number of economic variables and value and growth stock returns. The theory underlying tests for cointegrating relations within a VAR framework is described by Pesaran and Pesaran (1997) as follows.

Based on the framework for cointegrating VARS, cointegration among the variables in the VAR can be determined based on analysis of the rank of the long-run multiplier matrix, Π, in equation (4.30). Specifically, cointegration analysis is concerned with the presence of 'rank deficiency'. If, at most, the rank of Π could be equal to m_y, rank deficiency of Π can be illustrated by

$$H_r : \text{Rank}(\Pi_y) = r < m_y$$

This can be rewritten as,

$$\Pi_y = \alpha_y\beta'$$

where α_y and β are $m_y \times r$ and $m \times r$ matrices, each with full column rank, r. In the case where Π_y is rank deficient, we have $\mathbf{y}_t \sim I(1)$, $\Delta\mathbf{y}_t \sim I(0)$, and $\beta' z_t \sim I(0)$. The $r \times 1$ trend-stationary relations, $\beta' z_t$, are referred to as the cointegrating relations, and characterise the long-run equilibrium of the VECM of (4.30).

It is important to note that where a VECM includes a trend (ie. $\mathbf{a}_{1y} \neq 0$), there will generally be a trend in the cointegrating relations. This is shown in the following equation which is a combination of equations (4.30) and (4.31).

$$\Delta z_t = \mathbf{a}_0 + \mathbf{a}_1 t - \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-I} + \psi \boldsymbol{w}_t + \boldsymbol{u}_t \quad (4.34)$$

for $t = 1,2, \ldots, n$, where

$$z_t = \begin{pmatrix} y_t \\ x_t \end{pmatrix}, \quad \boldsymbol{u}_t = \begin{pmatrix} u_{yt} \\ v_t \end{pmatrix}, \quad \mathbf{a}_0 = \begin{pmatrix} \mathrm{a}_{0\mathrm{y}} \\ \mathrm{a}_{0\mathrm{x}} \end{pmatrix}, \quad \mathbf{a}_1 = \begin{pmatrix} \mathrm{a}_{1\mathrm{y}} \\ 0 \end{pmatrix}$$

$$\Pi = \begin{pmatrix} \Pi_{\mathrm{y}} \\ 0 \end{pmatrix}, \quad \Gamma_i = \begin{pmatrix} \Gamma_{iy} \\ \Gamma_{ix} \end{pmatrix}, \quad \Psi = \begin{pmatrix} \Psi_{y} \\ \Psi_{x} \end{pmatrix}$$

which is the vector error correction form of (4.1).

Whilst the cointegrating VAR requires an error correction variable, the problem is that in most situations the presence of cointegration may not be known prior to the VAR estimation. Johansen (1988), Phillips and Ouliaris (1990) and Stock and Watson (1988) have developed tests for cointegration among a group of variables. Johansen's (1988) method of identifying cointegration is undertaken in a VAR context, and is therefore of particular relevance to this research. Essentially, the Johansen procedure is a multivariate generalisation of the Dickey-Fuller test. Pesaran and Pesaran (1997) provide the following description of Johansen's Maximum Likelihood (ML) estimation of cointegrating relations.

Suppose the n observations of $z_1, z_2, \ldots, z_n$ and $\boldsymbol{w}_1, \boldsymbol{w}_2, \ldots, \boldsymbol{w}_n$ are available on the variables $z_t = (\boldsymbol{y}_t^{'}, \boldsymbol{x}_t^{'})$ and $\boldsymbol{w}_t$. By stacking the VECM in (4.30), we have

$$\Delta \mathbf{Y} = \iota_n \mathbf{a}_{0y}^{'} + \boldsymbol{t}_n \mathbf{a}_{1y}^{'} - \mathbf{Z}_{-1} \Pi_y^{'} + \Delta \mathbf{Z}_p \Gamma_y^{'} + \boldsymbol{W} \psi_y^{'} + \mathbf{E} \quad (4.35)$$

where

$$\Delta \mathbf{Y} = (\Delta \boldsymbol{y}_1, \Delta \boldsymbol{y}_2, \ldots, \Delta \boldsymbol{y}_n)^{'}$$

$$\mathbf{E} = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n)^{'}$$

$$\tau_n = (1, 1, \ldots, 1)^{'}, \quad \boldsymbol{t}_n = (1, 2, \ldots, n)^{'}$$

$$\Gamma_y = (\Gamma_{1y}, \Gamma_{2y}, \ldots, \Gamma_{p-1,y})$$

$$\Delta \mathbf{Z}_p = (\Delta \mathbf{Z}_{-1}, \Delta \mathbf{Z}_{-2}, \ldots, \Delta \mathbf{Z}_{1-p})$$

$$\Delta \mathbf{Z}_{-i} = (\Delta z_{1-i}, \Delta z_{2-i}, \ldots, \Delta z_{n-i})^{'}, \quad i = 1,2, \ldots, p-1$$

The log-likelihood function of (4.35) is given by

$$L_n(\varphi;r) = \frac{-nm_y}{2}\log 2\pi - \frac{n}{2}\left|\Sigma_y\right| - \frac{1}{2}Tr(\Sigma_y^{-1}E'E) \qquad (4.36)$$

where φ stands for the vector of the unknown parameters of the model, and r is the assumed rank of Π_y. Writing $\Pi_y = \alpha_y\beta'$ and maximising the log-likelihood function with respect to the elements of Σ_y, $\mathbf{a}_{0y}$, Γ_{iy}, $i = 1, 2, \ldots, p\text{-}1$, α_y, and ψ_y, we have the following concentrated log-likelihood function:

$$l_n^c(\beta;r) = \frac{-nm_y}{2}(1 + \log 2\pi) - \frac{n}{2}\log\left|\tilde{\Sigma}_y(\beta)\right| \qquad (4.37)$$

where

$$\left|\tilde{\Sigma}_y(\beta)\right| = \frac{\left|S_{00}\right|\left|\beta' A_n \beta\right|}{\left|\beta' B_n \beta\right|} \qquad (4.38)$$

$$A_n = S_{11} - S_{10}S_{00}^{-1}S_{01}, \text{ and } B_n = S_{11} \qquad (4.39)$$

$$S_{ij} = n^{-1}\sum_{t=1}^{n} r_{it}r_{jt}', \; i,j = 0,1 \qquad (4.40)$$

r_{0t} and r_{1t} for $t = 1, 2, \ldots, n$ are the residual vectors obtainable from the OLS regressions within the VAR system. Substituting (4.38) in (4.37) yields

$$l_n^c = \frac{-nm_y}{2}(1+\log 2\pi) - \frac{n}{2}\log\left|S_{00}\right| - \frac{n}{2}\left\{\log\left|\beta' A_n \beta\right| - \log\left|\beta' B_n \beta\right|\right\} \qquad (4.41)$$

As with traditional VAR modeling, the researcher must determine the number of variables to include in the VAR and the lag length of the variables. AIC, SBC, and log-likelihood statistics are all applicable here. Having determined the optimal lag length of the VAR, the number of cointegrating relations must be estimated. Eigenvalue and trace statistics provide the two primary measures of the number of cointegrating relations within a VAR system.

To explain the maximum eigenvalue statistic, suppose the interest is in testing the null hypothesis of r cointegrating relations

$$H_r \quad : \text{Rank}(\Pi_y) = r \qquad (4.42)$$

against the alternative hypothesis

$$H_{r+1} \quad : \text{Rank}(\Pi_y) = r + 1 \qquad (4.43)$$

$r = 0, 1, 2, \ldots, m_y - 1$, in the VECM of (4.30). The appropriate test statistic is given by the log-likelihood ratio statistic

$$LR\,(H_r|H_{r+1}) \;=\; -n\log(1-\hat{\lambda}_{r+1}) \qquad (4.44)$$

where $\hat{\lambda}_r$ is the rth largest eigenvalue of $\boldsymbol{S}_{00}^{-1}\boldsymbol{S}_{01}\boldsymbol{S}_{11}^{-1}\boldsymbol{S}_{10}$, and the matrices $\boldsymbol{S}_{00}$, $\boldsymbol{S}_{01}$, and $\boldsymbol{S}_{11}$ are defined by (4.40)

An alternative measure of cointegrating relations is the trace statistic. Trace statistics test the null hypothesis of (4.42) against the alternative of

$$H_{my} \quad : \text{Rank}(\Pi_y) = m_y \qquad (4.45)$$

for $r = 0, 1, 2, \ldots, m_y - 1$. The log-likelihood ratio statistic for this test is given by

$$LR\,(H_r|H_{m_y}) \;=\; -n\sum_{i=r+t}^{m_y}\log(1-\hat{\lambda}_{r+1}) \qquad (4.46)$$

where $\hat{\lambda}_{r+1}, \hat{\lambda}_{r+1}, \ldots, \hat{\lambda}_{m_y}$ are the largest eigenvalues of $\boldsymbol{S}_{00}^{-1}\boldsymbol{S}_{01}\boldsymbol{S}_{11}^{-1}\boldsymbol{S}_{10}$, where the matrices $\boldsymbol{S}_{00}$, $\boldsymbol{S}_{01}$, $\boldsymbol{S}_{11}$ are defined in equation (4.40).

The critical values of the eigenvalues and trace statistics are defined by equations (4.44) and (4.46) respectively and depend on $m_y - r$, m_x, whether the VECM (4.30) contains intercepts and/or trends, and whether these are restricted. It is important to note, however, that these values do not depend on the order of the VAR, p, and the stochastic properties of the I(0) exogenous variables, $\boldsymbol{w}$, at least in large samples.

AIC, SBC and Hannan-Quinn criterion (HQC) are also provided as measures of the number of cointegrating relations. These are computed for different values of the rank of the long-run matrix Π_y in (4.30). The reader is referred to Pesaran and Pesaran (1997) for the calculation of these statistics.

As when choosing the appropriate lag length, it is unlikely that all criterion will be consistent with regards to the number of cointegrating relations. There is therefore an element of subjectivity in choosing the number of cointegrating relations, however, where possible, this should be based on economic theory. (Pesaran & Pesaran, 1997).

4.6 Block Granger Causality

Another application of the VAR methodology is a test for block Granger causality. As the name implies, this is essentially a multivariate version of the bivariate causality tests described in section 3.4 of chapter 3. Similar to bivariate Granger causality, block Granger causality provides a "statistical measure of the extent to which lagged values of a set of variables are important in predicting another set of variables once lagged values of the latter set are included in the model" (Pesaran & Pesaran, 1997, p.131). Block Granger causality is therefore a test of causality between variables undertaken within a VAR framework. A log-likelihood ratio statistic provides a test for the null hypothesis of non-causality. Non-causality is where the coefficient of the jointly determined variables in the VAR are not statistically different from zero. Block Granger causality is best described by Pesaran and Pesaran (1997) as follows.

Let $z_t = (z'_{1t} z'_{2t})' z_{1t}$ and z_{2t} are $m_1 \times 1$ and $m_2 \times 1$, $(m_1 + m_2 = m)$ variables, and partition the system of equations (4.1) into the two sub-systems:

$$\boldsymbol{Z}_1 = \boldsymbol{Y}_1\boldsymbol{A}_{11} + \boldsymbol{Y}_2\boldsymbol{A}_{12} + \boldsymbol{W}\boldsymbol{A}_{13} + \boldsymbol{U}_1 \quad (4.47)$$

$$\boldsymbol{Z}_2 = \boldsymbol{Y}_1\boldsymbol{A}_{21} + \boldsymbol{Y}_2\boldsymbol{A}_{22} + \boldsymbol{W}\boldsymbol{A}_{23} + \boldsymbol{U}_2 \quad (4.48)$$

where $\boldsymbol{Z}_1$ and $\boldsymbol{Z}_2$ are the $n \times m_1$ and $n \times m_2$ matrices of observations on z_{1t} and z_{2t}, respectively; $\boldsymbol{Y}_1$ and $\boldsymbol{Y}_2$ are $n \times pm_1$ and $n \times pm_2$ matrices of observations on the p lagged values of $z_{1,t-l}$ and $z_{2,t-l}$ for $t = 1,2, \ldots, n$, $l = 1,2, \ldots, p$, respectively. The hypothesis that z_{2t} does not Granger cause z_{1t} is defined by the m_1m_2p restrictions $\boldsymbol{A}_{12} = 0$. The log-likelihood ratio statistic for the test of these restrictions is computed as,

$$LR_G\ (\boldsymbol{A}_{12} = 0) = 2\left(\log\left|\tilde{\Sigma}_R\right| - \log\left|\tilde{\Sigma}\right|\right) \quad (4.49)$$

where $\tilde{\Sigma}$ is ML estimator of Σ for the unrestricted (full) system, and $\tilde{\Sigma}_R$ is the ML estimator of Σ when the restrictions $\boldsymbol{A}_{12} = 0$ are imposed. Under the null hypothesis that $\boldsymbol{A}_{12} = 0$, LR_G is asymptotically distributed as a chi-squared variate with m_1m_2p degrees of freedom.

To summarise the methodology used in this thesis, firstly a simple bivariate analysis of the data will be undertaken. This involves return difference and regression analysis as well as cointegration and Granger causality tests. Whilst somewhat superceded in the literature by more sophisticated methodologies, these tests provide a useful starting point for examining the relationship between the variables. Vector autoregressions, however, provide the major methodological basis of this research. Vector autoregressions provide a multivariate framework for analysing the nature of the relationship between a number of variables, with impulse response functions and forecast error variance decompositions being the major byproducts of the VAR methodology. Impulse response functions show the response of the variables in the VAR to a one standard deviation shock to a chosen variable in the VAR, and in this way gives an indication of the nature of the relationship between the variables. For example, is there a positive or negative relationship between monetary policy and value and growth stock returns, and is the relationship greater or smaller for value or growth stocks. Forecast error variance decompositions indicate the relative contribution of the variables in the VAR to explaining future shocks of chosen variables in the VAR. In this way forecast error variance decompositions indicate the relative importance of the variables in explaining future value and growth stock returns. The other major use of the VAR methodology is to provide the framework for multivariate cointegration and block Granger causality tests. Like bivariate cointegration, multivariate cointegration gives an indication of any statistically significant relationship between the variables. However, unlike bivariate cointegration, multivariate cointegration provides little economic interpretation where there are cointegrating relations greater than two. In terms of this research they are used to reinforce the significance of the relationship between the variables included in the VAR. Block Granger causality provides a test for causality between variables in the VAR. That is, are a group of variables significant in causing future values of another chosen variable in the VAR. In this way, block Granger causality provides another measure of the statistical significance of the relationship between a number of economic variables and value and growth stock returns. Therefore, bivariate analysis combined with vector autoregressions serve to provide a number of alternative methods of determining the nature of the relationship between value and growth stock returns, monetary policy and economic activity.

Part Three

Data and Exploratory Analysis

Part three presents an exploratory analysis of the data over the 1990 to 1997 period in New Zealand, Australia and the US. Chapter five begins by outlining the data used in the analysis. A number of issues regarding New Zealand's Monetary Conditions Index (MCI) are discussed in section 5.2. Section 5.3 explains the construction of the value and growth stock indices, and section 5.4 explains how monetary policy stance is classified in New Zealand, Australia and the US. Section 5.5 discusses the pattern of value and growth stock returns, monetary policy stance and economic activity over 1990 to 1997 period. Finally, section 5.6 begins the statistical analysis of the value and growth stock return data.

Chapter Five

The Data, Monetary Policy Classification and Exploratory Analysis

5.1 The Data

Value and growth stock indices provide a measure of value and growth stock returns for all three countries. New Zealand value and growth stock indices were constructed by WestpacTrust Investment Services Limited. The Australian Stock Exchange Frank Russell Accumulation indices were used to measure value and growth stock returns in Australia, and the S&P/BARRA value and growth stock indices were collected for the US. Details of their construction are given in section 5.3.

Given the different nature of monetary policy implementation in New Zealand, Australia and the US, different measures of monetary policy stance were used for each country. The MCI was used for New Zealand, the cash rate for Australia, and the discount rate for the US. In addition to value and growth stock indices and monetary policy measures, a number of macroeconomic factors were also considered in this research. These included gross domestic product (GDP), a consumer prices index (CPI), short-term interest rates (INT), liquidity (M1/MB), a confidence index (CI) and a measure of exchange rates (TWI). GDP was used as the primary measure of economic activity, while the CPI was used as a measure of inflation. Short-term interest rates were measured by the 90-day bank bill rate in New Zealand, the 90-day Dealer Bill – middle rate in Australia, and the 90-day Bankers Acceptance – middle rate in the US. Liquidity was measured using the M1 monetary aggregate for New Zealand and Australia. M1 is defined as all notes and coins plus transactional balances held with the banking sector. The monetary base (MB) was used as a measure of liquidity for the US. This is similar to the M1 and includes the sum of legal reserves in the banking system plus the amount of currency and coins held by the public. The level of confidence in the economy was measured using a business confidence index for New Zealand and Australia. Confidence was measured in the US using an index of business expectations with respect to future employment. Finally, the New Zealand and Australian trade-weighted indices provided a measure of the exchange rate for New Zealand and Australia. A measure of the US dollar was obtained by weighting the US dollar 50/50 with the German Deutschemark and the Japanese Yen.

All data was collected in nominal terms and on a monthly basis. Where only quarterly data was attainable, the data was converted to a monthly basis. Due to data availability, economic data for New Zealand was collected for the period January 1990 to June 1997. Data for Australia was collected for the period January 1991 to December 1997. Data for the US was collected for the period January 1990 to December 1997.

5.2 The Monetary Conditions Index (MCI)

The Monetary Conditions Index (MCI) is an index which measures the relationship between the exchange rate and interest rates in a 2-1 framework. Because New Zealand does not use an intermediate target for implementing monetary policy, the MCI was introduced in New Zealand in 1996 with the aim to provide "an approximate measure of the state of overall monetary conditions" (RBNZ, Monetary Policy Statement, June 1997, p.25). The use of a MCI is suited to a small open economy, like that of New Zealand, where it is difficult to measure the level of aggregate monetary conditions based solely on the level of interest rates. Therefore, the introduction of the MCI was driven by the Reserve Bank's desire to provide a measure of monetary conditions that incorporated the role of both interest rates and the exchange rate in influencing the level of inflation in New Zealand. In this way the MCI has served to provide "a simple and consistent method of 'adding up' interest rate and exchange rate movements to give a better indicator of the overall stance of policy than can be captured by interest rates or the exchange rate alone" (RBNZ, Monetary Policy Statement, December 1997, p.13).

Research conducted by the Reserve Bank of New Zealand showed there exists a 2-1 relationship between changes in the TWI and changes in the interest rate as measured by the 90 day bank bill rate. That is, a 100 basis point fall in the 90-day interest rate has the same inflationary impact as a 2 per cent depreciation in the TWI. For this reason, the MCI is based on a 2-1 TWI/interest rate relationship. The Reserve Bank provides two forms of the MCI. A real MCI (inflation adjusted) and a nominal MCI (not adjusted for inflation). These are calculated as follows.

Nominal MCI = $\{(\text{90-day rate} - R_0) + (1/2)*[\log_n(TWI) - \log_n(TWI_0)]*100\}*100 + 1000$,
where 90-day and TWI are nominal rates, and R_0 and TWI_0 are corresponding averages of daily rates from the previous quarter.

Real MCI = $\{(\text{R90-day} - R_0) + (1/2)*[\log_n(RTWI) - \log_n(RTWI_0)]*100\}*100 + 1000$,
where R90-day and RTWI are the estimated real 90-day interest rate and the real TWI exchange rate. R90-day is calculated as the nominal 90-day rate less the annual inflation rate in the CPI excluding credit services. RTWI is calculated as the TWI multiplied by New Zealand's GDP deflator (interpolated from annual data) and divided by the trade-weighted average of GDP deflators of New Zealand's trading partners. R_0 and $RTWI_0$ are base levels for the previous quarter. (RBNZ, Monetary Policy Statement, June 1997, p.25).

It is important to note that given the arbitrary nature of the 1000 base level chosen for the MCI equation, the actual level of the MCI allows no interpretation of monetary conditions in its own right. What is important is the *change* in the level of the MCI. Changes in the MCI can be interpreted in light of the direction of monetary conditions desired by the RBNZ.

Whilst the MCI serves as a useful indicator of monetary conditions, it has its limitations. Firstly, the 2-1 relationship between the TWI and the 90-day bank bill rate is only an estimate which may in fact vary over time. Further, the MCI includes only two channels through which inflation may be influenced. Smets (1997) criticised the MCI as it "depends on a simple view of the transmission mechanism which may only be a poor approximation of the actual working of the economy" (Smets, 1997, p.10). For example, the reason behind changes in the TWI or interest rate may influence the level of impact these changes can have on monetary conditions. For this reason, Eika, Ericsson and Nymoen (1996) suggested that its use as a measure of monetary policy stance is limited with there being a number of variables that could impact on the level of both the exchange and interest rates. Therefore, the MCI could change despite the desired monetary policy stance remaining constant. In this context, it would be unwise to undertake an overly tight monetary policy simply in reaction to a falling MCI that could be a result of an external factor unrelated to current domestic monetary conditions.

Eika et al. (1996) summarised the limitations of the MCI as a measure of monetary policy by stating that the index is "model dependent. Both analytically and empirically, the model makes strong assumptions about parameter constancy, cointegration, dynammics, exogeneity, and the choice of variables" (Eika, Ericsson & Nymoen, 1996, p.2).

It is argued, however, that these disadvantages are outweighed by the advantages, with the RBNZ continuing to use the MCI as a measure of overall monetary conditions. Smets (1997) provided the following justification for the use of the MCI.

> "It clarifies the central bank's view of the monetary transmission mechanism. This increased transparency may be more important in a monetary policy strategy which does not rely on intermediate targets to communicate policy decisions. Moreover announcing the desired path of monetary conditions improves the transparency of the intentions of the monetary authorities and by reducing financial market volatility may make policy more effective" (Smets, 1997, p.10).

It is important to note that the MCI differs from the other data series used in this research in that it does not have zero as a lower bound. This is problematic when using logged values in the VAR analysis, as negative numbers cannot be logged. To solve this problem, 1000 has been added to each of the MCI values and in this way the index has been transformed into a positive one. Given the arbitrary addition of 1000 in the construction of the MCI index itself, it seems reasonable to add a further 1000 to obtain a positive series. The adjusted MCI series is represented by 'aMCI' in chapters six and seven of the results. The confidence index in New Zealand and Australia is also a series with no lower bound, and therefore 100 was added to this to obtain a positive series. 'aCI' represents the adjusted confidence index series for New Zealand and Australia.

5.3 Value and Growth Stock Indices

Value and growth stock indices were collected for New Zealand, Australia and the US. Because this research relies heavily on the accurate measurement of value and growth stock returns, it is necessary to consider the construction of these indices. The New Zealand value and growth indices, provided by WestpacTrust Investment Services, are constructed as follows.

All companies listed on the New Zealand stock exchange, except for property companies and index tracking funds, that form part of the NZSE gross index are eligible for inclusion in the value and growth stock indices. All eligible securities are then added together to determine the total aggregate market capitalisation. The companies are then ranked in order of market capitalisation with the top ten companies being removed to comprise a 'High Cap' index. The remaining companies are then ranked according to their price-to-book (net tangible assets) ratio. These group of stocks are then divided half-way according to market capitalisation, with these two groups comprising the 'pool' of value and growth stocks. From the pool of high price-to-book ratio (growth) companies, the highest ranking 30 companies are used to form the growth stock pool. Similarly, the first 30 (value) companies with low price-to-book ratios form the value stock pool. In situations where there are less than 30 companies, all companies are included in the value and growth stock groups. From the two pools, 20 companies with the largest *adjusted* market capitalisation are selected. These 20 companies comprise the value and growth stock indices.

The adjusted market capitalisation is the original market capitalisation following a liquidity adjustment procedure. This is where the index takes into account the liquidity of the 30 companies in the value and growth stock pool. Average required liquidity is defined as being the average monthly volume of traded securities divided by the number of securities required to hold a market capitalisation weighted portfolio of 'pool' companies' securities. This is calculated based on the previous six months figures. The average required liquidity for the individual stocks is compared to the average liquidity of the pool of stocks. The average liquidity of the pool of stocks being the average of the six monthly averages of the securities in the pool. Companies whose average liquidity lies outside three standard deviations from the pool average are considered outliers and are excluded. The pool average is then re-calculated. Any company which has an average number of securities on issue which is outside 2 standard deviations from the pool mean (including outliers) is adjusted downwards until the liquidity measure of that company (average volume traded divided by the adjusted number of securities outstanding) is within 2 standard deviations of the recalculated pool mean. It is this liquidity adjustment process that determines the adjusted market capitalisation of the stocks in the value and growth stock pools. The adjusted market capitalisation for each pool company is the adjusted number of securities outstanding multiplied by the current security price. The weighting of the companies in the index is based on the adjusted market capitalisation divided by the aggregate index adjusted market capitalisation.

Two further adjustments are made to the indices. These are referred to as the company classification procedure and the company ranking stability procedure. The company classification procedure is an adjustment made for stocks that move from the value stock pool to the growth stock pool or vice versa. Companies moving from one pool to another are only included in the new pool if they fall within one standard deviation of the mean of the new pool's price-to-book ratios. Mean and standard deviations are calculated once outliers of more than 3 standard deviations are removed. The company ranking stability procedure ensures stability in the respective indices by including new index companies in the index only if their aggregate adjusted market capitalisation is ranked 18th or higher. Old index companies are excluded from the index only if their aggregate market capitalisation is ranked 22nd or lower. The value and growth stock indices are reviewed at the end of each March, June, September and December, with the revised index taking effect on the 3rd working day following the review.

The construction of value and growth stock indices for Australia and the US follow a similar pattern to the New Zealand indices. An outline of their construction is as follows. The Australian Stock Exchange (ASX) Frank Russell value and growth stock indices provide a measure of value and growth stock returns in Australia. Stocks are included in these indices based on their Price-to-Net Tangible Assets ratio (P/NTA). Both the value and growth stock indices are constructed from all securities included in the ASX All Ordinaries index. The value stock index includes all stocks with low P/NTAs, whereas the growth stock index contains all securities in the ASX All Ordinaries index with high P/NTAs. The ASX All Ordinaries index represents approximately 95 percent of the Australian domestic equity market. In constructing these indices, all stocks in the ASX All Ordinaries index are ranked according to their Price-to-Net-Tangible Assets ratio. A non-linear probability algorithm is then applied to the distribution to determine their style member weights. 70 percent of the stocks are classified as all value stocks or all growth stocks, and 30 percent are weighted proportionately to both value and growth stocks. In terms of index maintenance, stocks deleted between reconstitution weights are not replaced. Style probabilities for intra-year changes made to the ASX All Ordinaries index are determined by the stock's P/NTA ratio.

US value and growth stock returns are measured using the S&P/BARRA value and growth stock indices. These indices determine value and growth stocks based on price-to-book ratios of all companies in the S&P 500 index. All companies are ranked according to their price-to-book ratios with the group being split so that the value stock index comprises firms with lower price-to-book ratios, and the growth stock index comprises firms with higher price-to-book ratios. Each stock within the two indices are weighted according to their proportion of market value, ie. capitalisation weight. Approximately 50 percent of the combined index capitalisation is in the value stock index and 50 percent is in the growth stock index. The indices are rebalanced semi-annually to ensure they are evenly split between value and growth stocks. The values used at the time of rebalancing are the equity's position at the close of trading one month prior. This one month lag makes it possible to invest in the indices as of the rebalancing dates. The indices are also adjusted each month to reflect additions and deletions to the larger index. At each rebalancing of the index, a cutoff value is determined based on the price-to-book ratio of the last company in the value stock index. That is the company with the highest price-to-book ratio. A company is added to the growth stock index if its price-to-book ratio is higher than the cutoff value, and added to the value stock index if it is lower than the cutoff value. Companies are deleted from the value and growth stock indices when they are deleted from the larger index.

5.4 Monetary Policy Classification

An important aspect of this research is the classification of monetary policy stance in the respective countries. Given the similar nature of monetary policy implementation in Australia and the US, classification of monetary policy stance in these two countries followed a similar approach. Changes in the cash rate for Australia, and the discount rate for the US, were used to signal changes in monetary policy stance. For example, if the discount rate was falling consistently over a two year period, that period represented a loosening monetary policy stance. This stance was considered to remain loose until a subsequent increase in the discount rate. From the day where the discount rate was increased, monetary policy was deemed to be tightening until the discount rate was once again reduced. This example applies equally to changes in the cash rate. Increases in the cash rate signaled a tightening monetary policy stance, whereas a fall in the cash rate indicated a loosening monetary policy stance.

Classification of monetary policy in New Zealand was not so straight forward. This research used the MCI as the major indication of New Zealand's monetary policy stance. There are, however, a number of ways in which the MCI can be used. This study used four methods of categorising monetary policy stance based on movements in the MCI. The first method considered single changes in the MCI. Where the MCI had fallen from one month to next, monetary policy during that month was considered to be loosening. Where the MCI had increased from one month to the next, monetary policy was considered to have been tightening. The second method was based on two consecutive changes in the MCI in the same direction. This was used as an alternative where single changes may have provided too volatile measure of monetary policy. This approach was based on the premise that if the MCI changes consistently for 2 or more months, we can safely assume that there is a strong monetary policy stance being taken by the Reserve Bank. Therefore, two months of an increasing MCI was considered to represent a period of tightening monetary policy. Under this method, all months that were not part of a two consecutive change in the MCI were excluded from the analysis. The third method of monetary policy classification was based on the second method, however, all months following a defined monetary policy stance were included in the analysis. For example, if monetary policy increased consistently for the months January, February and March, and following this, the next period of a consistent MCI change was in August and September, the period from March to August, like the period from January to March, was also considered to be tightening. Under the second approach the months from March to September would have been excluded from the analysis. This approach therefore included all months over the 1990 to 1997 period. The fourth approach considered only three directional changes in monetary policy as representing a defined stance in monetary policy. All months that involved changes of fewer than three months were excluded from the analysis. A fifth method of classifying monetary policy in New Zealand involved the use of the Reserve Bank's Monetary Policy Statements (MPS). Interpretation of these statements were based on comments made at the time of the statement, and the Reserve bank's opinion of current and future monetary policy conditions at that time.

5.5 Value and Growth Stock Returns, Monetary Policy and Economic Activity Over the 1990 to 1997 Period

New Zealand

The returns on value and growth stocks in New Zealand over the January 1990 to December 1997 period show that value stocks have outperformed growth stocks with the average monthly return of these stocks being 1.27 percent and 1.10 percent respectively. There were, however, a number of periods where growth stocks have outperformed value stocks. Over the 96 months being analysed, growth stocks have outperformed value stocks for 45 of them. During the remaining 51 months value stocks have provided superior returns. During the months where growth stocks were providing higher returns than value stocks, the average return on growth stocks was 2.68 percent, while the average return on value stocks was –0.08 percent. During periods where value stocks were outperforming growth stocks, average value stock returns were 2.45 percent per month, while average growth stock returns were –0.30 percent per month. This indicates that during periods of both higher value and growth stock returns, the superior performance of these stocks averaged 2.75 percent per month. The duration of the superior performance of growth stock returns varied between one and four months, however, there was one ten month period where growth stocks outperformed value stocks. This period was from the 30th June 1993 to 31st March 1994. In a similar fashion to growth stock returns, the duration of superior value stock returns varied from one to six months. However, unlike growth stock returns, there was no period longer than six months where value stocks persistently provided higher monthly returns.

As described in section 5.4, there are a number of methods for determining monetary policy stance in New Zealand. The four methods based on the use of the MCI, indicate there have been a number of changes in monetary policy stance over the seven and a half year period, with the number of periods of loosening monetary policy approximately equal to the number of periods of tightening monetary policy. The longest period of loosening monetary policy was from mid-1990 until the end of January 1992. The longest period of a sustained tightening monetary policy stance was from the end of March 1994 until the end of January 1995. Using the Reserve Bank's Monetary Policy Statements as an indicator of future anticipated monetary policy stance, four monetary policy stances were determined. A tightening stance was taken from May 1990 until August 1991, and from December 1992 until December 1996. A loosening stance was taken from August 1991 until December 1992, and from December 1996 until December 1997.

Business conditions over this period, as measured by GDP growth, indicate that over the January 1990 to June 1997 period there have been eight quarters where New Zealand experienced negative GDP growth. However, two consecutive quarters of negative GDP growth, the definition of a recession, occurred only twice. The first recession was in the first half of 1991, the second was in the last quarter of 1991 and the first quarter of 1992. The other quarters of negative GDP growth were during the first quarter of 1990, the third quarter of 1995, and the first quarter of 1997. Graphing New Zealand's GDP growth indicates that from the last quarter of 1992 until the second quarter of 1995, New Zealand experienced their longest period of sustained, and relatively high, economic growth.

Australia

Like New Zealand, value stocks in Australia have outperformed growth stocks over the period from January 1991 to December 1997, with their respective monthly returns being 1.57 and 0.88 percent. Over this period there have been a number of periods where value and growth stocks have outperformed each other. Over the 84 months being analysed, growth stocks outperformed value stocks for 29 of the months, while value stocks have provided higher returns during the remaining 55 months. During the months where growth stocks provided higher returns than value stocks, the average growth stock return was 3.36 percent, while the average value stock return was 2.06 percent. During periods where value stocks outperformed growth stocks, the average value stock return was 1.31 percent per month, while average growth stock returns were –0.45 percent per month. This indicates that during periods of higher growth stock returns, the average superior performance of growth stocks was 1.30 percent per month. During periods of higher value stock returns, the average superior performance of value stocks was 1.76 percent per month. The persistence of the superior performance of growth stocks varied between one and four months. The duration of superior value stock returns varied between one and seven months.

Using changes in the cash rate as an indication of monetary policy stance, a loose monetary policy stance was taken in Australia from 23 January 1990 to 17 August 1994. Over this period there were a number of decreases in the cash rate which saw the cash rate fall from 14 percent to 4.75 percent. The monetary policy stance over the 17 August 1994 to 31 July 1996 period was tight with three increases in the cash rate during 1994. Monetary policy became loose once again, from 31 July 1996 to 31 December 1997, with five decreases in the cash rate over this period.

Over the eight year period, Australia has experienced four quarters of negative economic growth, though only one recession. The two consecutive periods of negative economic growth occurred during the first half of 1991. The other times where the economy was declining was during the third quarter of 1993 and the last quarter of 1995. Analysis of Australia's GDP growth shows that Australia had a relatively high and sustained period of economic growth from the last quarter of 1993 until the third quarter of 1995. Australia also experienced a period of sustained economic growth from the second quarter of 1996 until the last quarter of 1997.

The United States of America

Unlike New Zealand and Australia, growth stocks in the US have outperformed value stocks over the period from January 1990 to December 1997, with their average monthly returns being 1.24 and 1.00 percent respectively. There were, however, a number of periods where value stocks have outperformed growth stocks. Over the 96 months being analysed, growth stocks outperformed value stocks during 47 of them, while value stocks have provided superior returns during 49 of the 96 months. During the months when value stocks outperformed growth stocks, the average value stock return was 1.28 percent, while the average growth stock return was 0.02 percent. During periods where growth stocks were outperforming value stocks, the average monthly return on growth stocks was 2.50 percent while the average monthly value stock return was 0.71 percent. This indicates that during periods of higher growth stock returns, the average superior performance of growth stocks was 1.79 percent per month. During periods of higher value stock returns, the average superior performance of value stocks was 1.25 percent per month. The persistence of the superior performance of growth stock returns varied from one to five months. The persistence of the superior performance of value stock returns also varied between one and five months.

Using the discount rate as a measure of monetary policy stance, there have been three distinct periods of different monetary policy stance in the US. A loosening stance was taken over the period January 1990 to July 2nd 1992, over which there were six reductions in the discount rate. The stance then became one of tightening over the July 2nd 1992 to January 31st 1996 period, over which there were four increases in the discount rate. The discount rate was reduced on January 31st 1996, and from January 31st 1996 to December 31st 1997 a loosening monetary policy stance was taken.

Analysis of business conditions in the US indicates that there has been, by definition, only one economic recession. This was a period where the economy experienced three consecutive periods of negative economic growth. This was during the last two quarters of 1990, and the first quarter of 1991. Only one other time during the eight year period did the US experience negative GDP growth. This was during the second quarter of 1995. Except for a short dip during the first and second quarters of 1993, analysis of GDP growth shows that from the first quarter of 1992 until the last quarter of 1994, the US experienced a period of sustained and relatively high economic growth. Growth also occurred from the third quarter of 1995 until the last quarter of 1997.

To summarise, value stocks in New Zealand and Australia have, on average, outperformed growth stocks over the 8 year period under study. Growth stocks have outperformed value stocks in Australia by an average of 0.69 percent per month, whereas the average superior performance of growth stocks in New Zealand was only 0.17 percent per month. Contrary to New Zealand and Australia, growth stocks outperformed value stocks over the same period in the US. The average superior performance of growth stocks was 0.24 percent per month. In terms of monetary policy and business cycles, the experience of the three countries was fairly similar. All three countries experienced loosening monetary conditions over the 1990 to 1992, and 1996 to 1997 periods, with tightening conditions prevailing over the period from 1994 to 1996. Over the 1992 to 1994 period conditions were defined as loosening for Australia and tightening for the US. There was not a clearly defined monetary policy stance for New Zealand over this period. In terms of business conditions, New Zealand has had twice as many periods of negative GDP growth than both Australia and the US. The US was the first to experience a recession at the end of 1990 and the beginning of 1991. With the US economy exerting a strong influence on the world economy, following the US, a recession occurred in Australia and New Zealand during the first half of 1991. New Zealand, however, took longer to recover, with there being another recession at the end of 1991 and the beginning of 1992. All three countries have experienced relatively high economic growth over the period from 1992 to 1994, and from 1996 to 1997. Once again, it appears that the US economy has led the Australian and New Zealand economies in changes in the business cycle.

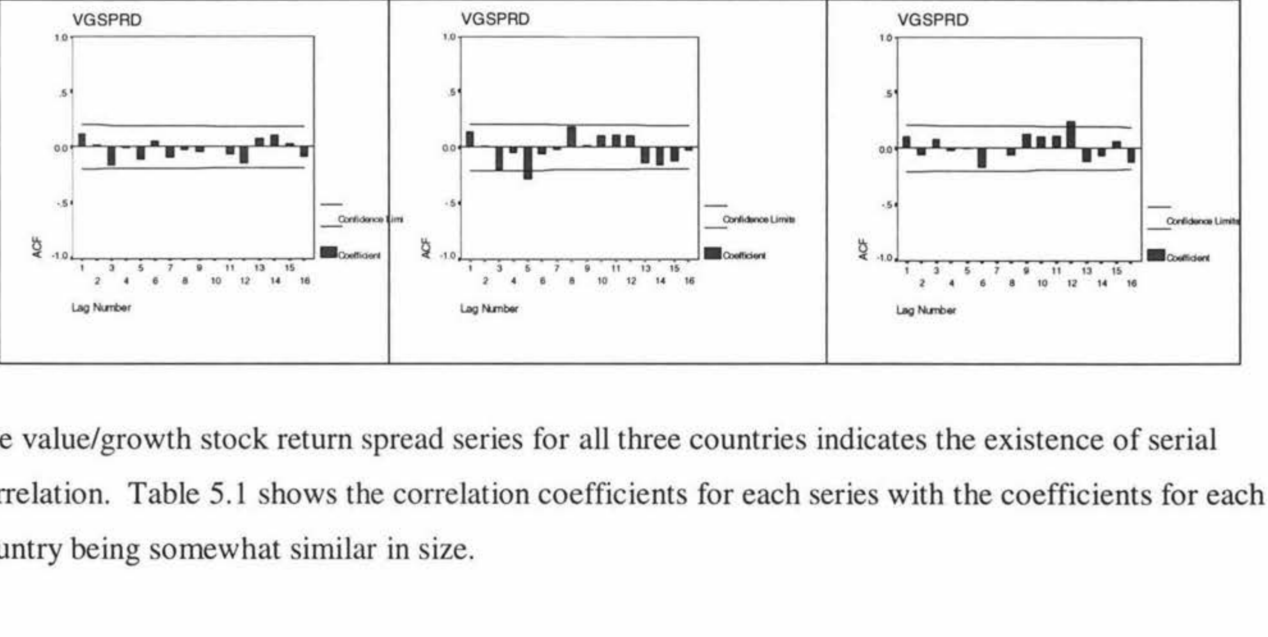
5.6 Statistical Exploratory Analysis

Analysis of value and growth stock returns in New Zealand, Australia and the US indicates the difference in their returns over the 8 year period is not statistically significant. Given this, one could argue that any attempt to isolate the different factors influencing value and growth stock returns over this period is futile. However, this research is concerned with the difference in value and growth stock returns over the shorter term, where the difference in returns may in fact hold more statistical significance.

Providing further justification for analysing the relative impact of monetary policy stance and economic conditions on value and growth stock returns, tests for serial correlation in the value/growth stock return spread series were conducted. The value/growth stock return spread series is a series of value stock returns minus growth stock returns and is referred to as the 'VGsprd' throughout this research. Serial correlation implies a lagged relationship exists between current and past observations in the series. Therefore, by testing for serial correlation in the VGsprd series, one is able to detect if a relationship exists between current and past values of the value/growth stock return spread series. By graphing the Autocorrelation Function (ACF) of the VGsprd series, a level of autocorrelation in the series is clearly visible.

Figure 5.1
ACF graphs for the difference in return on value and growth stocks in New Zealand, Australia and the US

New Zealand ACF Graph	Australia ACF Graph	The US ACF Graph



The value/growth stock return spread series for all three countries indicates the existence of serial correlation. Table 5.1 shows the correlation coefficients for each series with the coefficients for each country being somewhat similar in size.

Table 5.1
Serial correlation in the value/growth stock return spread series for New Zealand, Australia and the US

Country	Serial correlation coefficient
New Zealand	0.133
Australia	0.132
US	0.101

Like Ibbotson and Riepe (1997) we use evidence of serial correlation in the difference between value and growth stock returns to suggest there exists an underlying factor driving the relative performance of value and growth stock returns. No serial correlation between future and past values of the value/growth stock return spread would imply that the difference in value and growth stock returns varies randomly over time. That is, it is unlikely that investors would be able to anticipate when value stocks will outperform growth stocks and vice versa. Serial correlation between past and present values of the value/growth stock return spread, however, implies that the difference between value and growth stock returns does not vary randomly across time. This suggests that investors may be able to find a common factor underlying the relative performances of these two types of stocks. It is interesting to note that the level of serial correlation found in the VGsprd series for New Zealand, Australia and the US is similar to the level of serial correlation found by Ibbotson and Riepe (1997) in the US value/growth stock return spread series. Like Ibbotson and Riepe we therefore conclude that "This result gives hope to style rotators as they attempt to ascertain what underlying economic factors are driving this result" (Ibbotson & Riepe, 1997, p. 70).

Part Four

Results

Part four presents the results of this thesis and is divided into two chapters. Chapter six reviews the initial bivariate analysis. The includes the results from tests for a relationship between monetary policy and stock returns. This is primarily based on analysis of value and growth stock returns during different monetary policy periods (return difference analysis), regression analysis, bivariate cointegration and Granger causality tests. Chapter six also provides the results from further bivariate analysis which incorporates the variables interest rates and GDP into the monetary policy/stock return relationship. Similarly, these results are based on return difference and regression analysis, and cointegration and Granger causality tests. Chapter seven presents the results from the multivariate Vector Autoregression (VAR) analysis. This covers Impulse Response (IR) analysis, Forecast Error Variance (FEV) decompositions, multivariate cointegration and block Granger causality tests. All value and growth stock returns referred to throughout the following two chapters are quoted on a monthly basis.

Chapter Six

Bivariate Analysis Results

6.1 Value and Growth Stock Returns and Monetary Policy

Whilst considering the relationship between a number of economic and financial variables, the major focus of this research is on the relationship between monetary policy, and value and growth stock returns. For this reason, the analysis begins by considering the relationship between these variables in a simple bivariate context.

6.1.1 Return Differences and Regression Results

New Zealand

As already indicated, value stocks have outperformed growth stocks over the January 1990 to December 1997 period, with their average monthly returns being 1.27 and 1.10 percent respectively. These returns, however, were not significantly different from each other. Analysis of the relationship between monetary policy stance and value and growth stock returns indicate that, consistent with numerous empirical studies, both value and growth stocks perform better in a loosening monetary policy environment. This was shown consistently when comparing value and growth stock returns during loosening and tightening monetary policy periods, using the five classification techniques. This finding was also supported by the regression results which showed a significant negative relationship exists between changes in the MCI, and value and growth stock returns.

In relative terms, monetary policy stance was found to impact differently on the returns of value and growth stocks. For four out of the five monetary policy classification techniques, results suggest that value stocks perform better during tightening monetary policy periods. Conversely, growth stocks perform better than value stocks during loosening monetary conditions. These findings, however, were not supported when categorising monetary policy stance based on three directional changes in the MCI. Regressing the change in the value/growth stock return spread (value stock returns minus growth stock returns) on changes in the MCI, results indicate that a negative relationship exists between these two variables. That is, the superior performance of value stocks is smaller during periods of tightening monetary policy. It should be noted, however, that this relationship was not significant. Given these results, while inconclusive, it appears more likely that value stocks in New Zealand perform better during periods of tightening monetary policy.

Australia

Similar to the results for New Zealand, the returns on value and growth stocks in Australia over the 1991 to 1997 period show that value stocks have outperformed growth stocks. The average monthly returns for value and growth stocks were 1.57 percent and 0.88 percent respectively. The difference between value and growth stock returns over this period, however, was not significant. Consistent with expectations, returns for value and growth stocks were higher during loosening monetary policy than during tightening monetary policy. During loosening monetary policy, the average monthly value stock return was 1.81 percent, which fell to 1.18 percent during periods of tightening monetary policy. Average growth stock returns during periods of loosening monetary policy were 1.10 percent, and 0.53 percent during periods of tightening monetary policy.

In terms of the relative impact of monetary policy stance on value and growth stock returns, observing the average returns for these stocks during different monetary policy environments indicates that the superior performance of value stocks is more prominent during loosening monetary policy. As shown in table 6.2, during tightening monetary conditions value stocks continued to outperform growth stocks, however, by an average of 0.65 percent compared to 0.71 percent during loosening monetary policy. The results from the OLS regression supports this finding, with results showing a negative, although insignificant, relationship exists between value stock returns and changes in the cash rate, while a positive relationship exists between growth stock returns and changes in the cash rate. As a consequence of this, a negative relationship exists between changes in the value/growth stock return spread and changes in the cash rate which is significant at the 10 percent level. Whilst providing the first significant evidence of different impacts of monetary policy on value and growth stock returns, tests for autocorrelation in the residuals of this regression indicate the existence of autocorrelation, thereby substantially reducing the validity of this significant result. However, the negative relationship further reinforces the return difference findings that as monetary conditions become looser, the superior performance of value stocks is more prominent than during periods of tightening monetary policy.

The United States of America

As already indicated, growth stocks in the US have outperformed value stocks, with their average monthly returns being 1.24 percent and 1.00 percent respectively. The difference in their returns, however, was not statistically significant. In relation to monetary policy stance, OLS regression results indicate a negative relationship exists between growth stock returns, and monetary policy which is significant at the 10 percent level. That is, an increase in the discount rate leads to a significant decrease in growth stock returns. A negative relationship exists between monetary policy and value stock returns, however, this relationship is insignificant. A negative relationship between monetary policy and value and growth stock returns is further supported by the results which show the average returns on value and growth stocks during loosening conditions were 1.09 percent and 1.27 percent respectively, with this falling to –0.39 and 0.63 percent during tightening monetary conditions. In relative terms, the results in table 6.2 suggest that whilst growth stocks outperform value stocks during loosening and tightening monetary policy, their superior performance is greater during tightening monetary policy. During loosening periods, value stocks underperformed growth stocks on average by 0.18 percent, however, during periods of tightening monetary policy, the average underperformance of value stocks increased to 1.02 percent. These findings are inconsistent with the results from the OLS regression which show a positive relationship between the value/growth stock return spread and changes in the discount rate. The regression result indicates that during tightening of monetary policy, value stocks do relatively better than during loosening monetary policy. This result, however, was insignificant.

Comparison of the three markets is interesting. Firstly, it should be noted that the difference in average returns on value and growth stocks over the entire eight years was not significant in any of the three countries. Whilst this may cast some doubt on the purpose of continuing the analysis, it must be emphasised that this study is concerned with both the short-term and long-term impact of monetary policy stance on the relative returns on value and growth stocks. That is, the impact of monetary policy changes within the eight year period, may have a significantly different affect on the returns on value and growth stocks in the shorter term. In terms of the relationship between monetary policy and value and growth stock returns, the above analysis indicates very few significant relationships exist between any of the variables. Despite this, the above analysis can be used to infer the direction of the potential impact of monetary policy on value and growth stock returns. Given a number of potential problems inherent in OLS regression analysis, more weight is accorded the results based on analysis of value and growth stock returns during tightening and loosening monetary policy periods. In terms of the general impact of monetary policy stance on value and growth stock returns, results for all three markets are consistent in indicating a negative relationship between value and growth stock returns and monetary policy stance. That is, both value and growth stock returns are lower during tightening monetary policy than during loosening monetary policy.

In terms of the relative performance of value and growth stocks during different monetary policy environments, results for New Zealand suggest value stocks are more likely to provide superior returns during tightening monetary policy. On the other hand, results for both Australia and the US indicate that the value/growth stock return spread is smaller during periods of tightening monetary policy. That is, growth stocks perform relatively better during periods of tightening monetary policy and value stocks perform relatively better during loosening monetary conditions.

Table 6.1
OLS regression results for New Zealand, Australia and the US

Results from regressing value and growth stock returns and the change in value/growth stock return spread on the change in monetary policy. Monetary policy for New Zealand, Australia and the US being the changes in the MCI, cash rate and discount rates respectively.

Country	Value Returns		Growth Returns		ΔVGspread	
		MP		MP		MP
New Zealand	Constant	Coefficient	Constant	Coefficient	Constant	Coefficient
	0.012520	-0.000148	0.012057	-0.000183	0.00026140	-0.00003866
	(2.330)**	(-2.216)*	(2.188)**	(-2.666)**	(0.049)	(-0.582)
Australia	0.015544	-0.18254	0.0091953	0.62218	-0.0015473	-1.3610
	(3.602)**	(-0.167)	(1.875)*	(0.501)	(-0.0553)	(-1.912)*
US	0.0094854	-0.023841	0.011584	-0.037972	-0.00000006	0.0026689
	(2.730)**	(-1.379)	(2.916)**	(-1.921)*	(-0.00)	(0.201)

*Significant at the 5% level
**Significant at the 10% level

Table 6.2
Value and growth stock return differences for New Zealand, Australia and the US
Average monthly returns for value and growth stocks during periods of loosening and tightening monetary policy. Loosening and tightening periods classified as described in section 5.4 of chapter 5.

Country	Monetary Policy Stance	Value	Growth	VGspread
New Zealand				
• Single MCI changes	Loosening	2.19%	2.22%	-0.33%
	Tightening	0.07%	-0.34%	0.40%
• 2 MCI changes	Loosening	2.31%	2.40%	-0.09%
	Tightening	0.58%	0.35%	0.23%
• 2 MCI changes-all	Loosening	1.74%	1.72%	0.02%
	Tightening	0.54%	0.14%	0.39%
• 3 MCI changes	Loosening	2.60%	2.74%	-0.13%
	Tightening	-0.58%	-0.32%	-0.26%
• MPS	Loosening	2.05%	1.96%	0.08%
	Tightening	1.15%	0.80%	0.35%
Australia	Loosening	1.81%	1.10%	0.71%
	Tightening	1.18%	0.53%	0.65%
US	Loosening	1.09%	1.27%	-0.18%
	Tightening	-0.39%	0.63%	-1.02%

6.1.2 Cointegration and Granger Causality Results

Cointegration provides a method of testing for long-run relationships between the variables. The aim here is to test for cointegration between value and growth stock returns and monetary policy. The first step in testing for cointegration is to ensure the variables being tested are all of the same order and are non-stationary series. Table 6.3 provides the results from the unit root tests for value and growth stock returns, and the respective measures of monetary policy for New Zealand, Australia and the US. The results presented in table 6.3 indicate that all the series are integrated of order one. That is, they contain a unit root and therefore need to be differenced once in order to become stationary.

Table 6.3
Unit root test results
ADF-tests using logs and their differences for each series.
Starting with 8 lags and reducing the model until the highest significant lag is reached.

		Variables	Number of Lags	Trend	ADF statistic	5% Critical Value
New Zealand	Levels	Value	7	Yes	-2.8444	-3.464
		Growth	1	No	-0.75322	-2.894
		aMCI	7	No	-2.9323	-2.896
	First Differences	Value	5	No	-3.6301*	-2.896
		Growth	0	No	-7.5658*	-2.894
		aMCI	2	No	-3.3281*	-2.895
Australia	Levels	Value	0	Sig	-2.8212	-3.463
		Growth	0	Sig	-3.2839	-3.463
		Cash rate	2	No	-2.2777	-2.897
	First Differences	Value	0	No	-10.291*	-2.896
		Growth	0	No	-10.281*	-2.896
		Cash rate	1	No	-4.6503*	-2.897
US	Levels	Value	4	No	1.6166	-2.893
		Growth	4	No	1.6588	-2.893
		Discount rate	3	No	-1.9342	-2.893
	First Differences	Value	0	No	-11.251*	-2.892
		Growth	3	No	-6.2304*	-2.893
		Discount rate	2	No	-3.2518*	-2.893

*Significant at the 5% level

Given that all these series are integrated of the same order, they can all be tested for cointegration. Table 6.4 presents the results for the unit root test of the residuals from the cointegrating regressions.

Table 6.4
Unit root test of residuals from cointegrating regressions

Country	Variables	Test statistic for residuals	Critical Value
New Zealand	Value/aMCI	0.26094	-3.4051
	Growth/aMCI	0.045659	-3.0451
Australia	Value/Cash rate	-0.22042	-3.4211
	Growth/Cash rate	-1.4001	-3.4211
US	Value/Discount rate	1.1711	-3.4091
	Growth/Discount rate	1.1143	-3.4091

A significant result in table 6.4 indicates that the resulting residual series from the cointegrating regression is stationary. That is, the variables are cointegrated. Table 6.4 indicates the residuals are not stationary, and therefore we can say that none of the series are cointegrated. This result was robust to changes in the dependent variable. From this result we can conclude that no significant long-term relationships exist between value and growth stock returns and monetary policy in any of the three countries. Despite this result, causality may still exist between the variables. That is, lagged values of monetary policy may be significant in causing current value and growth stock returns. Using the Wald F-test to determine the significance of omitting lagged values of monetary policy in an equation for value and growth stock returns, results suggest that no causal relationships exist between monetary policy and value and growth stock returns in either New Zealand, Australia or the US. This is illustrated by table 6.5 which shows none of the p-values for the Wald statistic as being significant. A significant Wald statistic would suggest that the monetary policy variable has significant explanatory power in describing value and growth stock returns.

Table 6.5
Tests for Granger causality

Country	Variables	Wald Test Statistic	p-value
New Zealand	Value $\Rightarrow$ aMCI	0.27934	0.9231
	aMCI $\Rightarrow$ Value	0.63737	0.6718
	Growth $\Rightarrow$ aMCI	0.7193	0.6109
	aMCI $\Rightarrow$ Growth	0.85561	0.5148
Australia	Value $\Rightarrow$ Cash rate	0.98286	0.4344
	Cash rate $\Rightarrow$ Value	0.91664	0.4752
	Growth $\Rightarrow$ Cash rate	0.86773	0.5072
	Cash rate $\Rightarrow$ Growth	1.7187	0.1411
US	Value $\Rightarrow$ Discount rate	1.0549	0.3915
	Discount rate $\Rightarrow$ Value	0.48615	0.7857
	Growth $\Rightarrow$ Discount rate	0.78636	0.5625
	Discount Rate $\Rightarrow$ Growth	0.62908	0.6780

6.1.3 Summary

Results from the cointegration and Granger causality tests reinforce earlier findings of little significance between monetary policy, and value and growth stock returns. That is, whilst results from section 6.1.1 indicate the nature of the relationship between these variables, little significance was actually found. This suggests that perhaps macroeconomic factors other than monetary policy, or combined with monetary policy, may have a stronger influence on value and growth stock returns. Two alternative macroeconomic factors are considered in section 6.2. Interest rates and GDP. Both interest rates and GDP provide a measure of economic conditions with the aim being to determine the relationship between monetary policy, the business cycle and value and growth stock returns.

6.2 Value and Growth Stock Returns, Monetary Policy and Economic Activity

Having considered the relationship between monetary policy and value and growth stock returns, the second major focus of this research is on the relationship between monetary policy, economic activity, and value and growth stock returns. Whilst VAR analysis provides a multivariate framework for analysing the relationship between a number of variables, it is important to first establish whether there is any direct and significant bivariate link between these variables. This section therefore considers the relationship between monetary policy, GDP, interest rates, and value and growth stock returns in a bivariate context.

6.2.1 Return Differences and Regression Results

The following results are based on OLS regressions and analysis of return differences. Given a number of potential problems inherent in regression analysis, where there are conflicting results, the analysis of return differences are accorded greater weight in the conclusions made throughout this section.

New Zealand

When analysing value and growth stock returns in New Zealand, a fairly consistent pattern emerges. In absolute terms, both value and growth stocks perform better during periods of negative GDP growth, an increasing GDP growth rate and falling interest rates. This finding is supported by both analysis of return differences reported in table 6.6 and the regression results as shown in table 6.7. Of particular significance is interest rates, which is the only variable which holds a significant negative relationship with both value and growth stock returns.

Table 6.6
New Zealand value and growth stock return differences
Average monthly returns for value and growth stocks during periods of positive and negative GDP growth, and increasing and decreasing GDP growth and interest rates.

	Value	Growth	Average Spread
GDP growth			
Positive GDP	1.02%	0.85%	0.17%
Negative GDP	2.14%	2.49%	-0.35%
ΔGDP growth			
Increasing GDP	1.81%	1.56%	0.26%
Decreasing GDP	1.31%	1.48%	-0.17%
ΔInterest Rates			
Increasing interest	0.32%	-0.97%	1.28%
Decreasing interest	1.79%	2.55%	-0.76%

In relative terms, the results suggest that growth stocks outperform value stocks during periods of negative GDP growth, falling GDP growth rates and falling interest rates. This is indicated by the results of the return difference analysis. During periods of negative GDP growth, growth stocks outperform value stocks on average by 0.35 percent, and during periods of a falling GDP growth rate they outperform value stocks by 0.17 percent. However, it is during falling interest rates that growth stocks have the greatest advantage, with their average monthly returns being 0.76 percent higher than value stocks.

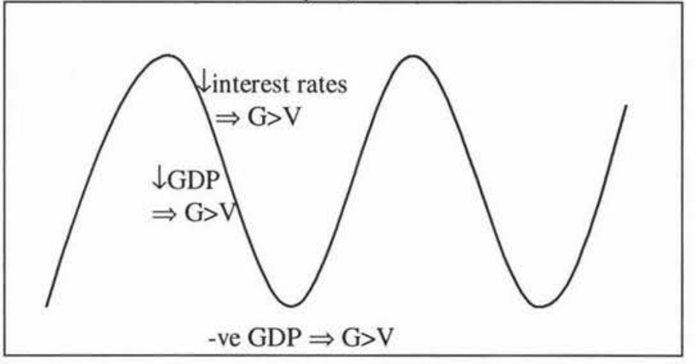
Table 6.7
New Zealand regression results
Results from regressing value stock returns, growth stock returns and the change in value/growth stock return spread on the change in the GDP growth rate and the change in interest rates.

Value Returns		Growth Returns		ΔVGSpread	
Constant	**Coefficient**	**Constant**	**Coefficient**	**Constant**	**Coefficient**
ΔGDP growth					
0.01375	1.484	0.0134	0.6267	0.0004587	-0.00773
(2.502)**	(1.199)	(2.331)**	(0.484)	(0.086)	(-0.006)
ΔInterest					
0.1094	-3.022	0.009528	-4.499	0.000938	0.6526
(2.035)**	(-2.637)**	(1.785)*	(-3.952)**	(0.173)	(0.568)

* significant at 10% level
**significant at 5% level

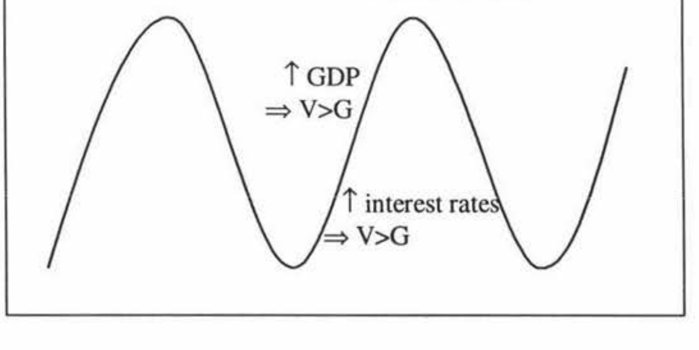
Combing these relationships, figure 6.1 places the periods where growth stocks outperform value stocks in a business cycle context. The peaks in figure 6.1 represent the peak of the business cycle (ie where GDP growth is high) and the lowest point represents a trough in the business cycle.

Figure 6.1
Periods where growth>value in relation to the business cycle, New Zealand



From figure 6.1 we can visualise the relationship between GDP, interest rates, and value and growth stock returns. It appears that growth stocks outperform value stocks during a downturn in the business cycle. That is, where the GDP growth rate is falling and eventually becomes negative. Placing interest rates in the context of figure 6.1, regression analysis indicates that a positive relationship exists between changes in the interest rate, and changes in the GDP growth rate. This suggests that as the GDP growth rate falls, so too do interest rates. This is consistent with the result suggesting that growth stocks perform better during periods of falling interest rates. Figure 6.2 indicates the periods where value stocks have outperformed growth stocks. This occurs during the opposite phase of the business cycle. That is, where the GDP growth rate and interest rates are increasing, and the economy is experiencing positive GDP growth.

Figure 6.2
Periods where value>growth in relation to the business cycle, New Zealand



Figures 6.1 and 6.2 allow an intuitive interpretation of the relationship between the business cycle and monetary policy. Both figures suggest that in anticipation of an economic downturn, a loosening monetary policy stance is taken and interest rates fall. When an economic upturn is

anticipated, a tightening stance will be taken and interest rates will increase at the same time as the GDP growth rate is increasing. With interest rates falling during loosening monetary policy, this result supports the results from section 6.1 where growth stocks were found to perform better than value stocks during loosening monetary policy.

Australia

When analysing value and growth stock returns in Australia on an absolute basis, there is evidence that both stock groups perform better during periods of negative GDP growth, increasing GDP growth rates and decreasing interest rates. This is supported by the results presented in tables 6.8 and 6.9.

Table 6.8
Australian value and growth stock return differences
Average monthly returns for value and growth stocks during periods of positive and negative GDP growth, and increasing and decreasing GDP growth and interest rates.

	Value	Growth	Average Spread
GDP growth			
Positive GDP	1.35%	0.48%	0.87%
Negative GDP	2.91%	3.20%	-0.29%
ΔGDP growth			
Increasing GDP	1.75%	1.07%	0.68%
Decreasing GDP	1.39%	0.66%	0.73%
ΔInterest rates			
Increasing interest rates	0.06%	-0.64%	0.71%
Decreasing interest rates	2.54%	1.75%	0.78%

In relative terms, results from table 6.8 suggest that growth stocks perform better than value stocks only during periods of negative GDP growth. Value stocks perform better during all other periods. The difference between value and growth stock returns, however, is smallest during periods of increasing GDP growth rates and increasing interest rates. In terms of the regression analysis, the relationship between changes in the GDP growth rate and the relative performances of value and growth stocks was less clear with regression results not supporting the finding of a smaller value/growth stock return spread being associated with an increasing GDP growth rate. However, as already mentioned, more weight has been accorded to the return difference analysis results.

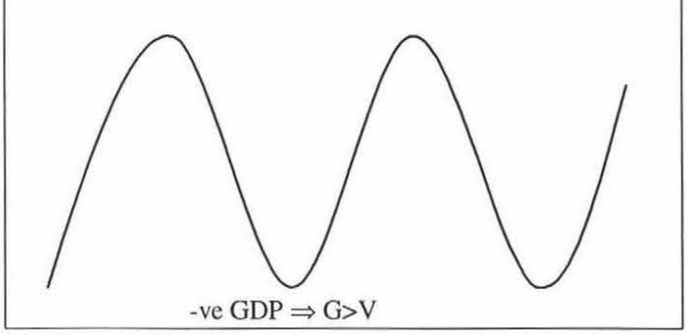
Table 6.9
Australian regression results
Results from regressing value stock returns, growth stock returns, and the change in the value/growth stock return spread on the change in the GDP growth rate and the change in interest rates.

Value Returns		Growth Returns		ΔVGSpread	
Constant	**Coefficient**	**Constant**	**Coefficient**	**Constant**	**Coefficient**
ΔGDP growth					
0.015698	0.64303	0.0086413	0.93217	-0.00061162	1.4656
(3.733)**	(0.360)	(1.807)	(0.459)	(-0.220)	(1.124)
ΔInterest					
0.012637	-3.6491	0.0055834	-3.6489	0.00074769	-0.38696
(3.070)**	(-3.037)**	(1.177)	(-2.635)**	(-0.260)	(-0.462)

* significant at 10% level
**significant at 5% level

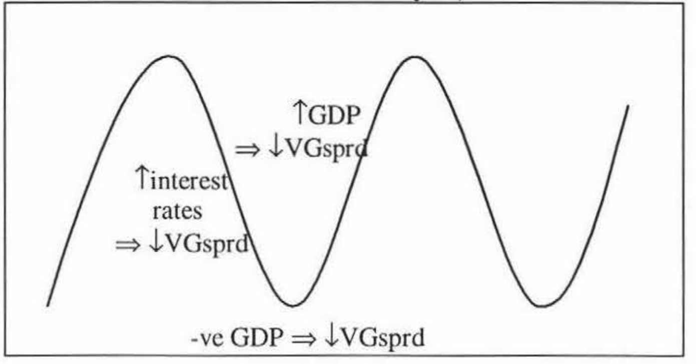
Figure 6.3 shows the periods where growth stocks have outperformed value stocks in relation to the business cycle. It indicates that it is only at the bottom of the business cycle that growth stocks have outperformed value stocks. During all other periods being analysed, value stocks have consistently outperformed growth stocks.

Figure 6.3
Periods where growth>value in relation to the business cycle, Australia



Whilst value stocks have provided consistently superior returns during all periods except during periods of negative GDP growth, figure 6.4 considers the environment in which the superior performance of value stocks is smallest. This occurs during the beginning of an economic upturn. That is, where the economy may still be experiencing negative growth, however, the economy is beginning to pick up.

Figure 6.4
Periods where the value/growth spread is the smallest in relation to the business cycle, Australia



In terms of the relationship between changes in interest rates and the GDP growth rate, regression results indicate that a negative relationship exists between the two variables. That is, interest rates increase as the GDP growth rate falls. This is contrary to previous results suggesting the superior performance of value stocks is less prominent during periods of both increasing interest rates and increasing GDP growth rates. It should be remembered, however, that this result itself was not entirely clear, with the regression and return difference analysis providing conflicting results. In addition to this, the differences in the value/growth stock return spread during both increasing and decreasing GDP growth rates and interest rates, is not large. It appears, therefore, that whilst we cannot be entirely certain of the relationship between changes in the GDP growth rate and interest rates, and the relative performance of value and growth stocks, it is clear that growth stocks provide superior returns during periods of negative GDP growth.

The United States of America

In absolute terms, value stocks in the US perform better during periods of positive GDP growth, falling GDP growth rates and falling interest rates. Growth stock returns follow a similar pattern, with the exception being that growth stocks perform better during periods of negative GDP growth.

Table 6.10
US value and growth stock return differences
Average monthly returns for value and growth stocks during periods of positive and negative GDP growth, and increasing and decreasing GDP growth and interest rates.

	Value	Growth	Average Spread
GDP growth			
Positive GDP	1.06%	1.26%	-0.20%
Negative GDP	0.87%	1.49%	-0.63%
ΔGDP growth			
Increasing GDP	1.00%	1.19%	-0.20%
Decreasing GDP	1.20%	1.44%	-0.24%
ΔInterest rates			
Increasing interest rates	-0.24%	0.51%	-0.75%
Decreasing interest rates	1.77%	1.70%	0.07%

In relative terms, growth stocks have outperformed value stocks during all periods except where interest rates are falling. During falling interest rates, value stocks outperformed growth stocks by an average 0.07 percent. Despite the fact that growth stocks were the superior performing class of stocks over this period, analysis of the value/growth stock return spread suggests that the superior performance of growth stocks is more prominent during periods of negative GDP growth, a decreasing GDP growth rate and increasing interest rates. These findings are reported in table 6.10. Note, however, that results from the regression analysis only support the finding for the negative relationship between interest rates and the value/growth stock return spread. Conflicting results are suggested for the GDP variable.

Table 6.11
US regression results
Results from regressing value stock returns, growth stock returns, and the change in value/growth stock return spread on the change in the GDP growth rate and the change in interest rates.

Value Returns		Growth Returns		ΔVGSpread	
Constant	**Coefficient**	**Constant**	**Coefficient**	**Constant**	**Coefficient**
ΔGDP growth					
0.010760	0.41144	0.013362	1.8777	-0.0000595	-0.19862
(3.128)**	(0.149)	(3.386)**	(0.591)	(-0.022)	(-0.093)
ΔInterest					
0.0086787	-4.8499	0.011139	-4.5991	-0.00041216	-1.3800
(2.608)**	(-3.297)**	(2.848)**	(-2.660)**	(-0.155)	(-1.176)

* significant at 10% level
**significant at 5% level

The relationship between value and growth stock returns and certain aspects of the business cycle are presented in figures 6.5 and 6.6. Figure 6.5 shows the one period where value stocks have outperformed growth stocks. That is, during falling interest rates. In relation to the business cycle, regression results indicate that a positive relationship exists between the two. For this reason, falling interest rates in figure 6.5 are associated with falling levels of the GDP growth rate.

Figure 6.5
Periods where value>growth in relation to the business cycle, US

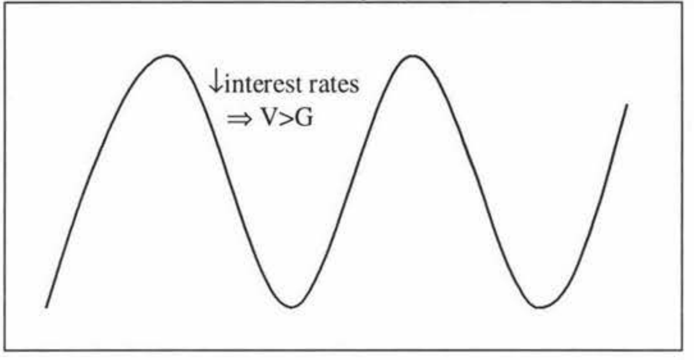
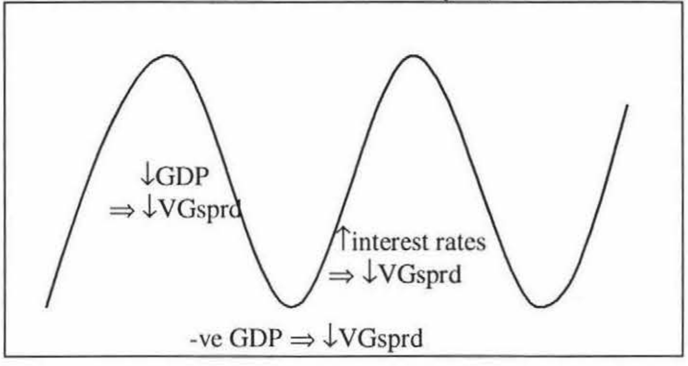


Figure 6.6 shows the periods where the spread between value and growth stock returns was the smallest. That is, the periods where the superior returns of growth stocks was typically greater. The results displayed in figure 6.6 give a somewhat conflicting picture. Whilst growth stocks have typically done better during periods of increasing interest rates, they also appear to provide higher returns during periods of a falling GDP growth rate. Given the relationship found between changes in interest rates and the GDP growth rate, this is a somewhat conflicting result. It could, however, be explained by the small difference in the value/growth stock return spread during periods of increasing and decreasing GDP growth rates. During periods of an increasing GDP growth rate, growth stocks provide on average 0.20 percent higher returns than value stocks. During periods of a decreasing GDP growth rate, growth stocks provide returns 0.24 percent higher than value stocks. One could conclude therefore that the impact of an increasing or decreasing GDP growth rate on the relative performances of value and growth stocks is somewhat negligible. The impact of interest rates and the level of GDP growth is certainly more clear. During periods of increasing interest rates, growth stocks provide 0.75 percent higher returns than value stocks. During falling interest rates, value stocks provide on average 0.07 percent higher returns. Similarly, during periods of positive GDP growth, growth stocks outperform on average by 0.20 percent, however, during negative GDP growth, this increases to an average of 0.63 percent. We therefore conclude that interest rates and the level of GDP growth are far more significant factors driving the relative performances of value and growth stocks in the US than changes in the GDP growth rate.

Figure 6.6
Periods where the value/growth spread is the smallest in relation to the business cycle, US



To summarise, results from New Zealand indicate that growth stocks provide higher returns than value stocks following falls in the GDP growth rate and interest rates, and during periods of negative GDP growth. Results from both Australia and the US are less clear. In terms of Australia, it is only possible to conclude that growth stocks provide higher returns than value stocks during periods of negative GDP growth. There did not appear to be a significant impact on the relative performances of value and growth stocks due to changes in the GDP growth rate and interest rates. Results from the US similarly did not provide much information regarding the impact of changes in the GDP growth rate on the relative performances of value and growth stock returns. Results, however, indicate that growth stocks are more likely to provide higher returns than value stocks during periods of increasing interest rates and negative GDP growth. It therefore appears that there is some consistency across the three countries. Whilst, analysis did not always provide definitive answers regarding all the variables, it seems somewhat clear that growth stocks outperform value stocks during periods of negative GDP growth in all three countries. In terms of interest rates, conflicting results exist between New Zealand and the US. Growth stocks in New Zealand appear to outperform value stocks during periods of falling interest rates, with growth stocks in the US providing relatively higher returns during periods of increasing interest rates. This is consistent with results from section 6.1, where growth stocks in New Zealand were shown to perform better than value stocks during periods of loosening monetary policy. Conversely, growth stocks in the US were shown to provide superior returns during periods of tightening monetary policy.

6.2.2 Cointegration and Granger Causality Results

This section tests for the existence of cointegration and causality between the variables GDP, interest rates, monetary policy, and value and growth stock returns, in a bivariate framework. Table 6.12 provides the results for the unit root tests of the variables GDP and interest rates. These results suggest that GDP in New Zealand is an I(2) series. GDP in the US and Australia are I(1) series, as are interest rates in all three markets.

Table 6.12
Unit root tests for the interest rate and GDP series for New Zealand, Australia and the US
ADF test for unit root. Using logged values and their differences. Tests starting with 8 lags and reducing until significant lag is reached. All variables tested for serial correlation in the residuals of the ADF model.

Country		Variables	Number of Lags	Trend	ADF Statistic	5% Critical Value
New Zealand	Levels	Interest rates	3	No	-1.9912	-2.895
		GDP	7	Yes	-2.9606	-3.464
	First differences	Interest rates	5	No	-3.2142*	-2.896
		GDP	6	No	-2.0212	-2.896
	Second Differences	GDP	5	No	-9.8479*	-2.896
Australia	Levels	Interest rates	2	No	-2.2653	-2.897
		GDP	4	Yes	-2.5906	-3.466
	First differences	Interest rates	1	No	-4.5930*	-2.897
		GDP	3	No	-4.2668*	-2.898
US	Levels	Interest rates	1	No	-1.6505	-2.892
		GDP	1	Yes	-3.1294	-3.457
	First differences	Interest rates	0	No	-7.5631*	-2.892
		GDP	0	No	-3.3423*	-2.892

*Significant at 5% level

Given that cointegration can only be tested between variables that are integrated of the same order, tests for cointegration between GDP and the variables, interest rates and value and growth stock returns for the New Zealand market could not be undertaken. Cointegration tests, however, were able to be undertaken between all the variables for Australia and the US. In addition to this, because the measure of monetary conditions in New Zealand, the MCI, is constructed using interest rates themselves, tests for cointegration between monetary policy and interest rates was not possible for New Zealand.

Table 6.13 indicates that no cointegration exists between any of the variables tested in the New Zealand and US markets. Cointegration did, however, exist between value stock returns and GDP in

Australia. This indicates that value stocks hold a long-term relationship with GDP. It should be noted, however, that this result was not robust when changing the order of the two variables in the cointegration test. Cointegration was also found to exist between the Australian cash rate and changes in the interest rate. Given the ability of monetary policy to influence short-term interest rates, this result is not surprising. It is interesting to note, however, that there was no cointegration found between the discount rate and interest rates in the US.

Table 6.13
Test of residuals from cointegrating regressions

Country	Variables	Test statistic for residuals	Critical Value
New Zealand	Value/Interest	0.15947	-3.4051
	Growth/Interest	-0.28484	-3.4051
Australia	Value/Interest	-0.18883	-3.4211
	Growth/Interest	-1.3586	-3.4211
	Cash rate/interest	-5.0816*	-3.4211
	Value/GDP	-3.5126*	-3.4211
	Growth/GDP	-3.3592	-3.4211
	Interest/GDP	-2.1182	-3.4211
	Cash rate/GDP	-2.1491	-3.4211
US	Value/Interest	1.2758	-3.4091
	Growth/Interest	1.1804	-3.4091
	Discount rate/interest	-2.9945	-3.4091
	Value/GDP	-1.9763	-3.4091
	Growth/GDP	-1.3687	-3.4091
	Interest/GDP	-1.5851	-3.4091
	Cash rate/GDP	-1.3881	-3.4091

Whilst cointegration may not exist between the variables, causality may still be present. Table 6.14 shows the results from the tests for Granger causality between value stock returns, growth stock returns, interest rates, monetary policy and GDP. As shown in table 6.14, results for New Zealand suggest that interest rates Granger cause growth stock returns, and monetary policy causes GDP. This is consistent with the results for Australia where interest rates were also significant in causing growth stock returns, and monetary policy was significant in causing GDP. Results for the US suggest only one pair of variables hold a causal relationship. Specifically, interest rates were found to cause the discount rate. This may appear unusual given the use of the discount rate to cause changes in the interest rate, however, this may merely reflect the markets anticipation of any changes in the discount rate.

The main conclusion from the causality tests is that in Australia and New Zealand, growth stocks are more significantly affected by movements in interest rates than value stocks. In addition to this, monetary policy in New Zealand and Australia tend to lead changes in economic growth. There was, however, no significant causality between these variables in the US.

Table 6.14
Granger causality test results
All variables logged and differenced until stationary.
5 lags used as a starting point for regression.

Country	Variables	Wald Test Statistic	p-value
New Zealand	Value ⇒ Interest	0.11514	0.9887
	Interest ⇒ Value	0.72827	0.6043
	Growth ⇒ Interest	0.40425	0.8444
	Interest ⇒ Growth	2.0217	0.0847*
	Value ⇒ GDP	0.62381	0.6820
	GDP ⇒ Value	1.1856	0.3239
	Growth ⇒ GDP	0.65951	0.6552
	GDP ⇒ Growth	1.0637	0.3871
	Interest rate ⇒ GDP	0.73056	0.6027
	GDP ⇒ Interest rate	1.1476	0.3430
	aMCI ⇒ GDP	2.2459*	0.0582*
	GDP ⇒ aMCI	1.4552	0.2147
Australia	Value ⇒ Interest	1.3617	0.2491
	Interest ⇒ Value	1.5271	0.1920
	Growth ⇒ Interest	0.87086	0.5051
	Interest ⇒ Growth	2.1404	0.0701*
	Interest ⇒ Cash rate	1.0551	0.3927
	Cash rate ⇒ Interest	1.0255	0.4095
	Value ⇒ GDP	1.0346	0.4045
	GDP ⇒ Value	1.1305	0.3521
	Growth ⇒ GDP	0.81535	0.5428
	GDP ⇒ Growth	1.882	0.1079
	Interest rate ⇒ GDP	1.3193	0.2662
	GDP ⇒ Interest rate	0.93233	0.4654
	Cash rate ⇒ GDP	2.3461	0.0501*
	GDP ⇒ Cash rate	0.52065	0.7598
US	Value ⇒ Interest	1.3087	0.2682
	Interest ⇒ Value	0.62495	0.6811
	Growth ⇒ Interest	0.62366	0.6821
	Interest ⇒ Growth	0.22127	0.9524
	Interest ⇒ Discount rate	3.1938	0.0110**
	Discount rate ⇒ interest	0.9652	0.4439
	Value ⇒ GDP	0.85925	0.5121
	GDP ⇒ Value	0.48221	0.7886
	Growth ⇒ GDP	0.74418	0.5926
	GDP ⇒ Growth	0.78444	0.5639
	Interest rate ⇒ GDP	1.4505	0.2149
	GDP ⇒ Interest rate	1.2704	0.2844
	Cash rate ⇒ GDP	1.7942	0.1228
	GDP ⇒ Cash rate	1.4625	0.2111

* significant at 10%
**significant at 5%

6.2.3 Summary

To summarise, results from this section indicate a number of relationships exist between monetary policy, GDP, interest rates, and value and growth stock returns. Results suggest that growth stocks in all three countries are more likely to provide higher returns than value stocks during periods of negative GDP growth. In relation to interest rates, however, growth stocks perform better in New Zealand during falling interest rates, whereas growth stocks in the US perform better during periods of increasing interest rates. Results for Australia were unclear.

Tests for cointegration and causality indicate the level of significance of these relationships. These results suggest that most of these relationships are insignificant with no cointegration found between any of the variables in New Zealand or the US. In addition to this, the cointegration found between Australian value stock returns and GDP was not robust to changes in the ordering of the variables. Causality tests did, however, provide some significant and consistent results. These suggest that for both New Zealand and Australia, interest rates have a significant causal effect on growth stock returns. In terms of macroeconomic factors, the MCI in New Zealand and the cash rate in Australia were both found to be significant in causing changes in GDP.

Despite some significant results, there is a lack of significance in many of the relationships tested thus far. Whilst the analysis in this chapter has been invaluable in obtaining a general feel for the relationships that exist between the variables, this lack of significance should serve to reinforce the caution with which the results should be interpreted. Therefore, in an attempt to enhance the credibility of the above conclusions, vector autoregressions will now be undertaken to provide a multivariate framework for understanding the relationships between value and growth stock returns and a number of economic variables.

Chapter Seven

Multivariate Analysis Results

7.1 Unit Root Test Results

Tables 7.1 – 7.3 provide the results from the unit root tests for all variables used in the VAR for all three countries.

Table 7.1
Unit root tests for New Zealand

ADF test for unit root. Using logged values and their differences. Tests starting with 8 lags and reducing until significant lag is reached. All variables tested for serial correlation in the residuals of the ADF model.

	Variables	Number of Lags	Trend	ADF statistic	5% Critical Value
Levels	Confidence Index	6	No	-1.5062	-2.896
	Value	7	Yes	-2.8444	-3.464
	Growth	1	No	-0.75322	-2.894
	Interest	3	No	-1.9912	-2.895
	TWI	0	No	-0.1114	-2.894
	M1	7	Yes	-2.9316	-3.464
	CPI	1	Yes	-2.0260	-3.460
	GDP	7	Yes	-2.9606	-3.464
	aMCI	7	No	-2.9323	-2.896
First Differences	Confidence Index	5	No	-3.4819*	-2.896
	Value	5	No	-3.6301*	-2.896
	Growth	0	No	-7.5658*	-2.894
	Interest	5	No	-3.2142*	-2.896
	TWI	0	No	-10.418*	-2.894
	M1	0	No	-12.692*	-2.894
	CPI	0	No	-5.2936*	-2.894
	GDP	6	No	-2.0212	-2.896
	aMCI	2	No	-3.3281*	-2.895
Second Differences	GDP	5	No	-9.8479*	-2.896

* Significant at 5%

Table 7.2
Unit root tests for Australia

ADF test for unit root. Using logged values and their differences. Tests starting with 8 lags and reducing until significant lag is reached. All variables tested for serial correlation in the residuals of the ADF model.

	Variables	Number of Lags	Trend	ADF statistic	5% Critical Value
Levels	Confidence Index	4	No	-2.7562	-2.898
	Value	0	Yes	-2.8212	-3.463
	Growth	0	Yes	-3.2839	-3.463
	Interest	2	No	-2.2653	-2.897
	TWI	0	No	-1.4507	-2.896
	M1	0	No	-0.5202	-2.896
	CPI	1	Yes	-2.1879	-3.464
	GDP	4	Yes	-2.5906	-3.466
	Cash Rate	2	No	-2.2777	-2.897
First Differences	Confidence Index	3	No	-3.6643*	-2.898
	Value	0	No	-10.291*	-2.896
	Growth	0	No	-10.281*	-2.896
	Interest	1	No	-4.5930*	-2.897
	TWI	0	No	-7.3346*	-2.896
	M1	0	No	-9.0248*	-2.896
	CPI	0	No	-2.4312	-2.896
	GDP	3	No	-4.2668*	-2.898
	Cash Rate	1	No	-4.6503*	-2.897
Second Differences	CPI	0	No	-8.9501*	-2.897

*Significant at 5%

Table 7.3
Unit root tests for the US

ADF test for unit root. Using logged values and their differences. Tests starting with 8 lags and reducing until significant lag is reached. All variables tested for serial correlation in the residuals of the ADF model.

	Variables	Number of Lags	Trend	ADF statistic	5% Critical Value
Levels	Confidence Index	7	Yes	-2.7244	-3.460
	Value	4	No	1.6166	-2.893
	Growth	4	No	1.6588	-2.893
	Interest	1	No	-1.6505	-2.892
	TWI	1	No	-1.6115	-2.892
	Monetary Base	1	No	-2.5302	-2.892
	CPI	3	Yes	-3.2154	-3.458
	GDP	1	Yes	-3.1294	-3.457
	Discount Rate	3	No	-1.9342	-2.893
First Differences	Confidence Index	6	No	-3.3348*	-2.894
	Value	0	No	-11.251*	2.892
	Growth	3	No	-6.2304*	-2.893
	Interest	0	No	-7.5631*	-2.892
	TWI	0	No	-7.7965*	-2.892
	Monetary Base	0	No	-4.8481*	-2.892
	CPI	4	No	-3.1329*	-2.893
	GDP	0	No	-3.3423*	-2.892
	Discount Rate	2	No	-3.2518*	-2.893

*Significant at 5%

7.2 VAR Results

New Zealand

When analysing the relationship between the variables listed in table 7.1, two approaches were required for the New Zealand analysis. Because the MCI is made up of both interest rates and the exchange rate, it is not possible to include these three variables in the VAR together. For this reason, two VARs were constructed for New Zealand. One that includes interest rates and the exchange rate separately, and one which includes the MCI, but not interest rates or the exchange rate.

Firstly, using the MCI-version of the VAR, table 7.4 provides the generalised Forecast Error Variance (FEV) decompositions for value and growth stock returns for forecast horizons up to fifteen months.

Table 7.4
Generalised forecast error variance decompositions, New Zealand
MCI-version of VAR
All variables in logged differences and stationary. Variables in following order: aCI, Val, Grth, aMCI, M1, CPI, GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR.

		By Innovations In						
Variables Explained	Forecast Period	ACI	Val	Grth	aMCI	M1	CPI	GDP
Value	1	0.0084	0.6051	0.3104	0.0460	0.0028	0.0152	0.0122
	4	0.0109	0.5940	0.3063	0.0463	0.0032	0.0268	0.0125
	8	0.0115	0.5907	0.3052	0.0465	0.0033	0.0302	0.0125
	12	0.0116	0.5902	0.3051	0.0466	0.0033	0.0308	0.0125
	15	0.0116	0.5901	0.3050	0.0466	0.0033	0.0309	0.0125
Growth	1	0.0093	0.2996	0.5985	0.0527	0.0081	0.0216	0.0101
	4	0.0138	0.2916	0.5824	0.0553	0.0099	0.0366	0.0103
	8	0.0146	0.2896	0.5792	0.0555	0.0099	0.0409	0.0102
	12	0.0147	0.2892	0.5787	0.0556	0.0099	0.0417	0.0102
	15	0.0148	0.2892	0.5786	0.0556	0.0099	0.0418	0.0102

Results suggest that 4.6 percent of the 1-month FEV of value stock returns are explained by innovations in the MCI. Inflation is the second most important variable explaining 1.52 percent of the 1-month FEV for value stock returns. Next is GDP, explaining 1.22 percent. Following GDP, the last two variables in descending order of importance are the confidence index and our measure of liquidity, M1. The combined percentage of FEV explained by the variables, inflation, GDP, the confidence index and M1 is 3.86 percent, which is less than that explained by the MCI. It is therefore concluded that out of the five macroeconomic variables, monetary policy plays the most significant role in explaining the 1-month FEV of value stock returns. The ability of all the variables in the VAR to explain the FEV increases with an increase in the forecasting period. Whilst the relative ability of the variables to explain the FEV over a longer time-frame remains the same as that over the shorter time-frame, their percentage of FEV changes somewhat. Whilst the MCI is still the most important variable, explaining 4.66 percent of the 12-month FEV of value stock returns, inflation now explains 3.08 percent. The explanatory power of GDP, however, only increases to 1.25 percent which is followed closely by the confidence index which explains 1.16 percent. Finally, the explanatory power of M1 remains relatively low, explaining only 0.33 percent of the 12-month forecast error variance.

Like value stocks, monetary policy plays the greatest role in explaining the 1-month FEV of growth stock returns at 5.27 percent. Following this is inflation and GDP, with each explaining 2.16 percent and 1.01 percent respectively. The level of business confidence explains 0.93 percent and M1 explains only 0.81 percent. Considering a 12-month forecasting horizon, the MCI still explains the greatest proportion of the FEV of growth stock returns, with their percentage of FEV increasing to 5.56 percent. Inflation still provides the second greatest explanation of FEV, with this increasing to 4.17 percent. GDP no longer plays such an important role over the longer term, with the level of business confidence explaining 1.47 percent followed by GDP explaining 1.02 percent. Looking at the longer term horizon, liquidity still only explains a very small proportion of growth stock returns. The percentage of FEV for M1 is 0.99 percent.

Comparing the percentage of FEVs for value and growth stock returns, results suggest that monetary policy plays the largest role in determining value and growth stock returns with growth stocks being slightly more influenced by monetary policy than value stocks. In fact, for both the 1-month and 12-month forecasting horizons, all variables except GDP explain a greater proportion of growth stock returns than value stock returns. Results indicate that inflation is also a significant factor in determining the returns of both stock groups, with their percentage of FEV not far behind that of monetary policy. GDP and the confidence index come next in explanatory power for both stock groups, and M1 appears to lack much explanatory power for either value or growth stock returns.

Having determined the level of influence the various variables have on value and growth stock returns, it is of interest to determine the nature of the relationship between the variables. Impulse Response (IR) functions provide information regarding the impact of a one standard deviation positive shock to one of the variables in the VAR, on the other variables in the VAR. Table 7.5 provides the impulse response results to these shocks at time zero.

Table 7.5
Generalised impulse response functions, New Zealand
MCI-version of VAR
All variables in logged differences and stationary. Variables in following order: aCI, Val, Grth, aMCI, M1, CPI, GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR.

Variables	Response Variables						
Shocked	aCI	VAL	GRTH	aMCI	M1	CPI	GDP
aCI	5.0655	-0.1837	-0.0974	0.2038	-0.1971	0.0051	0.0254
aMCI	0.3641	-0.5732	-0.6251	2.8356	0.0279	0.0007	0.0099
M1	-0.7592	-0.1461	-0.0579	0.0601	1.3154	-0.0011	-0.0176
CPI	0.8655	-0.1757	-0.2554	0.0671	-0.0483	0.0300	-0.0234
GDP	0.6572	0.2636	0.1832	0.1434	-0.1183	-0.0036	0.1956

From table 7.5 we see that a positive innovation in the confidence index has a negative impact on both value and growth stock returns, with the impact being larger for value stocks. As expected, tightening monetary policy has a negative impact on value and growth stock returns with growth stocks being more adversely affected by these innovations than value stocks. Liquidity has a negative impact on both value and growth stock returns with the impact being greater for value stocks. Inflation holds a negative relationship with both value and growth stock returns and this is greater for growth stocks than for value stocks. Finally, a positive innovation in GDP has a positive impact on value and growth stock returns, with this being greater for value stocks. The difference in value and growth stock return responses is similar for all of the shocked variables.

Having determined the impact of shocks to the variables at time zero, figures 7.1 – 7.5 describe the relationship between the shocked variables and value and growth stock returns in the 10-month period following the shock.

Figure 7.1 Generalised impulse responses to one standard deviation shock in aCI, New Zealand

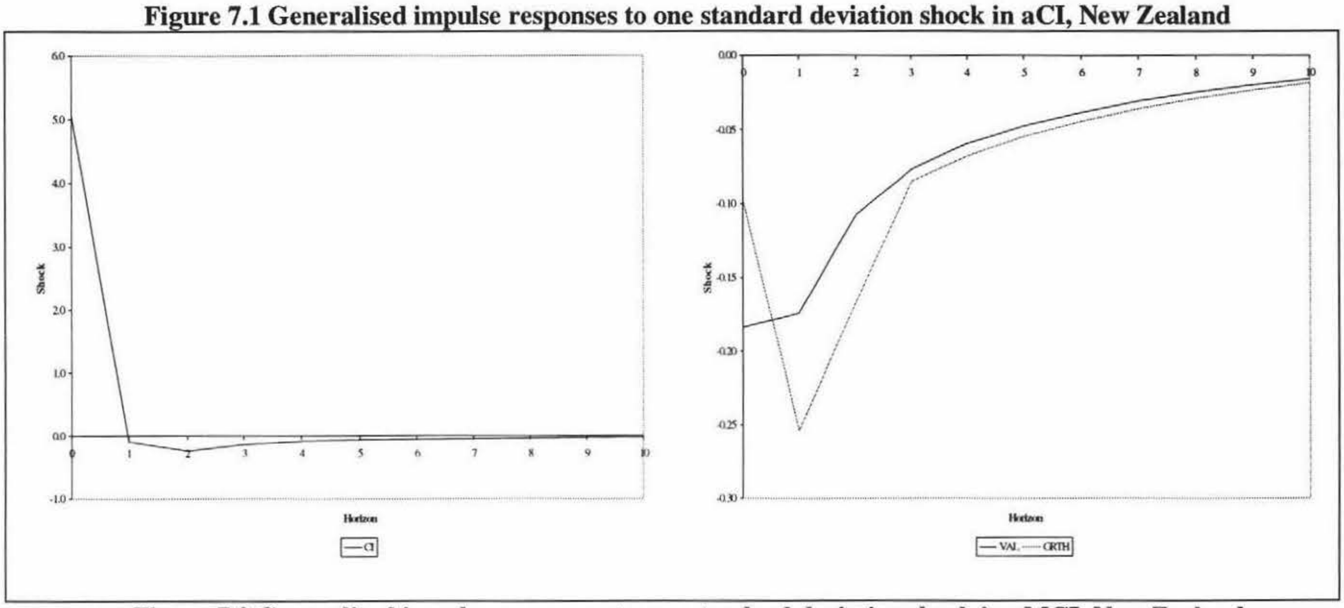


Figure 7.2 Generalised impulse responses to one standard deviation shock in aMCI, New Zealand

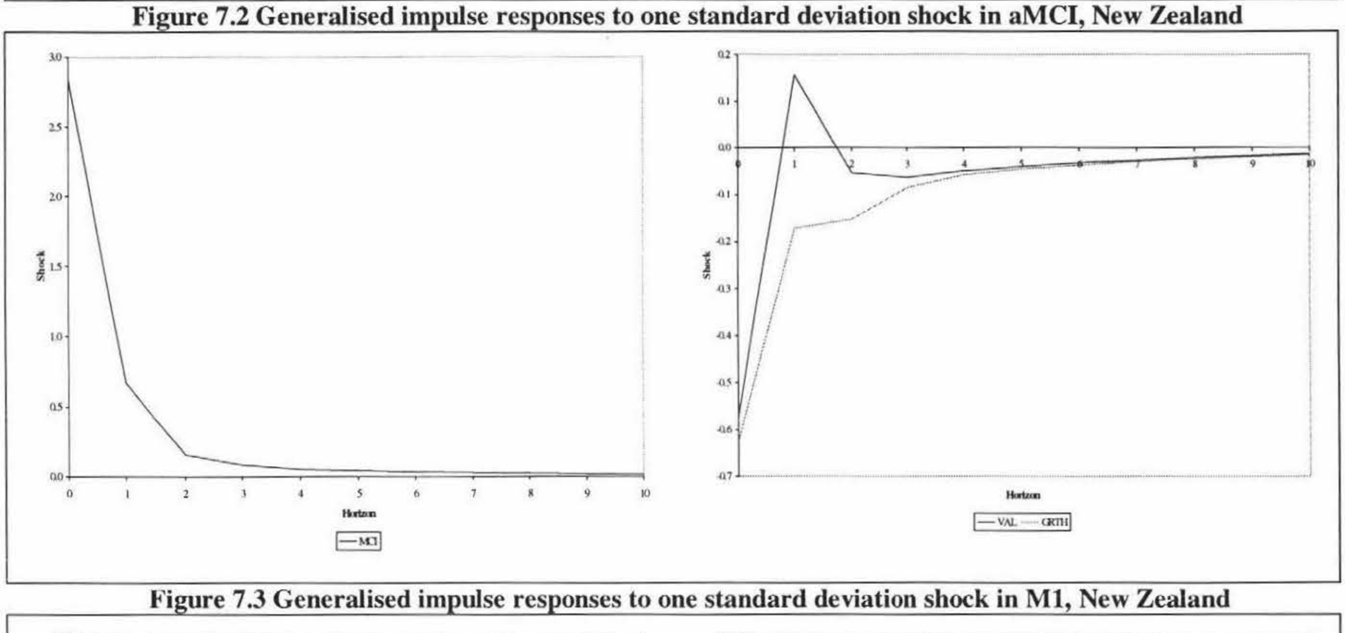


Figure 7.3 Generalised impulse responses to one standard deviation shock in M1, New Zealand

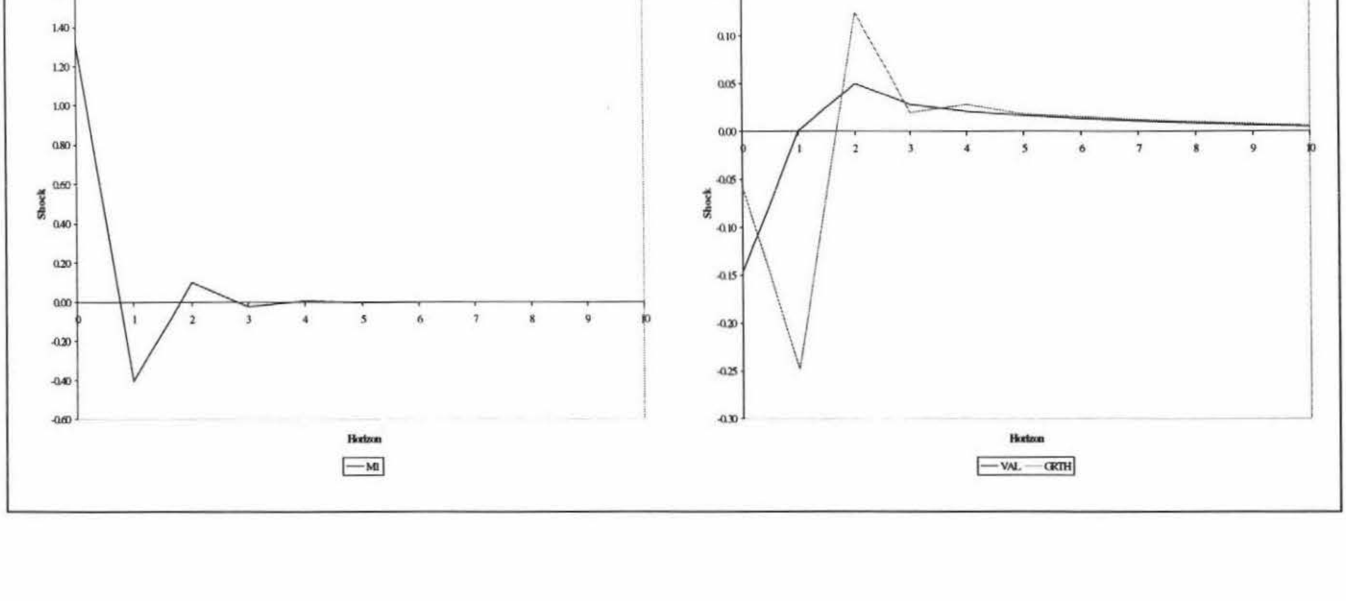


Figure 7.4 Generalised impulse responses to one standard deviation shock in CPI, New Zealand

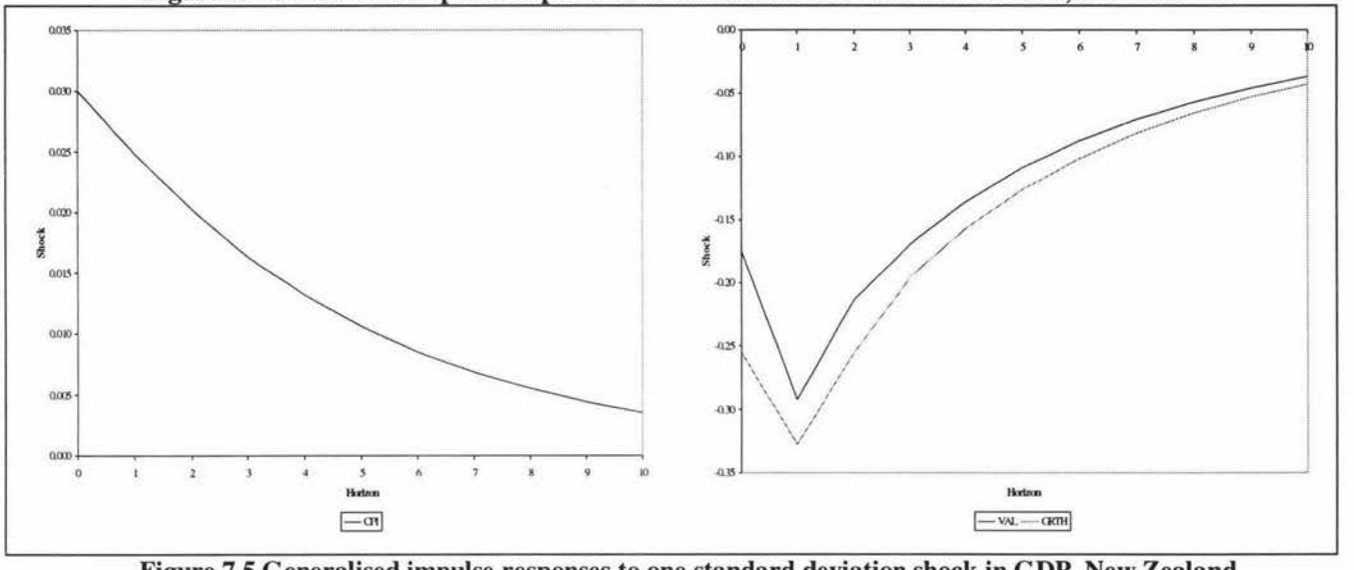
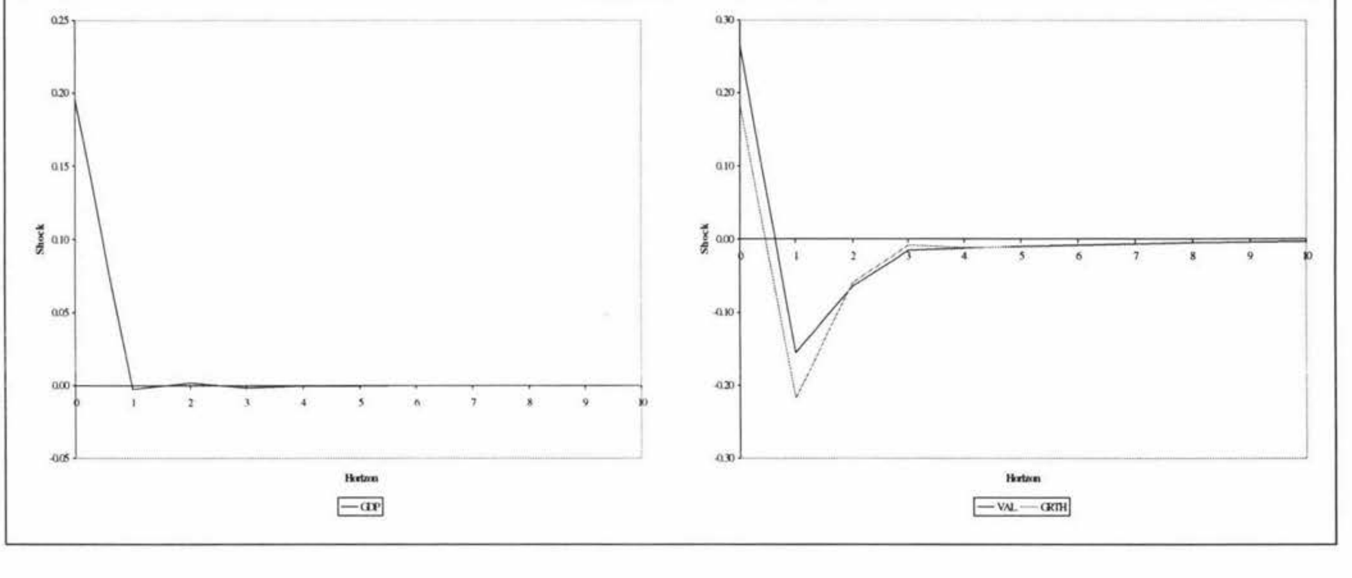


Figure 7.5 Generalised impulse responses to one standard deviation shock in GDP, New Zealand



It appears that for most variables, the impact of an innovation on value and growth stock returns is largely complete within a few months following the shock. The only exception is inflation where the affect on value and growth stock returns due to a shock in inflation persists beyond the 10-month period. Of particular interest are the graphs which indicate a change in the response of value and growth stock returns following the shock. It is interesting to note that whilst value stock returns appear to be more negatively affected by a positive shock to the confidence index, in the month following the shock, growth stock returns are more negatively affected by the shock to the confidence index. Figure 7.2 indicates that it is in the month following the positive innovation in the MCI that value stocks provide the greatest advantage over growth stocks. Graphing the relationship between GDP and value and growth stock returns, it appears that the effect of a positive innovation to GDP is positive for both value and growth stock returns. However, in the month following the shock, both value and growth stock returns exhibit a negative effect of the positive innovation in GDP.

We now consider the results from the generalised forecast error variance decomposition based on a VAR including interest rates and the exchange rate, and excluding the MCI. The INT/TWI-version of the VAR. Table 7.6 provides the results from the generalised forecast error variance decompositions of value and growth stock returns for forecast horizons up to fifteen months.

Table 7.6
Generalised forecast error variance decompositions, New Zealand
INT/TWI-VAR
All variables in logged differences and stationary. Variables in following order: aCI, Val, Grth, TWI, INT, M1, CPI, GDP. Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR.

		By Innovations In							
Variables Explained	Forecast Period	aCI	Val	Grth	TWI	INT	M1	CPI	GDP
Value	1	0.0089	0.6034	0.3044	0.0252	0.0331	0.0019	0.0131	0.0099
	4	0.0127	0.5895	0.2983	0.0259	0.0340	0.0037	0.0259	0.0101
	8	0.0133	0.5857	0.2969	0.0257	0.0348	0.0040	0.0295	0.0101
	12	0.0134	0.5850	0.2967	0.0257	0.0350	0.0040	0.0301	0.0101
	15	0.0135	0.5849	0.2966	0.0257	0.0350	0.0040	0.0302	0.0101
Growth	1	0.0083	0.2841	0.5795	0.0083	0.0901	0.0047	0.0155	0.0094
	4	0.0135	0.2746	0.5593	0.0090	0.0923	0.0105	0.0310	0.0097
	8	0.0142	0.2725	0.5557	0.0090	0.0928	0.0107	0.0352	0.0097
	12	0.0144	0.2722	0.5550	0.0090	0.0929	0.0108	0.0360	0.0097
	15	0.0144	0.2721	0.5549	0.0090	0.0929	0.0108	0.0361	0.0097

These results are consistent with the results from the MCI-version of the VAR. Interest rates play the greatest role in explaining the 1-month FEV of value stock returns (3.31 percent). Following this is the exchange rate and inflation, explaining 2.52 and 1.31 percent respectively. Following inflation, the variables in descending order of importance are GDP, the confidence index, and finally M1. Looking at a 12-month forecasting period, results show that whilst interests rates remain the most important variable, explaining 3.50 percent of the 12-month FEV of value stock returns, the exchange rate no longer explains the second greatest percentage of the 12-month FEV. Inflation explains 3.01 percent of the 12-month FEV of value stock returns. Closely behind this is the exchange rate which explains 2.57 percent, followed by the confidence index which explains 1.34 percent, GDP which explains 1.01 percent, and lastly M1 which explains 0.40 percent.

Like value stocks, interest rates also provide the greatest explanation for the 1-month FEV of growth stock returns, with their percentage being 9.01 percent. Following this, although providing somewhat smaller explanatory power, is inflation and GDP with each explaining 1.55 percent and 0.94 percent respectively. Both the exchange rate and confidence index explains 0.83 percent, while M1 explains only 0.47 percent of the 1-month FEV for growth stock returns. Considering a 12-month forecasting horizon, interest rates still explain the greatest proportion of the FEV of growth stock returns, with their percentage of FEV increasing to 9.29 percent. Inflation comes next with their percentage of FEV increasing to 3.60 percent. GDP no longer plays such an important role over the longer term, with the level of business confidence explaining 1.44 percent followed by M1 explaining 1.08 percent and GDP explaining 0.97 percent. The exchange rate is the least important variable, explaining only 0.90 percent of the 12-month FEV.

Comparing the above results for value and growth stock returns, it appears that for both types of stocks interest rates play the greatest role in determining their behaviour. However, in relative terms, interest rates play a greater role in the determination of growth stock returns. Interest rates explain 9.29 percent of the 12-month percentage of FEV for growth stock returns, and only 3.50 percent of the 12-month FEV for value stock returns. The relative importance of the other variables in the VAR is not consistent between value and growth stocks. Whilst the inflation rate is the second most important variable in explaining the 12-month FEV of both value and growth stock returns, the exchange rate plays a much greater role in explaining the returns of value stocks than it does in explaining growth stock returns. Growth stocks appear to be more influenced by the level of business confidence, GDP and liquidity than by the exchange rate. Conversely, the exchange rate plays a greater role in explaining value stock returns than does the level of GDP, business confidence and liquidity. Both stock groups, however, are similarly influenced by the level of GDP.

Looking now at the IR analysis we can gain more information regarding the respective influences of interest rates and the exchange rate on value and growth stock returns. As illustrated in table 7.7, these results suggest that a positive innovation in the exchange rate has a positive impact on value stock returns which is greater than the positive impact felt by growth stock returns. This supports the findings of the FEV's where value stocks were more affected by innovations in the exchange rate. As expected, interest rates have a negative impact on both value and growth stock returns with growth stocks being more adversely affected by these innovations than value stocks. The difference in value and growth stock return responses is in fact greatest for shocks to interest rates than to shocks in all of the other variables. Results from the shocks to all other variables are consistent with the results from the MCI-version of the VAR.

Table 7.7
Generalised impulse response functions, New Zealand
INT/TWI-VAR

All variables in logged differences and stationary. Variables in following order: aCI, Val, Grth, TWI, INT, M1, CPI, GDP. Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR

Variables	Response Variables							
Shocked	aCI	VAL	GRTH	TWI	INT	M1	CPI	GDP
ACI	5.1015	-0.2040	-0.1209	0.0853	-0.2476	-0.1865	0.0056	0.0240
TWI	0.7296	0.1792	0.1404	0.5966	-0.1228	-0.1197	0.0009	-0.0144
INT	-0.4883	-0.4730	-0.7290	-0.0283	2.5868	-0.0777	0.0008	-0.0026
M1	-0.7241	-0.1161	-0.0065	-0.0543	-0.1530	1.3142	-0.0019	-0.0169
CPI	0.9612	-0.1212	-0.1711	0.0173	0.0695	-0.0833	0.0296	-0.0220
GDP	0.6228	0.2288	0.1457	-0.0439	-0.0341	-0.1131	-0.0033	0.1962

Observing the longer term impact of a shock in the exchange rate and interest rates on value and growth stock returns, figure 7.6 indicates that while both value and growth stocks were fairly similarly affected by positive innovations in the exchange rate, it is in the month following the shock that value stocks provide the greatest advantage over growth stocks. The relationship between interest rates and value and growth stock returns suggests that growth stocks are slightly more negatively affected by shocks to interest rates than value stocks, and this relationship persists primarily in the three months following the shock.

Figure 7.6 Generalised impulse responses to one standard deviation shock in TWI, New Zealand

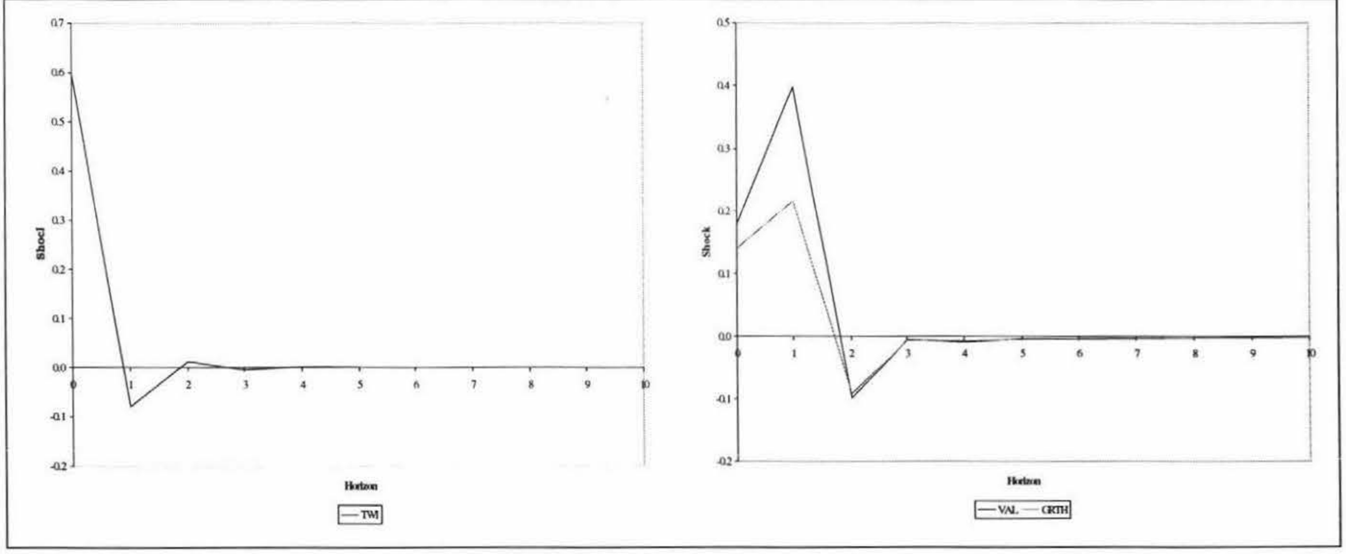
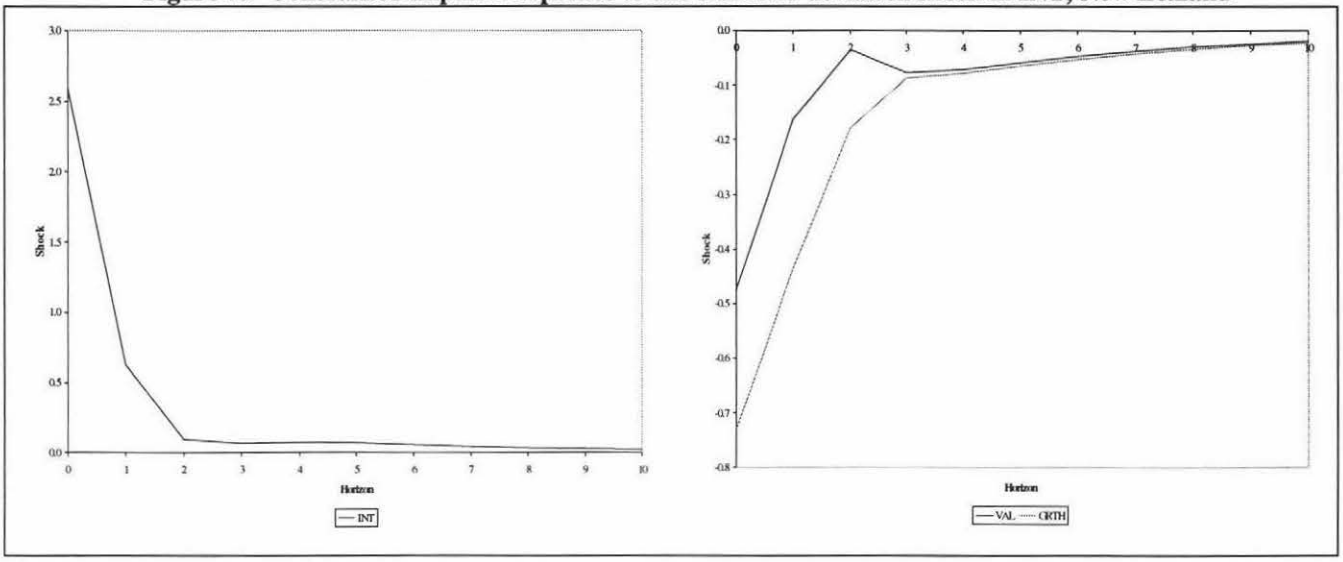


Figure 7.7 Generalised impulse responses to one standard deviation shock in INT, New Zealand



Australia

Table 7.8 presents the results from the generalised forecast error variance decompositions for value and growth stock returns.

Table 7.8
Generalised forecast error variance decompositions, Australia
All variables in logged differences and stationary.
Variables in following order: aCI, Val Grth, Cash rate, TWI, INT, M1, CPI, GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR

		By Innovations In								
Variables Explained	Forecast Period	aCI	Val	Grth	Cash rate	TWI	INT	M1	CPI	GDP
Value	1	0.0033	0.4798	0.3667	0.0120	0.0383	0.0669	0.0066	0.0105	0.0158
	4	0.0038	0.4762	0.3636	0.0122	0.0416	0.0680	0.0068	0.0115	0.0162
	8	0.0038	0.4762	0.3636	0.0122	0.0416	0.0680	0.0069	0.0115	0.0162
	12	0.0038	0.4762	0.3636	0.0122	0.0416	0.0680	0.0069	0.0115	0.0162
	15	0.0038	0.4762	0.3636	0.0122	0.0416	0.0680	0.0069	0.0115	0.0162
Growth	1	0.0050	0.3718	0.4933	0.0103	0.0384	0.0378	0.0212	0.0062	0.0159
	4	0.0054	0.3681	0.4879	0.0106	0.0427	0.0399	0.0214	0.0068	0.0171
	8	0.0054	0.3680	0.4877	0.0106	0.0427	0.0399	0.0215	0.0068	0.0173
	12	0.0054	0.3680	0.4877	0.0106	0.0427	0.0399	0.0215	0.0068	0.0174
	15	0.0054	0.3680	0.4877	0.0106	0.0427	0.0399	0.0215	0.0068	0.0174

These results indicate that interest rates play the greatest role in explaining the 1-month FEV of value stock returns. Following interest rates, which explain 6.69 percent, is the exchange rate which explains 3.83 percent. Following the exchange rate are the variables GDP, the cash rate, and inflation. These variables explain 1.58, 1.20 and 1.05 percent respectively. M1 and the confidence index provide the smallest percentage of 1-month FEV, each explaining 0.66 and 0.33 percent respectively. Considering a 12-month horizon, interest rates still play the greatest role in determining value stock returns, with a 12-month FEV of 6.8 percent. Not far behind is the exchange rate which explains 4.16 percent, followed by GDP, the cash rate, and inflation, explaining 1.62, 1.22 and 1.15 percent respectively. Once again, M1 and the confidence index explain the least amount of FEV of value stock returns. Their 12-month FEV is 0.69 and 0.38 percent respectively.

Results show that the exchange rate explains the greatest proportion of the 1-month FEV of growth stock returns (3.84 percent). Interest rates are not far behind at 3.78 percent. M1 provides the third greatest explanation of the 1-month FEV, explaining 2.12 percent. Following this is GDP and the cash rate, each explaining 1.59 and 1.03 percent respectively. Inflation and the confidence index provide the smallest explanation at 0.62 and 0.50 percent respectively. Considering a 12-month horizon, the exchange rate remains the variable of most importance, explaining 4.27 percent of the 12-month FEV. Interest rates are second, explaining 3.99 percent. The next group of variables with similar proportions of explanatory power are M1, GDP and the cash rate. These explain 2.15, 1.74 and 1.06 percent respectively. Inflation and the confidence index remain the least important variables, explaining only 0.68 and 0.54 percent respectively.

Comparing the percentage of FEV for value and growth stock returns, it appears that interest rates play a greater role in explaining value stock returns than growth stock returns, in both the short and long-term. The exchange rate has a similar percentage of FEV for both value and growth stock returns over the short and long-term, while inflation has a greater influence on value stock returns. GDP has a similar impact on value and growth stock returns, while M1 plays a substantially greater role in the FEVs of growth stock returns than value stock returns. In terms of monetary policy, the cash rate plays a greater role in determining value stock returns than growth stock returns, however, the difference does not appear substantial. The confidence index provides the smallest 1- and 12-month FEV for both value and growth stock returns.

Looking now at the impulse response functions, table 7.9 provides the impulse responses of shocks to the variables at time zero.

Table 7.9
Generalised impulse response functions, Australia
All variables in logged differences and stationary.
Variables in following order: aCI, Val Grth, Cash rate, TWI, INT, M1, CPI, GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR

	Response Variables								
Variables Shocked	aCI	VAL	GRTH	Cash rate	TWI	INT	M1	CPI	GDP
aCI	2.9138	0.0937	0.1589	-0.1635	0.2096	-0.1555	-0.0032	-0.0058	0.0413
Cash rate	-0.2282	-0.1169	-0.0168	2.0874	0.2160	1.4037	-0.1757	0.0031	-0.0055
TWI	0.5526	-0.1779	-0.1449	0.4080	1.1050	0.6589	0.0010	-0.0023	0.0071
INT	-0.2012	-0.5469	-0.4777	1.3012	0.3234	2.2518	-0.1258	-0.0013	-0.0055
M1	-0.0161	-0.0854	-0.1747	-0.6298	0.0018	-0.4865	0.5824	0.0000	0.0199
CPI	-0.5108	0.1815	0.1588	0.1956	-0.0769	-0.0894	0.0003	0.0332	-0.0093
GDP	1.3886	0.1997	0.1295	-0.1324	0.0901	-0.1419	0.1335	-0.0036	0.0867

These results indicate that a positive relationship exists between the confidence index, and value and growth stock returns. That is, a one standard deviation shock to the confidence index equation results in a positive response from both value and growth stock returns. The effect, however, is greater for growth stocks than it is for value stocks. A positive shock to the cash rate, the exchange rate and interest rates all have a negative impact on value and growth stock returns that is greater for value stocks than it is for growth stocks. The difference between the effect of the shock on value and growth stock returns, however, is greatest for the positive innovation in the cash rate. A shock to the variable M1 has a negative impact on both value and growth stock returns that is greater for growth stocks than it is for value stocks. Finally, a shock to inflation and GDP has a positive impact on value and growth stock returns, with this effect being greater for value stocks than it is for growth stocks.

Figures 7.8 – 7.14 provide a graphical illustration of the IR analysis over a 10-month horizon. As we can see from these graphs, the effect of the shock does not generally persist longer than 5 months following the shock. The graphs of interest are the ones where the initial relative effect of the shock on value and growth stock returns changes substantially in the months following the shock. There is only one situation where this occurs. This is for shocks in the cash rate equation. As already indicated, value stock returns appear to bear a greater proportion of the negative effect of the shock than growth stock returns. However, as figure 7.9 indicates, in the month following the shock, growth stocks bear a greater proportion of the negative impact. It is also interesting to note that after an initial positive response by value and growth stock returns to a shock in the confidence index, in the months following the shock, the response becomes negative for both stocks. This is the same for a shock to GDP, where following the initial positive response by value and growth stock returns, the response in the following months becomes negative.

Figure 7.8 Generalised impulse responses to one standard deviation shock in aCI, Australia

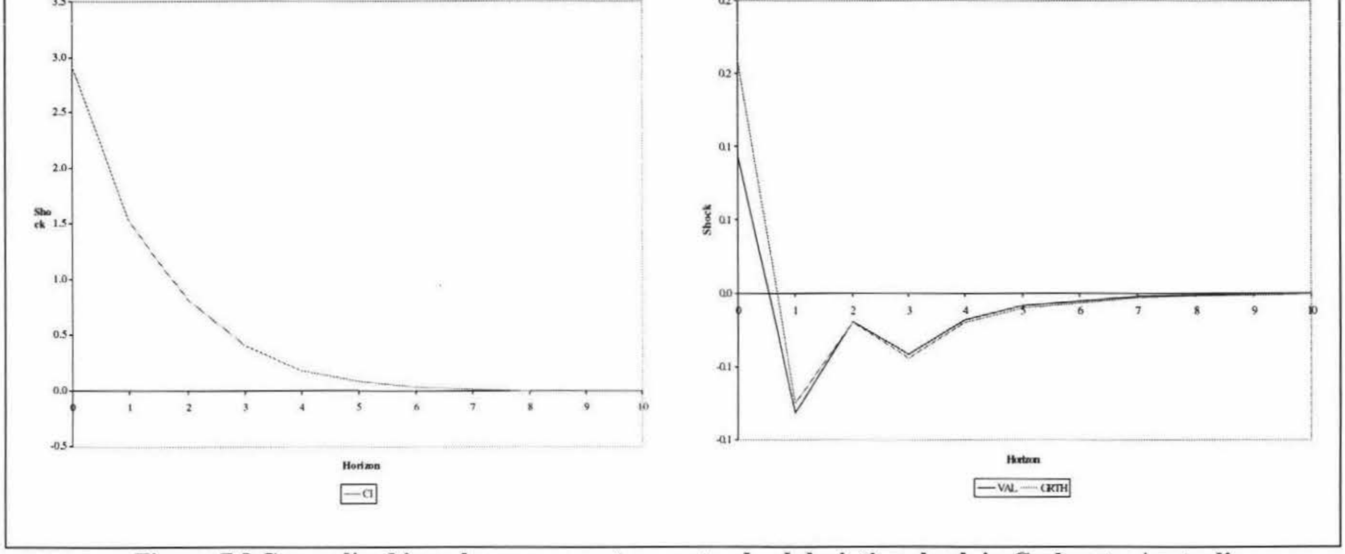


Figure 7.9 Generalised impulse responses to one standard deviation shock in Cash rate, Australia

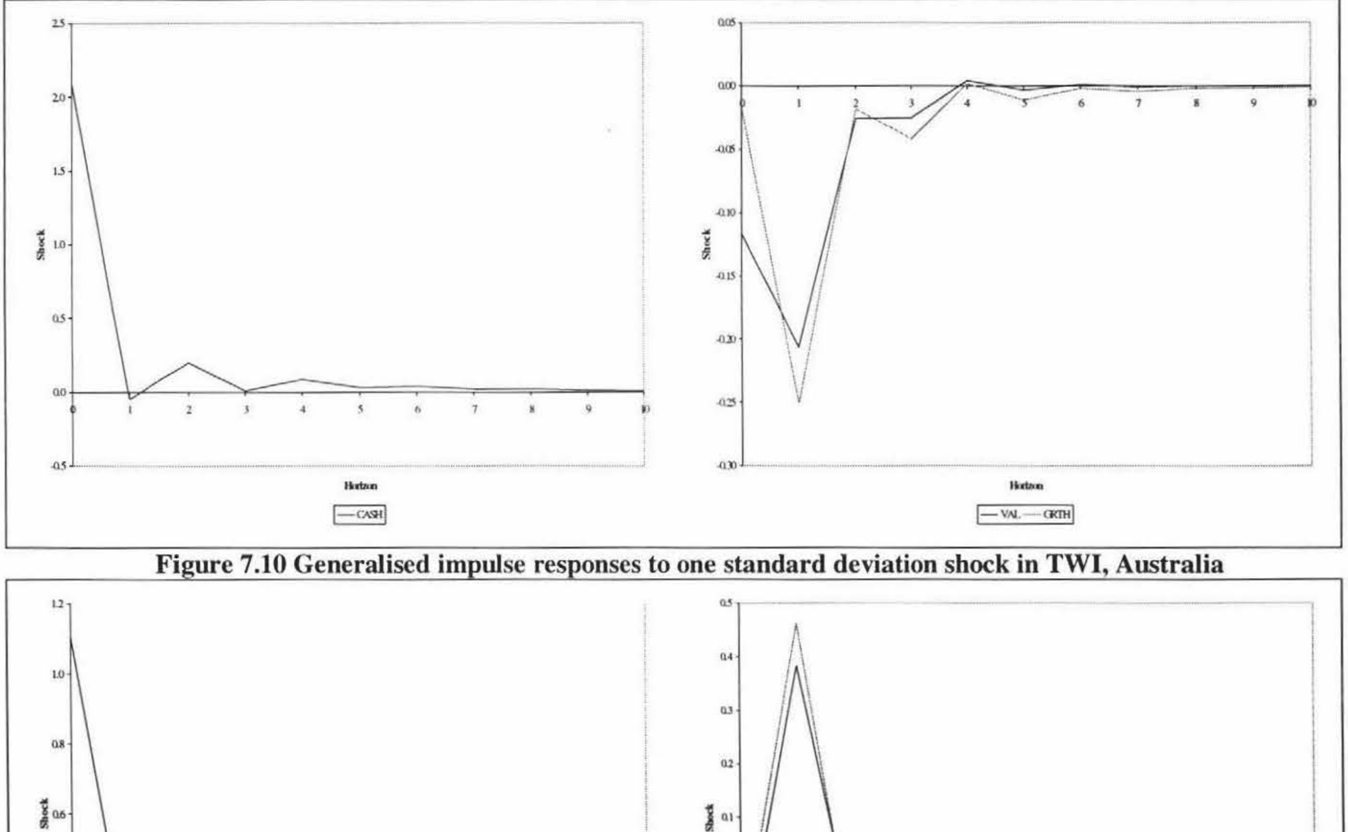


Figure 7.10 Generalised impulse responses to one standard deviation shock in TWI, Australia

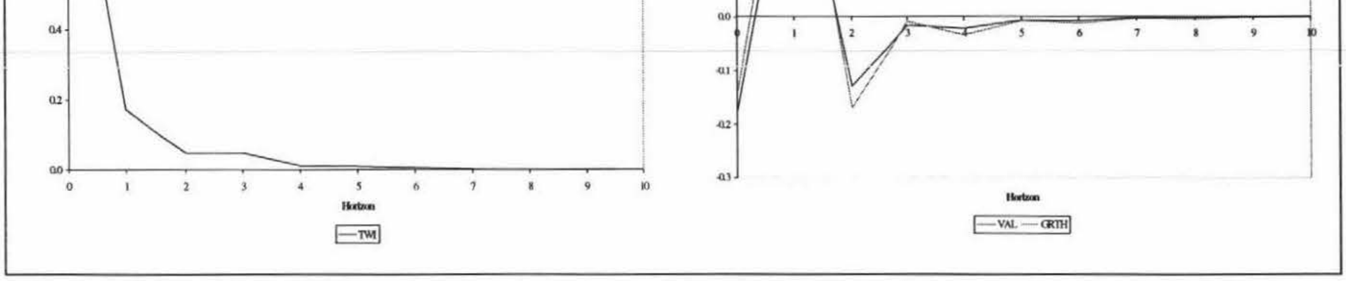


Figure 7.11 Generalised impulse responses to one standard deviation shock in INT, Australia

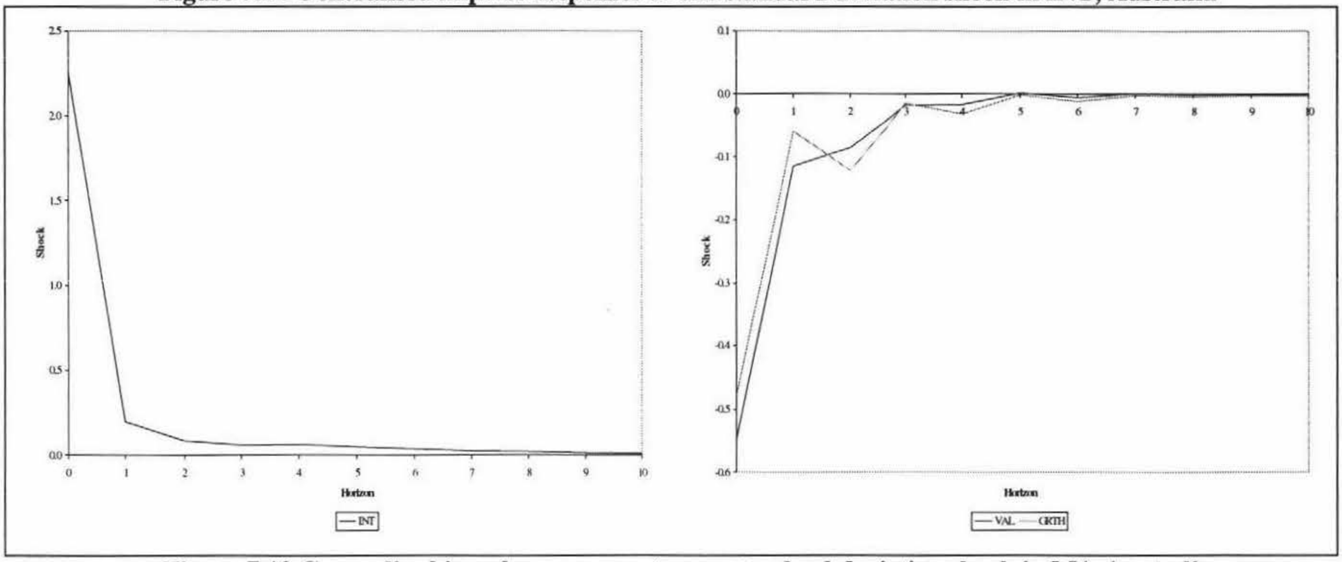


Figure 7.12 Generalised impulse responses to one standard deviation shock in M1, Australia

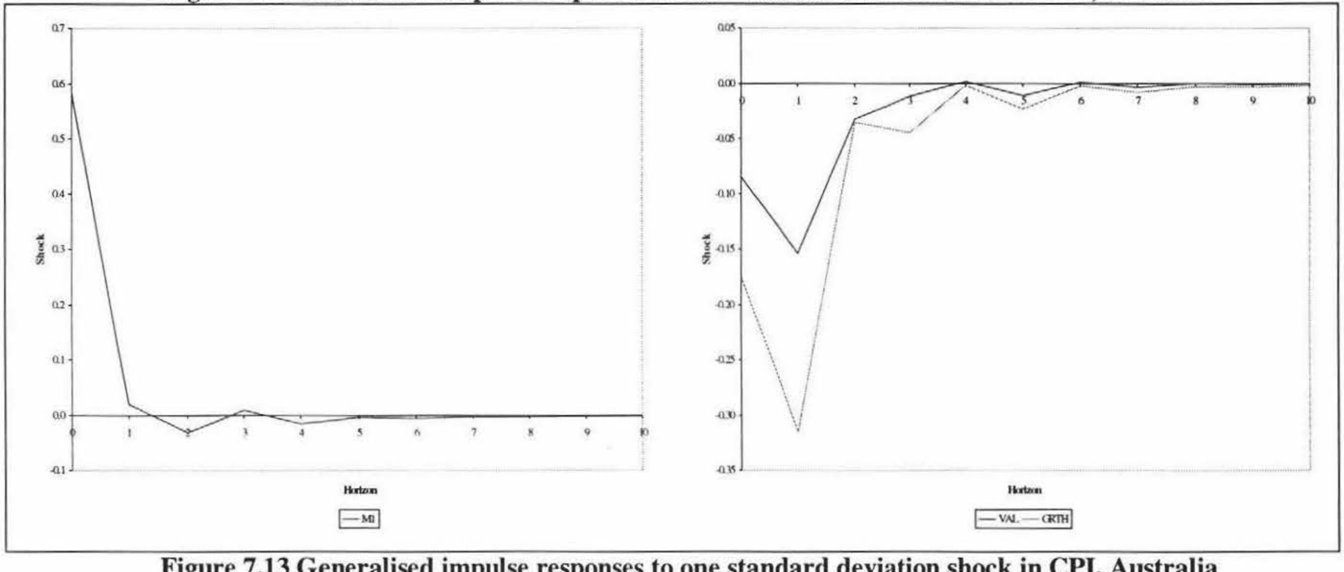


Figure 7.13 Generalised impulse responses to one standard deviation shock in CPI, Australia

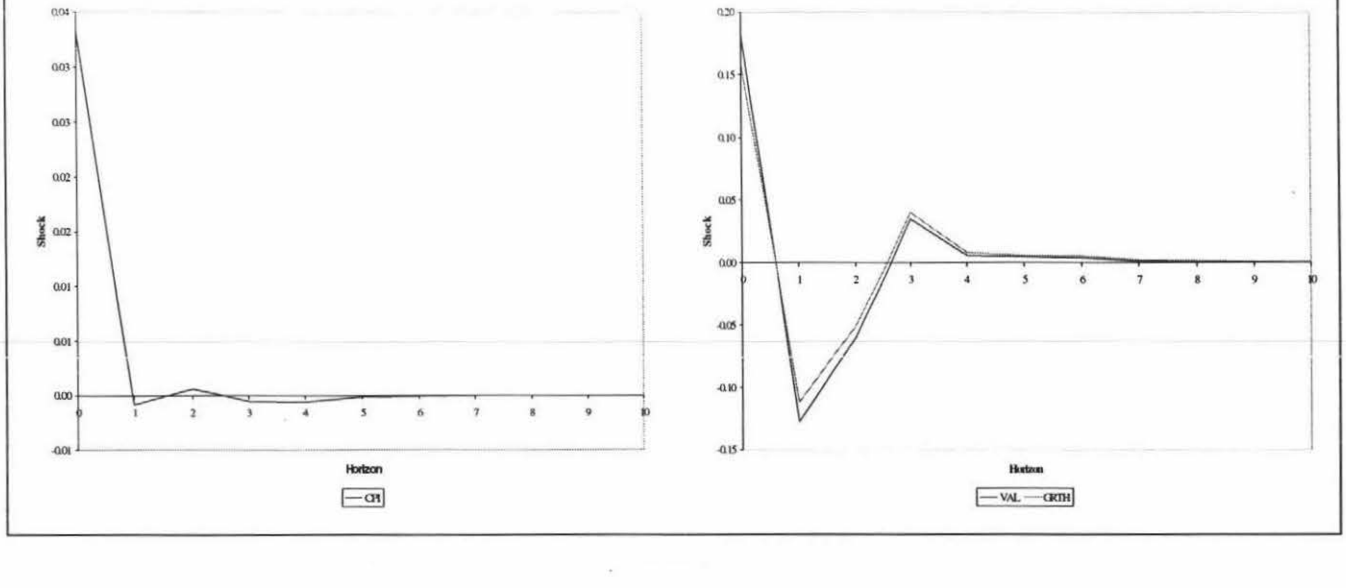
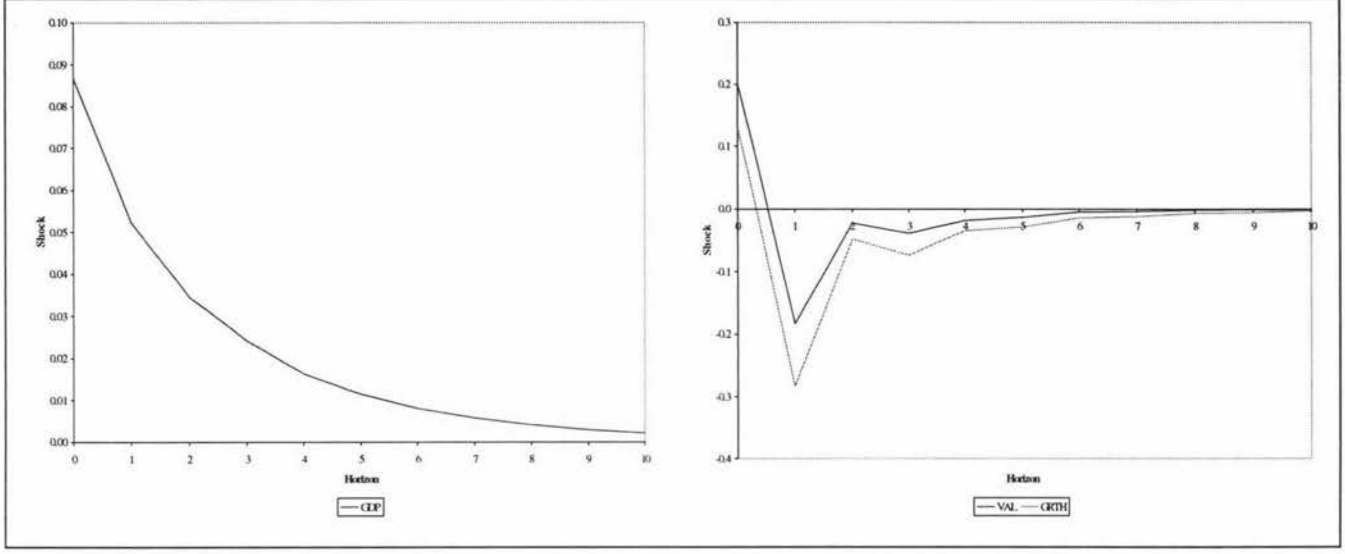


Figure 7.14 Generalised impulse responses to one standard deviation shock in GDP, Australia



The United States of America

Table 7.10 presents the results from the generalised forecast error variance decompositions for value and growth stock returns. These results indicate that inflation plays the greatest role in explaining the 1-month FEV of value stock returns (7.59 percent). Closely following inflation are interest rates which explain 6.15 percent. Well behind in explanatory power, in descending order of importance, are the discount rate, confidence index, monetary base, the exchange rate and lastly GDP. The discount rate, confidence index and monetary base explain 1.49, 0.57 and 0.55 percent respectively. The exchange rate and GDP explain only 0.16 and 0.10 percent respectively. Considering the 12-month horizon, results are fairly similar. The major change was in the explanatory power of the confidence index. For the 12-month forecasting period, the confidence index now explains 1.39 percent of the FEV, not far behind the explanatory power of the discount rate. Over the longer term, the exchange rate is the least important variable in explaining the 12-month percentage of FEV.

Table 7.10
Generalised forecast error variance decompositions, US
All variables in logged differences and stationary.
Variables in following order: CI, Val Grth, Disc. rate, TWI, INT, MB, CPI, GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR

		By Innovations In								
Variables Explained	Forecast Period	CI	Val	Grth	Disc. rate	TWI	INT	MB	CPI	GDP
Value	1	0.0057	0.4800	0.3537	0.0149	0.0016	0.0615	0.0055	0.0759	0.0010
	4	0.0138	0.4728	0.3521	0.0149	0.0022	0.0605	0.0059	0.0754	0.0024
	8	0.0139	0.4715	0.3512	0.0150	0.0025	0.0605	0.0060	0.0756	0.0039
	12	0.0139	0.4713	0.3510	0.0150	0.0026	0.0605	0.0060	0.0756	0.0042
	15	0.0139	0.4713	0.3510	0.0150	0.0026	0.0605	0.0060	0.0756	0.0042
Growth	1	0.0166	0.3611	0.4944	0.0200	0.0100	0.0287	0.0083	0.0573	0.0035
	4	0.0195	0.3586	0.4922	0.0200	0.0101	0.0285	0.0084	0.0574	0.0053
	8	0.0195	0.3578	0.4912	0.0200	0.0104	0.0286	0.0084	0.0575	0.0066
	12	0.0195	0.3577	0.4910	0.0200	0.0104	0.0286	0.0084	0.0575	0.0068
	15	0.0195	0.3577	0.4910	0.0200	0.0104	0.0286	0.0084	0.0575	0.0068

Results indicate that inflation also plays the greatest role in explaining the 1-month FEV of growth stock returns. Inflation explains 5.73 percent, while interest rates explain 2.87 percent of the FEV. Following interest rates, the discount rate explains 2 percent, the confidence index explains 1.66 percent, and the exchange rate explains 1 percent. The monetary base and GDP provides the smallest explanation, explaining only 0.83 and 0.35 percent respectively. Considering the 12-month FEV, results are similar to the 1-month forecasting horizon. In terms of ordering, inflation remains the most important variable and GDP remains the least important variable. The actual percentage levels are also very similar with little change in the level of explanation over the longer term.

Comparing the FEVs of value and growth stock returns, results show that the order of explanatory power of the variables follow a similar pattern. That is, inflation is the most important variable for both stock groups, whilst GDP is the least important variable. However, when comparing the actual percentage figures, results suggest that both interest rates and inflation explain a much greater proportion of value stock returns than growth stock returns. On the other hand, the discount rate, the confidence index and the exchange rate play a slightly greater role in explaining the 1-month and 12-month FEV of growth stock returns.

Looking now at the impulse response functions for shocks to a given variable in the VAR, we can gain more information regarding the nature of the relationship between the variables. Table 7.11 presents the impulse responses to shocks at time zero.

Table 7.11
Generalised impulse response functions, US
All variables in logged differences and stationary.
Variables in following order: CI, Val Grth, Disc. rate, TWI, INT, MB, CPI, GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR

	Response Variables								
Variables Shocked	CI	VAL	GRTH	Disc. rate	TWI	INT	MB	CPI	GDP
CI	2.6288	-0.0191	-0.2577	0.0598	-0.3499	-0.0733	-0.0035	-0.0010	-0.0136
Disc. rate	0.0772	-0.1680	-0.2984	2.0379	0.0999	1.0015	-0.0004	0.0178	0.0003
TWI	-0.7285	0.0596	0.1892	0.1612	1.2627	0.2808	-0.0158	-0.0041	0.0136
INT	-0.0912	-0.4726	-0.3748	0.9664	0.1679	2.1119	0.0059	0.0113	0.0168
MB	-0.0879	-0.1388	-0.2065	-0.0079	-0.1892	0.1171	0.1057	0.0063	0.0002
CPI	-0.0331	-0.5472	-0.5447	0.4786	-0.0686	0.3158	0.0088	0.0759	-0.0028
GDP	-0.6741	0.0115	0.0958	0.0127	0.3239	0.6713	0.0003	-0.0041	0.0529

These results indicate that a negative relationship exists between the confidence index and both value and growth stock returns, with the negative effect being greater for growth stocks. In terms of monetary policy, results suggest that a positive innovation in the discount rate results in a negative impact on both value and growth stock returns which is also greater for growth stocks. A shock to the exchange rate has a positive effect on value and growth stock returns which, once again, is greater for growth stocks. A positive innovation in interest rates has a negative impact on the return on both stock groups which is greater for value stocks than it is for growth stocks. Positive innovations in the monetary base and inflation has a negative impact on both value and growth stock returns. Finally, a shock to GDP has a positive effect on both value and growth stock returns which is greater for growth stocks. The difference in response in value and growth stock returns is greatest for the shock to the confidence index. This is followed by the discount rate and the exchange rate. The impulse responses of shocks to the other variables result in only small differences in their responses. Testing the robustness of these results, the federal funds rate was used as an alternative measure of monetary policy. Results from the federal funds rate version of the VAR were very similar to those presented above.

Figures 7.15 – 7.21 provide a graphical illustration of the IR analysis over a 10-month horizon. As these graphs indicate, the effect of the shock does not persist longer than approximately 5 months following the shock. Of interest are the graphs which indicate a large difference between the response of value and growth stock returns, and how this may change over the 10-month period. Four graphs, therefore, are of particular interest. The confidence index graph indicates that whilst growth stock returns are more negatively affected at time zero, in the months following the positive innovation in the confidence index, value stock returns are more negatively affected by the shock than growth stock returns. Figure 7.16 indicates that whilst growth stock returns are more negative affected by innovations in the discount rate at time zero, in the months following the shock, value stock returns are more negatively affected by the shock. Figure 7.19 shows that whilst growth stock returns are more negatively affected by a shock in the monetary base, they recover a lot more quickly than value stock returns. That is, in the month following the shock, the response of growth stock returns is a lot smaller and positive, while the response of value stock returns remains negative. Finally, as indicated by figure 7.21, whilst both value and growth stock returns are positively affected by a shock to GDP, in the months following the shock their response becomes negative, and this persists for the whole 10-month period. In addition to this, while the response of growth stock returns had been more positive at time zero, in the month following the shock, the response of growth stock returns becomes more negative than the response of value stock returns.

Figure 7.15 Generalised impulse responses to one standard deviation shock in CI, US

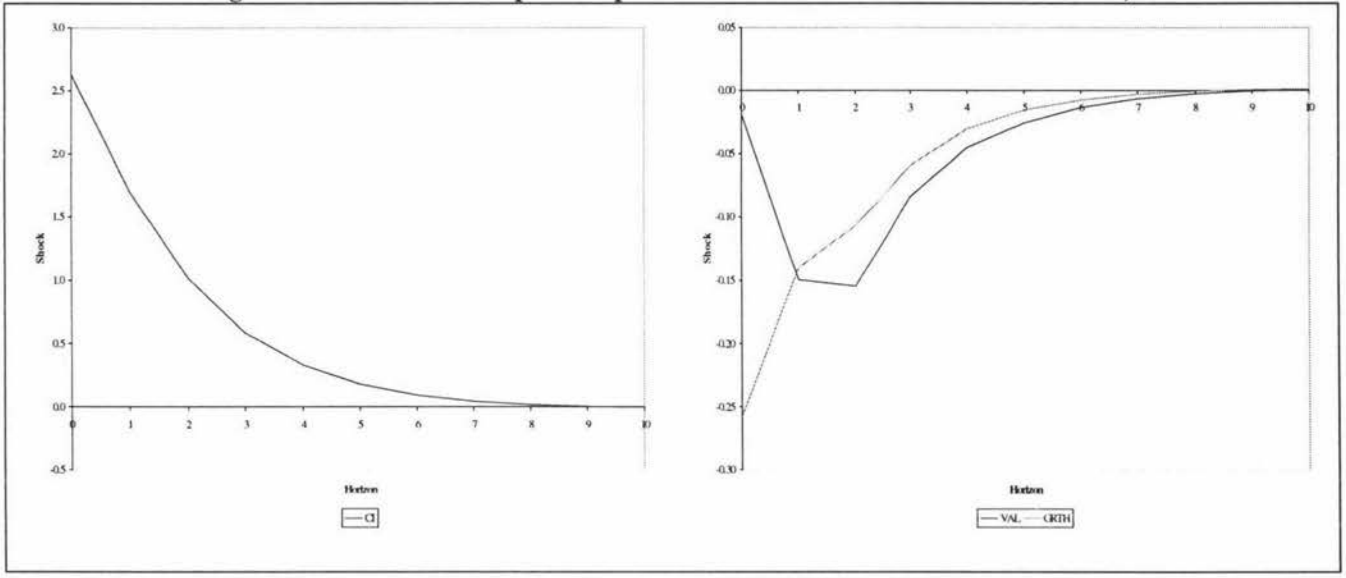


Figure 7.16 Generalised impulse responses to one standard deviation shock in Discount rate, US

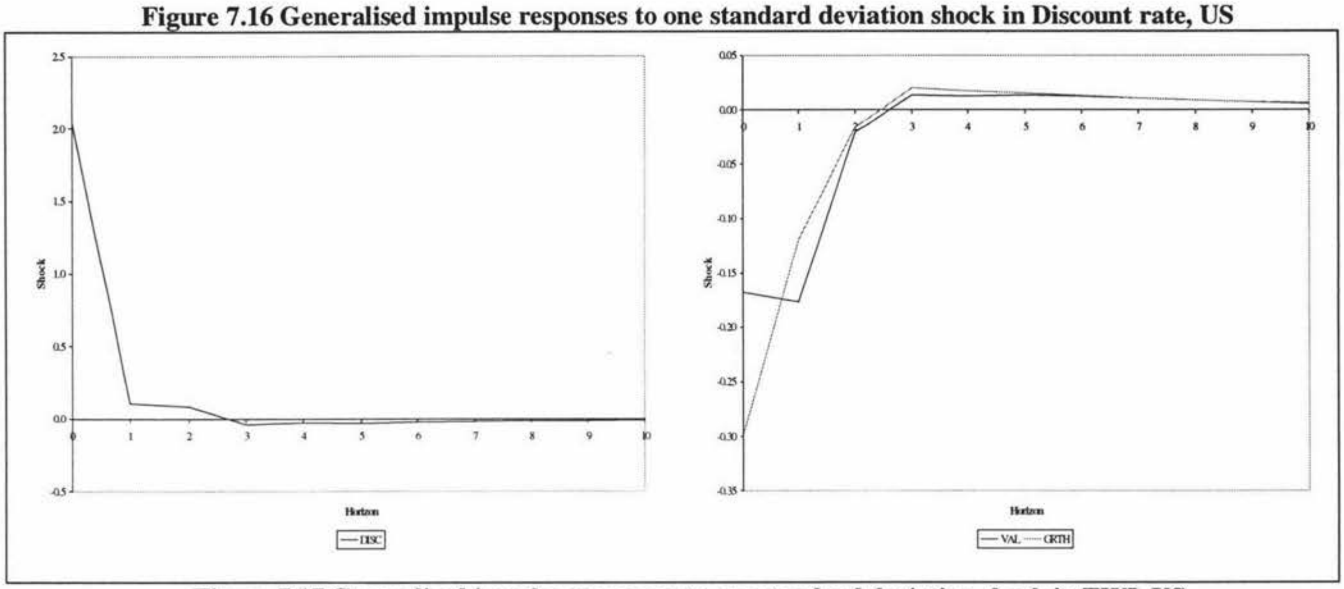


Figure 7.17 Generalised impulse responses to one standard deviation shock in TWI, US

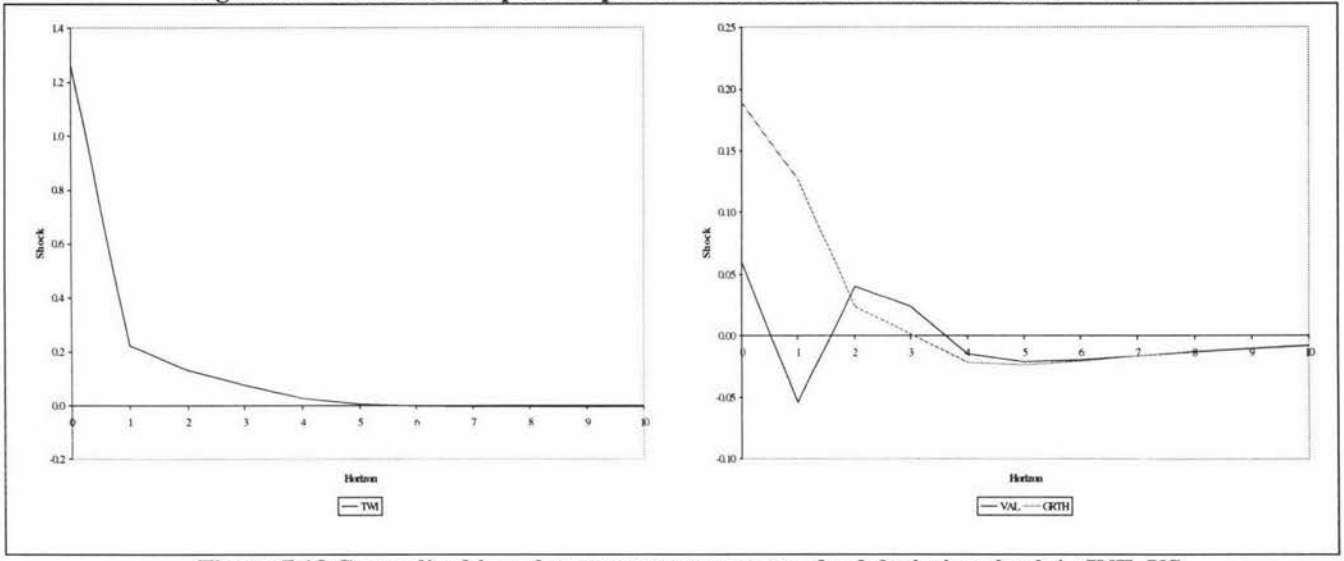


Figure 7.18 Generalised impulse responses to one standard deviation shock in INT, US

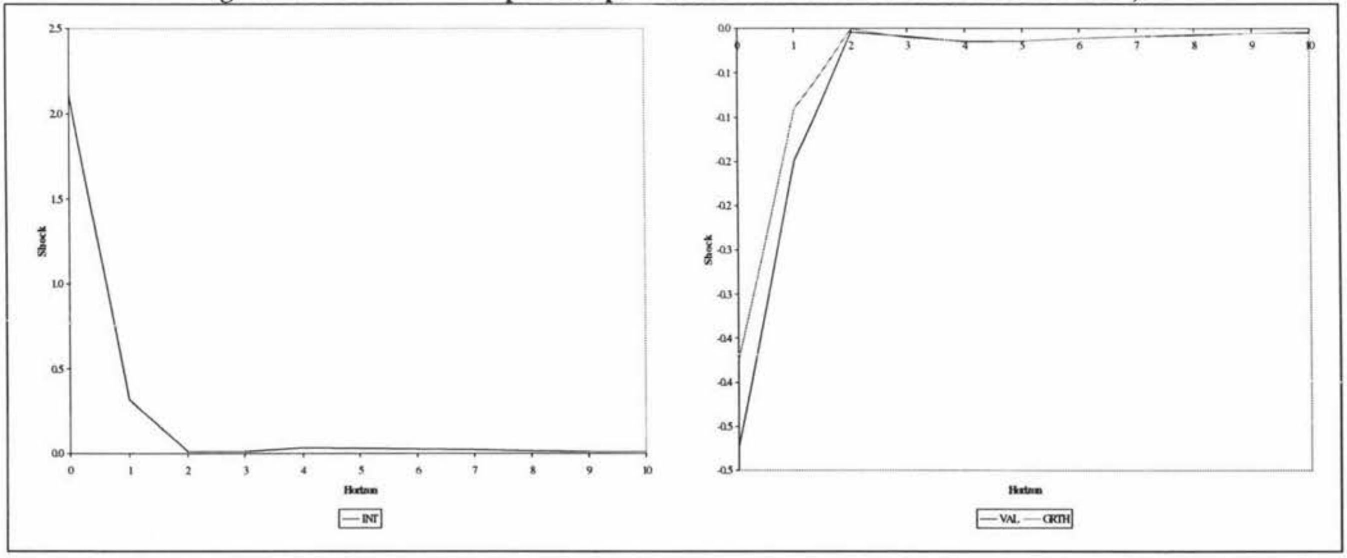


Figure 7.19 Generalised impulse responses to one standard deviation shock in MB, US

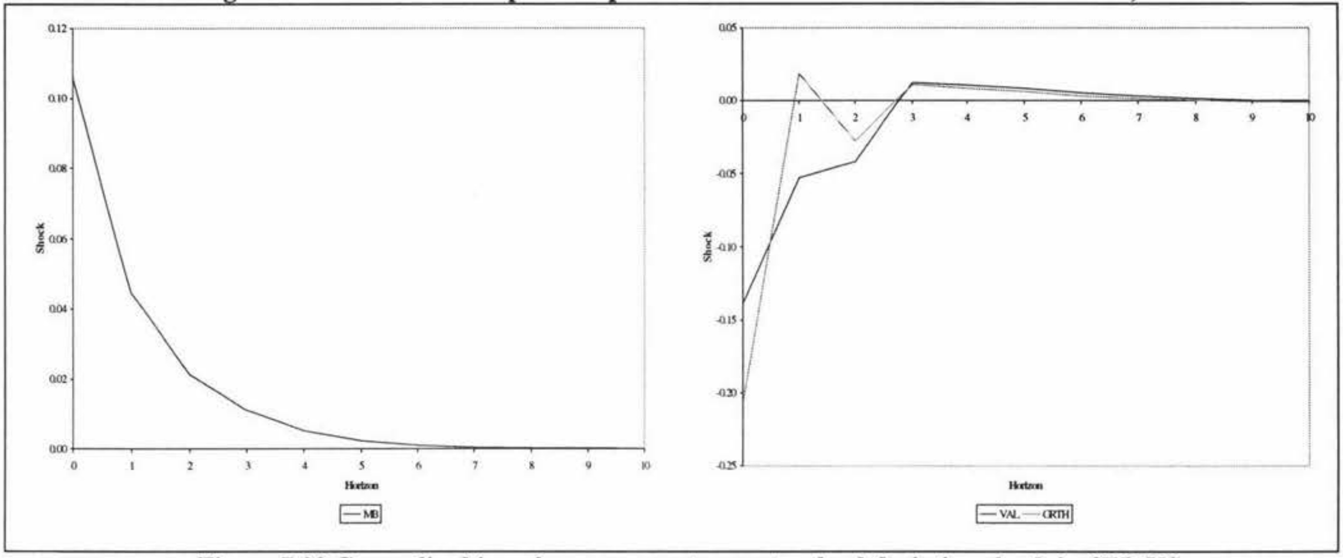


Figure 7.20 Generalised impulse responses to one standard deviation shock in CPI, US

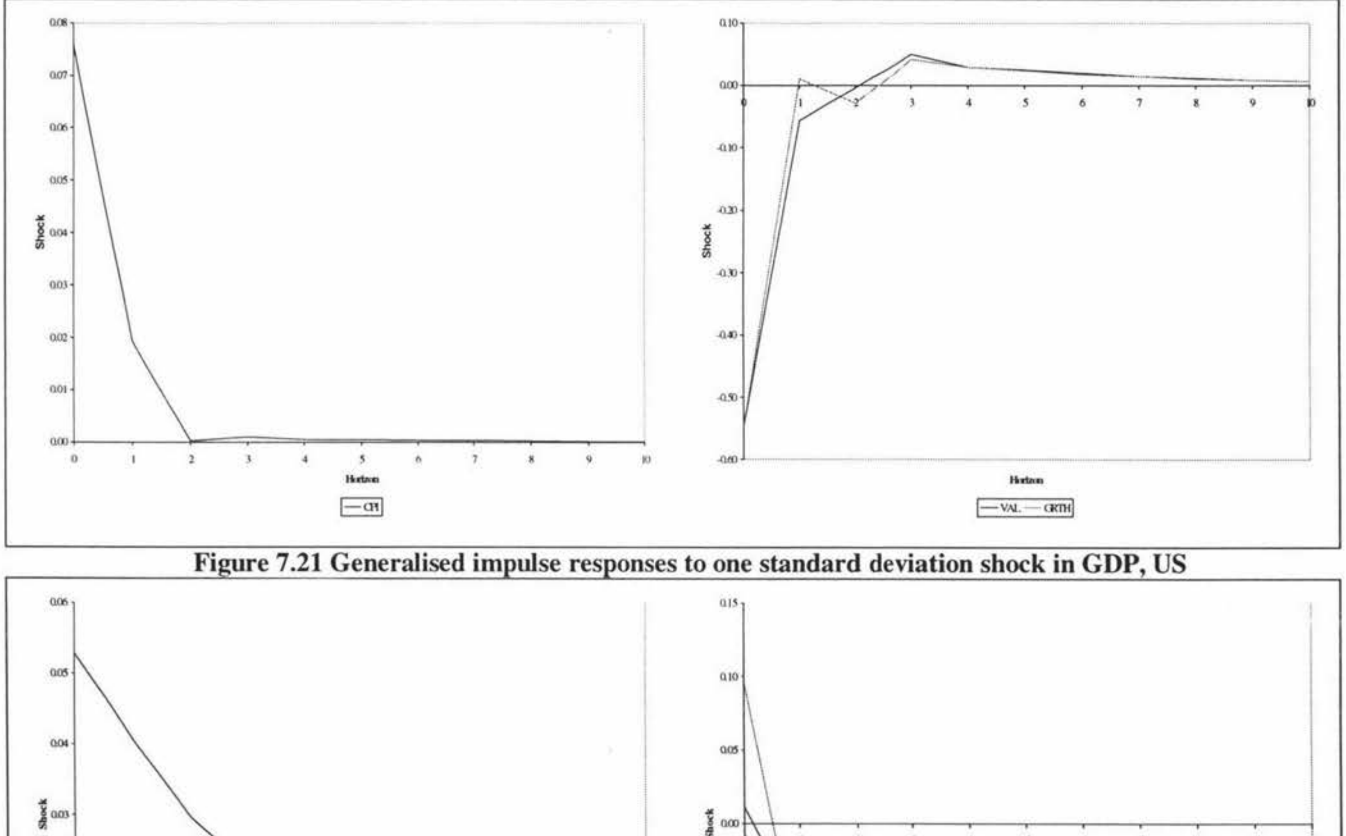
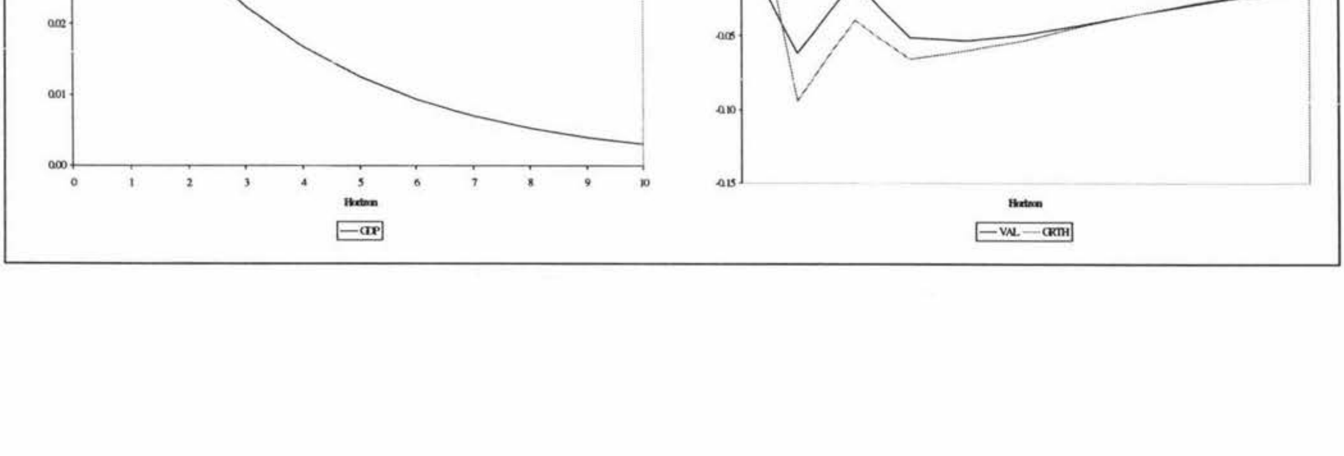


Figure 7.21 Generalised impulse responses to one standard deviation shock in GDP, US



7.3 Block Granger Causality Results

Tests for block Granger causality were undertaken for all three countries. Two VARs were constructed. One including growth stocks plus a number of macroeconomic variables, the other including value stocks with the same number of macroeconomic variables. These variables were then tested for non-causality of value and growth stock returns. Comparison of the results from the two tests of causality should indicate the importance of these variables in causing value and growth stock returns.

Table 7.12
Block Granger causality test results
All variables in logged differences and stationary.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend insignificant and therefore not included in VAR
Variables tested for causing value and growth stock returns:
CI, Val, Grth, aMCI (NZ), Cash rate (AUS), Disc. rate (US), TWI, INT, M1, CPI and GDP.

Country	Variables caused	LR-statistic	p-value
New Zealand			
• MCI-VAR	Value	7.6566	0.176
	Growth	8.9037	0.113
• INT/TWI-VAR	Value	10.9729	0.089*
	Growth	12.2807	0.056*
Australia	Value	7.6615	0.363
	Growth	15.3649	0.032**
US	Value	8.7963	0.268
	Growth	5.7535	0.569

* sig at 10%
** sig at 5%

Results from these tests are presented in table 7.12. Results for New Zealand suggest that the variables, confidence index, the exchange rate, interest rates, M1, inflation and GDP play a significant role in explaining the returns on value and growth stocks. The p-value of the LR statistic suggests significant causality, with the significance being greater for growth stocks. That is, growth stocks may be more significantly affected by these macroeconomic factors than value stocks. When testing the MCI-version of the VAR, results suggest that no significant causality exists between the variables. Significance at the 10 percent level is almost reached for growth stocks, once again indicating the greater role these macroeconomic factors may play in determining growth stock returns.

Similar to the results for New Zealand, results for Australia suggest that growth stocks are more affected by the chosen macroeconomic variables than value stocks. That is, there is no significant block causality between the chosen macroeconomic variables and value stock returns. There is, however, significant causality between the variables and growth stock returns. This was significant at the 5 percent level.

Results from the US suggest that no significant block causality exists between the group of economic variables, and value and growth stock returns. That is, the LR statistic is insignificant at both the 5 and 10 percent levels.

7.4 Multivariate Cointegration Results

This section presents the results from the tests for cointegration among the variables in the VAR. These results are based on the eigenvalues and trace statistics provided by the cointegration tests.

New Zealand

As with the VAR analysis conducted in section 7.2, it is necessary to test for cointegration using the two VARs for New Zealand. One including the MCI and excluding interest rates and the exchange rate, and the other including interest rates and the exchange rate separately. Using eigenvalues and trace statistics the number of cointegrating relations between the variables can be determined. Table 7.13 provides the eigenvalues and trace statistics for the MCI-VAR for New Zealand. These VARs excluded GDP as only variables of the same order can be cointegrated.

Table 7.13

Tests for cointegrating relations within MCI-VAR, New Zealand

All variables in logged levels and in the following order: aCI, Val, Grth, aMCI, M1, and CPI.

Based on AIC and SBC selection criteria, model includes 1 lag. Trend significant and therefore included.

Cointegration LR test based on Maximal Eigenvalue of the stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r=1	103.8504	43.6100	40.7600
r<=1	r=2	35.3919	37.8600	35.0400
r<=2	r=3	29.9909	31.7900	29.1300
r<=3	r=4	15.3096	25.4200	23.1000
r<=4	r=5	12.2072	19.2200	17.1800
r<=5	r=6	5.7672	12.3900	10.5500
Cointegration LR Test Based on Trace of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r>=1	202.5172	115.8500	110.6000
r<=1	r>=2	98.6668	87.1700	82.8800
r<=2	r>=3	63.2749	63.0000	59.1600
r<=3	r>=4	33.2839	42.3400	39.3400
r<=4	r>=5	17.9743	25.7700	23.0800
r<=5	r=6	5.7672	12.3900	10.5500

Using the 95 percent critical values, the eigenvalues in table 7.13 suggest that one cointegrating relationship exists between the variables, however, the trace statistic suggests that three cointegrating relations exist. Using the 90 percent critical values, both statistics suggest that three cointegrating relations exist.

Table 7.14 provides the eigenvalues and trace statistics testing for cointegrating relations within the INT/TWI-VAR. These results are inconsistent at both the 90 and 95 percent level, with the eigenvalues suggesting one cointegrating relationship exists between the variables, and the trace statistic suggesting that three cointegrating relations exist.

Table 7.14
Tests for cointegrating relations within INT/TWI-VAR, New Zealand
All variables in logged levels and in the following order: aCI, Val, Grth, TWI, INT, M1, and CPI.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend significant and therefore included.

Cointegration LR test based on Maximal Eigenvalue of the stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r=1	167.7590	49.3200	46.5400
r<=1	r=2	36.6717	43.6100	40.7600
r<=2	r=3	33.4015	37.8600	35.0400
r<=3	r=4	24.7789	31.7900	29.1300
r<=4	r=5	12.1825	25.4200	23.1000
r<=5	r=6	11.6912	19.2200	17.1800
r<=6	r=7	5.4533	12.3900	10.5500
Cointegration LR Test Based on Trace of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r>=1	291.9381	147.2700	141.8200
r<=1	r>=2	124.1791	115.8500	110.6000
r<=2	r>=3	87.5074	87.1700	82.8800
r<=3	r>=4	54.1059	63.0000	59.1600
r<=4	r>=5	29.3270	42.3400	39.3400
r<=5	r>=6	17.1445	25.7700	23.0800
r<=6	r=7	5.4533	12.3900	10.5500

As indicated by Pesaran and Pesaran (1997) it is unlikely that these two tests for cointegration will provide consistent results. They recommend that in these situations, one must decide on the number of cointegrating relations based on general knowledge of economic theory. Given the literature has shown a number of significant relationships exist between the variables included in the VAR, it is concluded that it is more likely three cointegrating relations exist.

Australia

Because the variable CPI is integrated of order two, it is not included in the tests for cointegration. All other variables, however, were included. Table 7.15 provides results from the tests for cointegration between the variables, confidence index, value and growth stock returns, the cash rate, the exchange rate, interest rates, M1 and GDP.

Table 7.15
Tests for cointegrating relations within VAR, Australia
All variables in logged levels and in the following order: aCI, Val, Grth, Cash rate, TWI, INT, M1, and GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend significant and therefore included.

Cointegration LR test based on Maximal Eigenvalue of the stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r=1	100.5576	55.1400	52.0800
r<=1	r=2	78.8325	49.3200	46.5400
r<=2	r=3	40.8051	43.6100	40.7600
r<=3	r=4	36.2951	37.8600	35.0400
r<=4	r=5	15.3698	31.7900	29.1300
r<=5	r=6	11.6211	25.4200	23.1000
r<=6	r=7	8.8151	19.2200	17.1800
r<=7	r=8	4.8105	12.3900	10.5500
Cointegration LR Test Based on Trace of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r>=1	297.1067	182.9900	176.9200
r<=1	r>=2	196.5492	147.2700	141.8200
r<=2	r>=3	117.7167	115.8500	110.600
r<=3	r>=4	76.9116	87.1700	82.8800
r<=4	r>=5	40.6165	63.0000	59.1600
r<=5	r>=6	25.2457	42.3400	39.3400
r<=6	r>=7	13.6265	25.7700	23.0800
r<=7	r=8	4.8105	12.3900	10.5500

Using the 95 percent critical values, the eigenvalues indicate two cointegrating relations exist between the eight variables. The trace statistic suggests that there are three cointegrating relations. Using the 90 percent critical values, the eigenvalues suggest that four cointegrating relations exist while the trace statistic suggests that three cointegrating relations exist. Similar to New Zealand, we conclude that there are, most likely, three cointegrating relations that exist between the variables in the VAR.

The United States of America

Tests for cointegration were conducted for the US. Because all variables were integrated of the same order, all variables were able to be included in the VAR. Table 7.16 provides the results for the cointegration tests.

Table 7.16
Tests for cointegrating relations within VAR, US

All variables in logged levels and in the following order: CI, Val, Grth, Disc. rate, TWI, INT, MB, CPI and GDP.
Based on AIC and SBC selection criteria, model includes 1 lag. Trend significant and therefore included.

Cointegration LR test based on Maximal Eigenvalue of the stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r=1	138.8879	61.2700	58.0900
r<=1	r=2	76.6397	55.1400	52.0800
r<=2	r=3	71.1361	49.3200	46.5400
r<=3	r=4	42.0379	43.6100	40.7600
r<=4	r=5	32.6482	37.8600	35.0400
r<=5	r=6	20.2528	31.7900	29.1300
r<=6	r=7	16.8274	25.4200	23.1000
r<=7	r=8	10.6785	19.2200	17.1800
r<=8	r=9	5.3634	12.3900	10.5500
Cointegration LR Test Based on Trace of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r=0	r>=1	414.4719	222.6200	215.8700
r<=1	r>=2	275.5840	182.9900	176.9200
r<=2	r>=3	198.9442	147.2700	141.8200
r<=3	r>=4	127.8082	115.8500	110.600
r<=4	r>=5	85.7703	87.1700	82.8800
r<=5	r>=6	53.1221	63.0000	59.1600
r<=6	r>=7	32.8693	42.3400	39.3400
r<=7	r=8	16.0419	25.7700	23.0800
r<=8	r=9	5.3634	12.3900	10.5500

Using the 95 percent critical values, the eigenvalues suggest that 3 cointegrating relations exist, whereas the trace statistics indicate that 4 cointegrating relations exist. Using the 90 percent critical values, the eigenvalues suggest four cointegrating relations, while the trace statistic suggests five cointegrating relations. We therefore conclude that there are, most likely, four cointegrating relations within the 9-variable VAR.

Results for the three countries are fairly similar. New Zealand and Australia indicate that approximately 3 cointegrating relations exist between the variables, whereas the US VAR suggests that 4 cointegrating relations exist. Given the extra variable included in the US VAR, this result is somewhat expected. These cointegration results provide significant evidence that some long-term relationships exist between the variables in the VAR. Whilst interpretation of the cointegrating relations is difficult where the number of cointegrating relations is greater than two, these results serve to provide further evidence of meaningful relationships between value and growth stock returns and the selected macroeconomic variables.

7.5 Summary

Results from this chapter are based on generalised forecast error variance decompositions, generalised impulse response functions, block Granger causality tests and cointegration analysis. Results for the three countries are somewhat mixed. In terms of the relative importance of the macroeconomic variables in explaining the percentage of FEV, results from all three countries suggest that interest rates are one of the most important variables in explaining future value and growth stock returns. In relative terms, New Zealand growth stocks were more influenced by interest rates than value stocks, whereas in both Australia and the US value stocks were more affected by the interest rate variable. Inflation also played a significant role in the FEVs of both value and growth stock returns in New Zealand and the US. New Zealand growth stocks were more influenced by inflation than value stocks, however, it was value stocks in the US that were more influenced by inflation than growth stocks. Whilst inflation did not play a large role in explaining value and growth stocks returns in Australia, the exchange rate played a large role, along with interest rates, in explaining the FEV of value stock returns. Considering the relative importance of monetary policy to value and growth stock returns, the cash rate for Australia fell behind interest rates, the exchange rate and GDP in explaining the FEVs of both value and growth stock returns. In relative terms, it had a greater influence on value stocks than it did on growth stocks. Monetary policy in the US, on the other hand, had a greater influence on growth stock returns, with the discount rate for both stock groups following inflation and interest rates in order of FEV importance. Comparison of the actual percentages of FEV suggests a greater significance of monetary policy in the US, compared to Australia, in determining value and growth stock returns. Comparison between the relative importance of monetary policy in New Zealand to monetary policy in Australia and the US is difficult given the nature of the MCI, and therefore the need to construct two VARs. We can say, however, that monetary policy in New Zealand has a greater influence on growth stock returns than it does on value stock returns.

Another point of interest is the lack of ability of liquidity to explain value and growth stock returns. The only exception was for growth stock returns in Australia, where liquidity played a greater role. Another variable that differed in explanatory power was the exchange rate in New Zealand. This variable explained a substantially larger portion of value stock returns than growth stock returns. The exchange rate in the US explained a greater portion of growth stock returns, while the exchange rate in Australia explained a similar portion of both value and growth stock returns. GDP was a variable that surprisingly offered relatively little explanation of value and growth stock returns. Comparisons between the three countries indicate that GDP is a more important variable in New Zealand and Australia than it is in the US.

Considering the nature of the relationship between the variables, impulse response analysis suggests that monetary policy in all three countries holds a negative relationship with both value and growth stock returns. In terms of degree, results suggest that monetary policy has a greater impact on growth stock returns in both New Zealand and the US, whereas the impact is greater on value stock returns in Australia. Interest rates were also negatively related to value and growth stock returns, with both Australia and the US showing value stock returns are more affected by interest rates than growth stock returns. There were a number of consistencies between New Zealand and the US. Both countries showed a negative relationship between value and growth stock returns, and money supply, inflation and the confidence index. Australia also showed a negative relationship between value and growth stock returns and the money supply, however, there was a positive relationship between value and growth stock returns, and inflation and the confidence index. Considering the longer term, however, the positive effect on value and growth stock returns from the inflation and confidence index shock in Australia became negative in the month following the shock, and is therefore somewhat consistent with New Zealand and the US. Both New Zealand and the US showed a positive relationship between the exchange rate and value and growth stock returns, whereas Australian stock returns showed a negative relationship with the exchange rate. All three countries indicate a positive relationship exists between value and growth stock returns and GDP which becomes negative in the months following the shock.

Considering the relative impact of impulse responses on value and growth stock returns, growth stocks in Australia and the US were more affected by shocks in the confidence index and money supply, whereas value stock returns in New Zealand were more affected by these variables. Value stock returns in Australia and the US were more affected than growth stock returns to changes to interest rates and inflation, whereas growth stock returns in New Zealand were more affected by these variables. Whilst New Zealand appears to be the odd one out, there were also some consistencies between Australia and New Zealand. Value stocks in Australia and New Zealand were more affected by GDP and the exchange rate than growth stock returns, whereas growth stock returns in the US were more affected by these variables.

Finally, Granger causality and cointegration analysis provide an alternative measure of the significance of these relationships. Granger causality suggests that both value and growth stock returns in New Zealand are significantly affected by the variables, confidence index, interest rates, the exchange rate, M1, inflation and GDP. Results for Australia indicate that growth stock returns are significantly affected by the variables, confidence index, the cash rate, interest rates, the exchange rate, M1, inflation and GDP, however, value stock returns are not. Value and growth stock returns in the US were not significantly affected by the group of selected macroeconomic variables. Cointegration results suggest, however, that there are a number of long-term relationships that exist between the variables in all three countries. These ranged from 3 to 4 cointegrating relations within the 6 to 8 variable VARs.

Chapter Eight

Discussion

The aim of this discussion is to consolidate, interpret, and where possible, provide a number of explanations for the results presented in chapters six and seven. Analysis of the relationship between monetary policy and stock returns suggests that growth stocks in New Zealand perform better during periods of loosening monetary policy, whereas growth stocks in Australia perform better during periods of tightening monetary policy. Results from the US were interesting. Initial return difference analysis suggests that growth stocks perform relatively better during periods of tightening monetary policy. However, results from the VAR analysis suggests that positive innovations in the discount rate (tightening monetary policy) has a greater negative effect on growth stocks. That is, growth stocks perform better during periods of loosening monetary policy. Given this conflicting result, we consider monetary policy in terms of interest rates. Results for both New Zealand and Australia were consistent whether using the MCI/cash rate, or interest rates, as a measure of monetary policy stance. That is, positive shocks to both interest rates and the MCI/cash rate had a greater negative impact on growth stock returns in New Zealand, and a greater negative impact on value stock returns in Australia. For the US, however, a positive innovation in the discount rate had a greater negative impact on growth stock returns while a positive innovation in interest rates had a greater negative impact on value stock returns. This could suggest that either the discount rate is not a good measure of monetary policy, or that growth stocks are more affected by expectations than value stocks. That is, the discount rate may have more influence on investors' expectations than actual changes in interest rates. This is further supported by the impulse response graph showing growth stocks were more negatively affected by innovations in the discount rate only at time zero. In the months following the innovation, value stocks were more negatively affected. This interpretation is consistent with Calderwood (1997) who suggested growth stocks are more reliant on expectations than value stocks which are more reliant on 'hard data'.

Results concerning the relationship between monetary policy and stock returns for Australia and the US are consistent with Jensen, Johnson and Mercer (1997). That is, in relative terms, value stocks perform better during loosening monetary policy. Results, however, were inconsistent for New Zealand.

Whilst it is difficult to determine why this is the case, and indeed this is outside the scope of this research, three reasons are suggested as explanations of these findings. It may be due to either the different method of measuring monetary policy in New Zealand compared to the US and Australia, differences in the type of companies which comprise the indices, or the timing of monetary policy initiatives in relation to the business cycle which is fundamentally different between the three countries.

Introducing a number of economic variables into the analysis, further conclusions are drawn. Considering firstly absolute value and growth stock returns, results suggest stock returns in New Zealand and the US are negatively related to the level of business confidence. This is contrary to expectations where one would expect higher business confidence to be associated with higher stock returns. This could, however, be a reflection of human nature, where it may take a while for opinions to change regarding the future course of the economy. That is, people may be more inclined to feel confident about the economy after a period of sustained economic growth. By this stage, however, the economy may have reached its peak and future economic conditions may be weaker than current levels. Whilst Australia showed a positive relationship between business confidence and stock returns, this turned negative in the months following the shock, and so is similar to both New Zealand and the US.

Impulse response analysis indicates that the exchange rate is positively related to stock returns in New Zealand and the US, and negatively related to stock returns in Australia. Both results are consistent with the literature which has shown both a positive and negative relationship to exist between these variables. As also indicated in the literature, the relationship between stock returns and the exchange rate is likely to be influenced by the nature of the companies comprising the indices. That is, indices comprised more of export-orientated companies are more likely to be adversely affected by increases in the exchange rate. The opposite situation will occur for import-orientated companies. It is interesting to note that, because of the nature of the MCI index, an increase in the exchange rate leads to an increase in the MCI. Therefore, a positive relationship between the exchange rate and stock returns indirectly suggests that tightening monetary policy increases stock returns. This result is in direct contrast to the literature which suggests tightening monetary policy decreases stock returns, and could therefore provide more insight into the shortcoming of the MCI approach in determining monetary conditions than it does to the relationship between monetary policy and stock returns.

Results concerning the relationship between interest rates and stock returns is consistent for all three countries, and with much of the empirical research. That is, increasing interest rates have a negative affect on both value and growth stock returns.

The relationship between money supply and stock returns for all three countries was negative. This relationship has been shown to exist in past research (Berkman 1978, Pearce & Roley 1982, Cornell 1983) and can be interpreted in two ways. In terms of monetary policy, it indicates that loosening monetary policy has a negative effect on stock returns and vice versa. This is contrary to much empirical research and therefore suggests that money supply should be viewed more in terms of liquidity than in terms of monetary policy. The negative relationship between liquidity and stock returns could be indicative of market efficiency. That is, increases in the money supply increases investors' expectations of higher inflation and therefore the negative relationship between money supply and stock returns is more to do with the negative relationship between inflation and stock returns (Friedman, 1968).

A negative relationship existed between inflation and stock returns in New Zealand and the US, however, a positive relationship existed in Australia. Much empirical research has indicated a negative relationship between these two variables and therefore Australia's results are somewhat surprising. However, when analysing the longer term response of the positive shock to inflation, results show that, in the month following the shock, the response of Australian stock returns becomes negative.

Consistent with the literature, results suggest that a positive relationship exists between economic activity and stock returns for all three countries. That is, stock returns are higher during periods of economic growth. It is interesting to note, however, that in the months following the positive innovation in GDP, stock returns for all three countries became negative. This could suggest an element of overreaction in all three markets, where investors initially overreact in response to increased economic activity. This overreaction leads to a period of correction where stock returns become negative in the months following the increase in GDP.

Using impulse response analysis, many consistencies are present between Australia and the US. For example, growth stock returns in Australia and the US were more affected by innovations in the confidence index and money supply, and value stock returns in Australia and the US were more affected by innovations in interest rates and inflation than growth stock returns. There are a number of explanations for this. In terms of the confidence index, growth stocks may be more influenced by business confidence given growth stocks are driven more by expectations than by hard data (Calderwood, 1997). An explanation for the greater negative effect of inflation on value stock returns in Australia and the US is provided by Young (1998) who suggested that value stocks are more likely to operate on smaller margins. If this is true, it is likely that value stocks will be more adversely affected by higher inflation. Finally, higher interest rates may have a greater negative impact on value stock returns for a number of reasons. As suggested by Young (1998), value stocks are more likely to be adversely affected by increasing interest rates as these stocks are primarily purchased for their dividend yield. Young's timing explanation may also apply here. That is, tightening monetary policy coincides with stronger economic growth which is when growth stocks should be expected to perform better. This, however, was not supported by Australia's results which suggest that growth stocks perform better during periods of negative GDP. Alternatively, Gertler and Gilchrest's (1994) explanation suggests that value stocks, which are typically smaller than growth stocks, may be more adversely affected by increasing interest rates due to the effect it has on the companies' balance sheet and therefore its access to credit. Greater difficulty in accessing credit may cause value companies to reduce their productivity and lower their costs. Whilst these relationships were consistent between Australia and the US, and a number of theoretical explanations, opposite results were found for New Zealand. NATWEST (1998) provide an explanation for the greater negative impact of interest rates on growth stock returns in New Zealand. They suggested that growth stocks are longer duration assets and therefore more likely to be influenced by changing interest rates.

Results on the relative importance of the exchange rate in predicting future value and growth stock returns suggest that value stock returns in New Zealand are more positively affected by increases in the exchange rate than growth stock returns. On the other hand increases in the exchange rate had a greater negative impact on value stock returns in Australia and a greater positive impact on growth stock returns in the US.

The relative impact of innovations in GDP on value and growth stock returns was consistent between New Zealand and Australia. Value stock returns in New Zealand and Australia were more positively affected by GDP, whereas growth stock returns in the US were more positively affected by GDP than value stock returns. Results for the US therefore supports Young's (1997) theory that growth stocks perform better during periods of economic growth, and Jensen et al's (1997) theory that value stocks provide higher returns during periods of economic recessions. Results for New Zealand and Australia supports NATWEST's (1998) theory of growth stocks providing a premium during periods of weak economic growth.

Tests for block Granger causality support the bivariate analysis results. That is, growth stock returns in New Zealand and Australia appear to be more influenced by economic variables than value stock returns. Both value and growth stock returns in the US were not significantly affected by these variables. This result supports the theories of NATWEST (1998) and Calderwood (1997) who suggested growth stocks are more affected by future expectations than value stocks.

Whilst the impulse response analysis indicated the nature of the relationship between economic variables and value and growth stock returns, forecast error variance decomposition provided information regarding the relative importance of the economic variables in explaining future value and growth stock returns. The forecast error variance results were consistent with the impulse response analysis. That is, where the impulse response functions showed value stock returns were more affected by a chosen economic variable than growth stock returns, the forecast error variance of that variable was greater for value stock returns than growth stock returns. It is, however, also interesting to compare the order of importance of the economic variables in explaining value and growth stock returns.

Interest rates and inflation played the greatest role in explaining value and growth stock returns in New Zealand and the US, with interest rates and the exchange rate the most important variables for explaining value and growth stock returns in Australia. In terms of monetary policy, the discount rate for the US fell behind only inflation and the interest rate. The Australian cash rate came behind interest rates, the exchange rate and GDP for value stock returns, and behind these variables plus M1 for growth stock returns. In relative terms, therefore, we can say that monetary policy in the US plays a greater role in determining stock returns than in Australia. However, using interest rates as a measure of monetary policy, results suggest that monetary policy plays a greater role in Australia than in the US. Direct comparison with New Zealand is difficult given the need to construct two VARs for New Zealand. However, we can say that monetary policy, measured using interest rates or the MCI, was the most significant factor contributing to the forecast error variances of both value and growth stock returns.

Conclusion

The primary focus of this research has been the relationship between monetary policy and value and growth stock returns. The major conclusion of this research is that whilst tightening monetary policy has a negative impact on both value and growth stock returns in all three countries, growth stocks in New Zealand are more adversely affected by tightening monetary policy whereas value stocks in Australia and the US are more adversely affected by tightening monetary policy.

This study has also introduced a number of economic variables into the analysis and examined the relationship these variables hold with value and growth stock returns. The relative importance of these variables in explaining future value and growth stock returns was also examined. A concise summary of these findings is somewhat difficult given the number of variables considered, and therefore the reader is referred to the discussion chapter for a more detailed analysis of these results. It appears, however, growth stocks in New Zealand and Australia perform better during weaker economic activity while growth stocks in the US perform better during strong economic activity. These findings support a timing explanation for the results for New Zealand and the US. Growth stocks in New Zealand perform better during weaker economic activity and a loosening monetary policy stance. This is consistent with a timing explanation where one would expect a loosening monetary policy stance to be taken during a period of weak economic activity. Growth stocks in the US perform better during periods of strong economic activity and this coincides with the tightening monetary policy stance one would expect during periods of strong economic growth. A timing explanation, however, is not supported for Australia where growth stocks were found to perform relatively better during weak economic activity and a tightening monetary policy stance.

There is much scope for further research in this area. For a start, only one previous study by Jensen, Johnson and Mercer (1997) has considered the role of monetary policy in relation to value and growth stock returns. Further clarification of their results, and the results presented in this thesis, would provide a beneficial test of the robustness of these results. An obvious progression in this research would be to consider the reasons underlying the relative impact of monetary policy and a number of economic variables on value and growth stock returns. Why is it that tightening monetary policy in Australia and the US has a greater negative impact on value stock returns. Why does this differ from New Zealand? Certainly more variables could be included in the analysis in an attempt to find a variable that may provide more explanatory power for value and growth stock returns than those analysed here.

The major contribution of this study was to provide a greater understanding of the potential factors that may be driving the relative performances of value and growth stock returns. In doing so, this study has laid the foundation for further empirical research and presents a number of challenges in terms of providing further evidence and explanations for the relationship between value and growth stock returns and a number of economic variables.

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