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ANALYSIS OF THE RELATIONSHIP BETWEEN THE SHARE MARKET PERFORMANCE AND EXCHANGE RATES IN NEW ZEALAND: A COINTEGRATING VAR APPROACH

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ABSTRACT

This study employs the cointegrating VAR approach to characterise the relationships between the five exchange rates comprising the TWI and the share market in New Zealand. Weekly data covering January 1999 to June 2006 are analysed. The study discovers there are two types of long-run relationship mimicking the portfolio balance and goods market theories. That implies there is bi-directional causality in the foreign exchange and stock markets in both the short run and long run although different exchange rates may be implicated. In the long run, the empirical results for the relationship between the NZ-US dollar exchange rate and the overall share market index support both the portfolio balance and goods market theories. In the short run, the portfolio balance theory is further supported by all the exchange rates but the goods market theory is supported significantly only by the NZ-Australian dollar exchange rate. Thus the evidence is predominantly in support of the portfolio balance theory and that the firms most at risk of foreign exchange rate exposure are those that export to Australia.

JEL Classifications: F31, F41, G20, N27,
Key words: share market index, exchange rate, cointegration, New Zealand.

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1. INTRODUCTION

Many commentators have noted the high value of the New Zealand dollar (NZD) in recent years has been hurting NZ exporters and many NZ companies face ruin unless the NZD depreciates quickly. It is to be expected that the shares of such companies would be less desirable and affect the share market index. This presumes causality to run from exchange rates to the share market. But both the theory and empirical evidence are ambiguous whether it is the exchange rate that affects the share market or it is the other way round. The portfolio balance theory asserts that causality runs from the share market to the exchange rate, and the goods market theory asserts that causality runs from the exchange rate to the share market. Empirical studies report mixed and contrasting findings. Apart from the inconsistent results, the empirical studies are also ridden with methodological weaknesses such as omitted variables bias and possible spurious regression results because cointegration among the set of variables analysed was not ascertained. This study adopts the VAR (vector autoregression) approach to analysing the relationship between the share market and exchange rates that can capture either one or both of the portfolio balance and goods market approaches and can help to characterise the linkage between the fluctuations in the equity and foreign exchange markets.

There are a few reasons why such a study is important. First, the analysis might uncover information that can be used to predict the path of the exchange rate and gauge the effect upon share market performance. Second, foreign ownership of the NZ share market was reported to be 55% in 2000 (Newman and Briggs, 2000) and 48% in 2005 (Stuff, 2006). The results should be of interest to foreign portfolio investors concerned about their currency exposure in NZ. Third, the results may affect decisions about fiscal and monetary policy, especially the latter. The preferred instrument of the NZ Reserve Bank in its inflation targeting policy is the interest rate. Tightening monetary policy in response to inflationary pressure will be effectual if the NZD is currently depreciating and it is known that depreciation stimulates the economy via the share market. If, on the other hand, it is known that the falling NZD dampens the share market, there may be justification not to intervene since inflationary pressures may naturally ease. Finally, the insights may prove helpful to avert a financial/currency crisis. Khalid and Kawai (2003), Ito and Yuko (2004) and others have noted that in the Asian financial crisis of 1997 the sharp depreciation of the Thai baht triggered depreciation of other currencies in the region that led to the collapse of the stock markets as well.

In the VAR approach all variables are assumed to be endogenous. Each variable is regressed on its own lags plus the lags of the other variables. Although criticised for being *atheoretical*, the approach has been found to be useful in investigating economic issues where the specification of structural relationships is difficult. The VAR approach is data based and it also assumes that there is no *a priori* direction of causality among the variables; this is particularly useful for financial variables which are often co-determined (Charemza and Deadman, 1997; Blanchard and Perotti, 1999). In our application of the cointegrating VAR on two share market indices, five exchange rates and an interest rate variable in NZ we discovered that there is bi-directional causality in the foreign exchange and stock markets in both the short run and long run although different exchange rates may be implicated. In the long run the empirical results suggest both the portfolio balance and goods market theories are supported by the relationship between the NZ dollar and US dollar exchange rate and the overall share market index. In the short run the portfolio balance theory is supported by all the exchange rates but the goods market theory is supported significantly only by the NZ dollar and Australian dollar exchange rate. Thus the evidence is predominantly in support of the portfolio balance theory and that the firms most at risk are those that export to Australia.

This study is divided into five sections. After this introductory section, Section 2 gives an overview of the theoretical and empirical literature and rationalises the analytical method to be used. Section 3 describes the data and outlines the analytical methods used in the empirical estimations. Section 4 reports the analytical results and the interpretations thereof. Section 5 concludes the study.

2. LITERATURE REVIEW

In the literature, two approaches have been taken to model the relationship between share prices (SP) and exchange rate (ER). The earlier approach, known as the goods market approach (Dornbusch and Fischer, 1980), posits that changes in the exchange rate affect the international competitiveness of an open economy and therefore the profitability of its firms as reflected in share prices. Hence, the direction of causality runs from exchange rates to share prices. However, the effect of exchange rate fluctuations on the share market will depend on whether the constituent firms are preponderantly net exporters or net importers, whether they own foreign subsidiaries and whether they hedge against exchange rate fluctuations. Depending on these and other factors, an appreciation of the home currency may cause a net increase or net decrease in the share market index. For an example, a currency appreciation will be expected to stimulate the share market of an import-dominant country (a positive effect) and depress that of an export-dominant economy (a negative effect). A goods market model[2] (GMM) may compactly be represented as: $GMM \Rightarrow SP \leftarrow ER$, or $SP = f[ER^{(+/-)}]$ where the arrow indicates the direction of causality and the superscripted signs in the parentheses indicate positive or negative relationship.

The second approach is the portfolio balance approach to exchange rate determination[3] which asserts that a rising share market would attract capital inflows leading to increases in the demand for and appreciation of the home currency. Hence, the portfolio balance approach posits that the direction of causality runs from share prices to exchange rates. A portfolio balance model[4] (PBM) may compactly be represented as: $PBM \Rightarrow ER \leftarrow SP$, or $ER = h[SP^{(+)}]$, where the superscripted positive sign in the parentheses is used to capture the expected positive relationship.

[2] Goods market models are also known as 'flow-oriented' models.
[3] Studies that have contributed to the development of the portfolio balance approach include Dornbusch (1975, 1976, 1980), Frenkel (1976, 1993), Frenkel and Rodriguez (1975), Boyer (1977), Kouri (1976), Branson, 1977, 1984), Blanchard (1981), Branson and Buiter (1983) and Gavin (1989).
[4] Portfolio balance models are also known as 'stock oriented' models.

Empirical studies attempting to verify the relationship between exchange rates and share prices have come out with mixed results. Prior to 1992, the few studies available only tested for one-way relationships via OLS regressions without checking for stationarity or cointegration in their data series. For example, Franck and Young (1972), Ang and Ghallab (1976), Aggarwal (1981), and Soenen and Hennigar (1988) tested the goods market model by simply regressing stock prices on exchange rates. The results were not uniformly supportive of the model: Franck and Young (1972) and Ang and Ghallab (1976) found no significant relationship; Aggarwal (1981) found a significant positive relationship but Soenen and Hennigar (1988) found a significant negative relationship for the US. Solnik (1987), testing the portfolio balance model for the world's eight largest economies, found only very weak evidence in support of the portfolio balance approach. It must be noted, however, that the correlation that OLS regression unearths does not necessarily imply causality.

One of the first studies to test the portfolio balance model and account for the possibility of two-way relationships is Bahmani-Oskooee and Sohrabian (1992). Using the Granger concept of causality[5] and cointegration, the authors were able to show that in the short run there is dual causal relationship between the US stock prices measured by the monthly S&P 500 index and the effective exchange rate of the US dollar for the period 1973-88. Since then, other investigators have used similar econometric procedures and have reported sundry results.

Ajayi and Mougoue (1996) found conflicting short-run and long-run causalities for eight advanced countries; Abdalla and Murinde (1997) found evidence of uni-directional causality from stock prices to exchange rates for India, Korea and Pakistan. Ajayi *et al.* (1998) however, found this causality to be the opposite for the US and South Korea. Phylaktis and Ravazzolo (2000) and Wu (2000) provide evidence supporting the goods market approach for many Asian countries, whilst Yu (1997) reported conflicting results for Hong Kong, Japan and Singapore. Granger *et al.* (2000) found mixed results for Asian countries. Ramasamy and Yeung (2001) found the direction of causality to vary, depending upon the time period analysed. It would seem from all the available studies that regardless of the countries, periods, industries, data frequency, share market indices and exchange rates studied, there is no uniform conclusion.[6] Some authors have attempted to adduce reasons for the disparities in empirical findings. Ajayi *et al.* (1998) speculate that the disparity between the developed and developing economies' financial markets are a consequence of differences in foreign access and exchange rate controls. Granger *et al.* (2000) proffer that barriers to capital movement were a critical influence on their results. Nieh and Lee (2001) reckon their mixed results for the G-7 countries were due to inter-country differences in government policies, the degree of internationalisation, liberalisation and capital control. In the end, one would have to agree with Ramasamy and Yeung (2001) that whether stock price movements cause exchange rate volatility, or vice versa, is country and period dependent. But the finding could also be dependent on the methodology.

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[5] Given two inter-related time series X(t) and Y(t), it is said X Granger causes Y (i.e., $X \rightarrow Y$) if past values of X are useful (in addition to past values of Y) for predicting Y. Granger causality is concerned with short-run forecastability.

[6] Stavarek (2004) provides an extensive review of the empirical studies on the topic.

The presence of cointegrating variables requires the inclusion of lagged residuals from the cointegrating regression in an error correction model to ensure convergence towards long run equilibrium (Engle and Granger, 1987). Granger (1988) emphasises that the omission of the error correcting mechanism may lead to incorrect conclusions. Bahmani-Oskooee and Sohrabian (1992), Ajayi *et al*. (1998) and Mishra (2004) failed to include this term. For the latter two studies, the omission of the error correcting mechanism resulted because cointegration was not tested for.

Another issue of contention is omitted variable bias. Because most of the studies utilised a two-variable framework[7] to investigate the relationship between exchange rates and share prices (e.g., Mishra, 2004; Muhammad and Rasheed, 2003; and Granger *et al.*, 2000), they reported pair-wise Granger causality and also left out potentially important determinants of both exchange rates and stock prices. For instance, the theory of uncovered interest parity (UIP)[8] shows the exchange rate to be influenced by the difference between the domestic and foreign interest rates. Relatively higher domestic interest rates spur foreign capital inflows and also depress share prices. Furthermore, in the fundamentals-based valuation of equities, the price of a stock is equal to the sum of the discounted expected future dividends that depend on an array of factors including interest rate changes. Granger (1969, p. 429) warned empirical results are at risk of becoming spurious where relevant variables are omitted in testing bivariate causality. Caporale and Pittis (1997) found causality to be sensitive to relevant variable omission. Phylaktis and Ravazzolo (2000) also noted the problem of variable omission. Additionally, Ibrahim (2000) was critical of the bivariate framework tested for by Bahmani-Oskooee and Sohrabian (1992), Yu (1997), Abdalla and Murinde (1997).

In view of the methodological weaknesses noted above, this study will include domestic and foreign interest rates to the exchange rate and share price variables in a multivariate framework. To ameliorate the omitted variable bias problem further, the NZ trade-weighted foreign exchange index (TWI) will be decomposed into the constituent rates so as to capture the influence of cross rates. It is conceivable that the exchange rates comprising the TWI can move in opposite and diverse directions and still leave the TWI unchanged. But in the process, the impacts of the various movements on the different firms can lead to non-zero changes in the share market index. We would like to be able to reflect such differential effects if they exist.

The proposed methodology is the cointegrating VAR. In that context, the bi-variate Granger causality is of limited usefulness. A more appropriate measure of causality is the block Granger causality whereby we ascertain the direction of causality between a given variable and the rest of the variables in the model considered as a group. The null hypothesis of the test is that the given variable is not block Granger-caused by the

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[7] The two-variable framework relates one share market index to one exchange rate. For the share market index, discretion is exercised in choosing any of the well-documented series for the country. For the exchange rate variable researchers have opted to utilise either the bilateral nominal or real exchange rate or the multilateral (i.e., trade weighted) nominal or real effective exchange rate. Preferences may be rationalised by the authors but there does not seem to be demonstrated universal superiority of one set of variables over another.

[8] For an exposition on the theory of uncovered interest parity, see Miles and Scott (2005, pp. 532-537).

other variables. If the null is not rejected it means the nominated variable Granger-causes the other variables taken as a single group but the other variables as a block do not jointly Granger-cause the given variable. It is then concluded that the nominated variable is characterised by block Granger noncausality; the converse is correct. In the VAR methodology, the conjunction of Granger noncausality and weak exogeneity[9] classifies a variable as being strongly exogenous. Weak exogeneity is required for efficient estimation and testing of parameters; strong exogeneity ensures valid conditional forecasting (Ericsson, 1992). And in VAR analysis where the generation of impulse responses is a key analytical result, the selection of the variable(s) to be shocked must be buttressed by exogeneity properties.

3. DATA AND METHODOLOGY

3.1 Data Sources and Description

The exchange rates utilised in the study are for those currencies used in constructing New Zealand's trade weighted index (TWI) series. These are the New Zealand dollar (NZD) exchange rates with the US dollar (USD, weighted 0.3171), the Australian dollar (AUD, weighted 0.1861), the Japanese yen (JPY, weighted 0.1740), the British pound (GBP, weighted 0.0669), and the euro (EURO, weighted 0.2559). The exchange rate convention applied is the price of the domestic currency (i.e., the NZD) in units of the foreign currency; hence an increase implies appreciation of the NZD, and a decrease implies a depreciation of the NZD. As explained earlier, we are using the disaggregated exchange rates of the TWI in an attempt to ameliorate the omitted variable bias and also to capture the effects of cross rates.

Share market performance in NZ is captured with a variety of indices. This study will consider the four most popular alternative indices initially to determine which will best serve our modelling purposes. The four share market indices considered are: (i) NZSXALL – the NZ share market index covering all listed companies; (ii) NZSX10 – the NZ share market index covering the ten largest listed companies; (iii) NZSX50 – the NZ share market index covering the fifty largest listed companies; and (iv) MidCap30 (shortened to MCAP30) – the NZ share market index covering the fifty largest listed companies minus the top 10 and the bottom 10 in that group. The domestic interest rate used is the 90-day bank bill rates and the 'foreign' interest rate used is the rate on US 3-month Eurodollar deposits. The daily data on all the variables were sourced from http://www.globalfinancialdata.com, the URL of Global Financial Data, one of the most important official providers of financial data worldwide.[10] Since it is the domestic and foreign interest rate differential that is of importance, the

[9] If a variable in a system is influencing the long-run development of the other variables of the system but is itself not influenced by them, then the variable is said to be weakly exogenous (Ericsson, 1992).

[10] The NZSXALL series utilised from the Global Financial Data is the 'NZSE All-Share Capital Index' (series ID No. NZCID) which is a composite stock index and not the alternative' NZSE Gross All-Share Index' (series ID No. NZGID) which is a total return stock index. The former is based on the prices of stocks excluding dividends; the latter includes both the changes in the price of the stock and the dividends that are paid to investors and then reinvested. The NZSX50 is the 'NZSX50 Benchmark Index' (series ID No. NZ50D) which is a total return stock index. NZSX10 (which is the 'NZSE Gross Top 10 Index' with series ID No. NZ10GD) and MCAP30 (which is the 'NZSE MidCap 30 Index' with series ID No. NZMGCD) are size-and-style stock indices.

foreign interest rate was subtracted from the domestic interest rate to create the requisite variable dubbed IDIFF (suggesting interest rate difference).

Weekly averages were calculated from the daily data covering the period 1st January 1999 to 30th June 2006. The start of the sample period was dictated by the availability of data on the euro which came into being on 1st January 1999, and the end of the sample period was the latest date we could obtain data before we commenced our analysis. That approach produced 391 observations on each variable in the sample. The resulting dataset constituted our 'raw data'. We used weekly data because, just as Yang (2003), we are convinced that data of higher frequency (e.g., daily or intraday) will contain too much noise whilst data of lower frequency (e.g., monthly or quarterly) will not capture the information content of changes in stock prices and exchange rates. Also, given that VAR and other time series models tend to be quite 'data hungry', we wanted a sample of at least 100 observations to be confident about the reliability of our results. With the study period being only about 7.5 years long, monthly or quarterly observations would not yield our target sample size.

The summary statistics of the variables are presented in Table 1. For graphical purposes, each of the variables, except IDIFF, was transformed into an index series with the first observation in the sample taking the base value of 100. The stylised indices for the exchange rates are graphed in Figure 1; those for the four share market indicators are graphed in Figure 2. As Table 1 shows, during the sample period the NZD averaged 55.24 US cents, 85.62 Australian cents, 63 Japanese yen, 33.52 British pence and 0.51 euro. The NZD fluctuated relatively most widely against the USD and the least against the AUD. The interest rate differential averaged 2.5% but was relatively the most volatile among the variables as its coefficient of variation is the highest. The share market sub-indices fluctuated much more widely than the overall index.

Table 1

Summary Statistics of NZ Exchange Rates and Share Market Performance Indicators

Variables	Minimum	Maximum	Average	Std Dev	Coef of Variation
USD	0.3955	0.7415	0.5524	0.1037	18.8%
AUD	0.7493	0.9495	0.8562	0.0517	6.0%
JPY	42.732	85.4	62.998	10.335	16.4%
GBP	0.2738	0.4075	0.3352	0.0345	10.3%
EURO	0.4424	0.6003	0.5103	0.0329	6.5%
IDIFF	-1.151	4.762	2.504	1.900	75.9%
NZSXALL	647.44	1095.96	820.672	119.223	14.5%
NZSX50	1644.81	3760.9	2287.7402	608.1382	26.6%
NZSX10	1802.57	4060.92	2551.5230	629.3232	24.7%
MCAP30	2923.434	8440.902	4719.8853	1402.9168	29.7%

A casual inspection of Figure 1 shows that during the study period, the secular trend of the exchange value of the NZD against each of the five currencies is nonlinear with a downward phase from the start of 1999 to about the end of 2001 followed by an upward phase that peaks round about end-2005 and has been descending since. This suggests a general continual depreciation of the NZD from 1999 to 2001 and the reverse from about the start of 2002 to the end of 2005 and another round of depreciations during the first half of 2006.

In Figure 2, each of the four share market indices seems to display little trend from the start of the sample period until after 2002 when each one exhibits a discernibly positive trend for the rest of the study period. The interest rate gap variable IDIFF (not graphed here) exhibits a nonlinear trend that mimics the cubic trends of the exchange rates for the study period. After staying below zero and not varying much during 1999 and 2000, the interest rate gap increased sharply during 2001 and 2002, levelled off during 2004 and started declining during 2005. These pieces of evidence illustrate the basic co-movements among the variables to be analysed.

Figure 1

Stylised Indices of the New Zealand Exchange Rates: Jan 1999 - June 2006

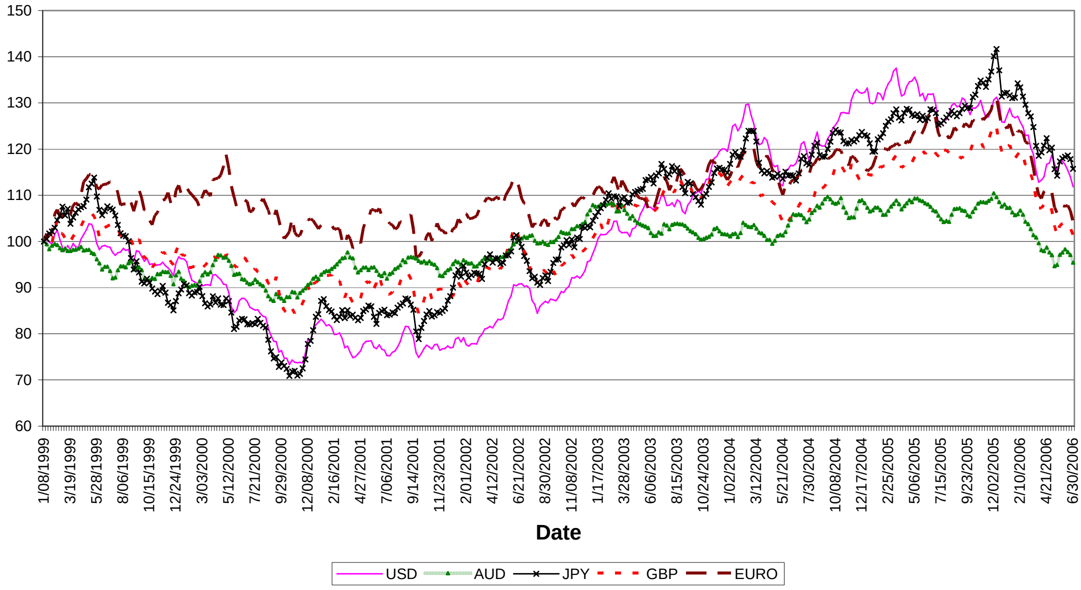
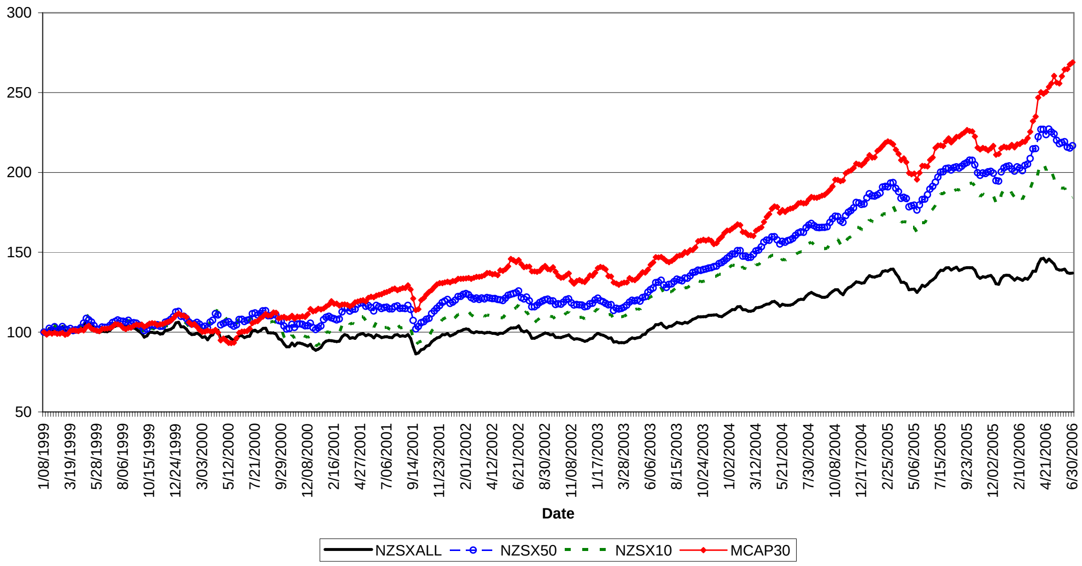


Figure 2

Stylised Indicators of the New Zealand Share Market Performance: Jan 1999 - June 2006



3.2 The Analytical Method: The Multivariate Cointegration Model

We employ the vector autoregression (VAR) approach which has become quite standard in time series modelling because, compared to the structural approach, it sidesteps the need to provide a dynamic theory specifying the relationships among the jointly determined variables; also it can handle endogenous variables on both sides of the equation as well as a mix of I(1) and I(0) variables in one system. In a VAR system, each variable is regressed on its own lags plus the lags of the other variables. The appropriate lag length (p), which should be specified long enough for the residuals not to be serially correlated, can be determined using standard model selection criteria such as the AIC (Akaike Information Criterion), SBC (Schwarz-Bayesian Criterion) and HQC (Hannan-Quinn Criterion). The VAR model can also be used to test for weak exogeneity and parameter restrictions.

Assume $\mathbf{X_t}$ is a vector of k-jointly determined endogenous variables and $\mathbf{W_t}$ is a vector of m exogenous variables. A pth order VAR model of the inter-related time series, VAR(p), can be written as:

$$X_t = \sum_{i=1}^{p} \Phi_i X_{t-i} + \Psi W_t + \varepsilon_t \qquad (1)$$

where Φ_i and Ψ are matrices of coefficients to be estimated, and ε_t is a vector of independent and identically distributed disturbances. If the endogenous variables are each I(1) we can write the VAR(p) model as a vector error correction model (VECM):

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Psi W_t + \varepsilon_t \qquad (2)$$

where $\Pi = \sum_{i=1}^{p} \Phi_i - I$, and $\Gamma_i = -\sum_{j=i+1}^{p} \Phi_j$

Granger's Representation Theorem asserts that if the coefficient matrix Π has reduced rank (i.e., rank(Π) = r < k) then there exist k-by-r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta'\mathbf{X}_t$ is I(0). The rank r is the number of cointegrating relations and each column of β is the cointegrating vector (CV). The Johansen maximum likelihood estimation procedure (Johansen, 1988, 1991, 1990, 1995a; Johansen and Juselius, 1990) can be used to estimate the two matrices α and β and to test for the number of distinct CVs. Restrictions on the elements of β help to determine which variables are relevant in the long-run relations; economic theory may have to be invoked to decide on the restrictions to impose on each CV (Johansen, 1995b). The elements of α are known as the adjustment parameters in the VECM. Restrictions on the adjustment parameters help to determine which variables are weakly exogenous.

As the coefficients of the VECM only reveal the direct effects, the VAR analysis relies a great deal on impulse response functions (IRFs) that capture the direct and indirect effects. IRFs trace out the time paths of the effect of a shock in a nominated variable on each of the other variables in the system. From them we can determine the extent to which an exogenous shock causes short-run and long-run changes in the respective variables. Two types of IRFs can be generated: orthogonalised and generalised IRFs. Whereas orthogonalised IRFs depend on the order in which the variables are arranged in a VAR model, generalised IRFs are invariant to the ordering of variables (Pesaran and Shin, 1998). For that reason, generalised IRFs are preferable. These concepts are amply described in texts such as Enders (1995), Hamilton (1994), Harris (1995) and Johnston and Di Nardo (1997).

For a meaningful set of variables for our model we had to rationalise which stock market indices to include. For simplicity and plausibility we wanted to effect our analysis with stock price indices that excluded dividends. As explained in a footnote in Section 3.1, the overall share market index (NZSXALL) we are using is a composite stock index, not a total return stock index. However, NZSX50, being a total return stock index does not satisfy our criterion and so it will be excluded. It is widely known that the top ten listed companies account for an inordinately high proportion of the total capitalisation of the NZ share market. Thus, NZSXALL is so highly correlated with NZSX10 (0.978 by our calculation) that for our modelling purposes it would be tautological to include NZSX10 with NZSXALL. Compared to the big firms, the nature and degree of internationalisation of the firms covered by MCAP30 lead us to think that their influences and responses in the financial market dynamics may be qualitatively and quantitatively different to warrant inclusion of MCAP30 to capture how differently the medium-sized companies feature. Hence, the eight variables selected for inclusion in the model are: USD, AUD, JPY, GBP, EURO, IDIFF, NZSXALL and MCAP30.

Before implementing the VAR/VECM and the attendant statistical tests, all the selected variables were transformed. Straightforward natural logarithms of all the variables, except IDIFF, were generated. The regression coefficients of such logged variables may be interpreted as elasticities or percentage changes. IDIFF contains some negative values and negative numbers do not have logarithms. The transformation of IDIFF was effected by re-expressing the interest rates in decimal format, rather than in percentages. This meant the observations on IDIFF ranged from

-0.01151 to 0.04762 (see Table 1). For variables with such a tight range clustered around zero, the log of the sum of 1 and the value of the variable is approximately equal to the original value (i.e., $ln(1 + y) \cong y$, where y represents the variable).[11] This equivalence means modelling with the levels of IDIFF in the decimal format would give the same results as the log of the sum of IDIFF and a scalar of 1. With either transformation of IDIFF, its regression coefficient would reflect a levels effect or a *percentage point* change which is intuitively more meaningful for an interest rate variable (rather than a percentage change). The transformation we applied is the log of the sum of IDIFF in decimals and a scalar of 1. From this point onwards, the variables must be understood to be the appropriately transformed versions of the original ones. The correlations between the variables are reported in Table 2 where it will be noticed that among the exchange rates, the most important one, USD, has comparatively its highest correlation with GBP and its lowest correlation with AUD. The software EViews5 was used for all the computations.

Table 2

Correlation Matrix of the Variables Used in the Cointegrating VAR Model

	USD	AUD	JPY	GBP	EURO	IDIFF	NZSX ALL	MCAP 30
USD	1.000							
AUD	0.801	1.000						
JPY	0.941	0.868	1.000					
GBP	0.966	0.831	0.952	1.000				
EURO	0.867	0.733	0.833	0.912	1.000			
IDIFF	0.356	0.640	0.454	0.386	0.273	1.000		
NZSX ALL	0.856	0.624	0.827	0.809	0.770	0.383	1.000	
MCAP 30	0.762	0.711	0.797	0.731	0.664	0.675	0.902	1.000

4. ANALYTICAL RESULTS

4.1 Pre-Modelling Tests: Unit Root, VAR Order, Pair-wise Granger Causality, Cointegration

To check the order of integration of each of the variables in the system, the well-known ADF (Augmented Dickey Fuller) and PP (Phillips-Perron) unit root tests were implemented. The results, reported in Table 3, indicate that each of the variables is integrated of order 1 (i.e., each variable is I(1)).

Basing the choice of the order of the VAR model on the Akaike Information Criterion (AIC), the general-to-specific approach led to the selection of order 2 (i.e., an unrestricted VAR(2)).

[11] See Wooldridge (2003, pp. 187-189) for an elaboration on logarithmic transformation of variables.

Table 3

Results of the Unit Root Tests

Variable	ADF		PP	
	Levels	1st Differences	Levels	1st Differences
USD	-1.7868	-14.2864	-1.6806	-14.1451
AUD	-1.9474	-14.8422	-2.0011	-14.7432
JPY	-2.1453	-15.1065	-2.0033	-14.9828
GBP	-1.6944	-13.4138	-1.6724	-15.0332
EURO	-2.0774	-14.3508	-2.1308	-15.5030
IDIFF	1.3012	-13.9563	1.2738	-14.1173
NZSXALL	-2.3111	-13.1933	-2.0938	-15.6362
MCAP30	-2.4034	-9.5001	-2.2060	-14.9181

Notes

The 5% critical value (constant with trend) is -3.4214.

To ascertain the existence of long-run relationships among the variables, the Johansen cointegration test was implemented. The estimated trace (λ_{trace}) and maximal eigenvalue (λ_{max}) test statistics and their corresponding 5% critical values are reported in Table 4. The trace statistic tests the null hypothesis that the number of cointegrating vectors, or rank(Π), is less than or equal to r (where r = 0, 1, … k-1, for k endogenous variables) against the general alternative that the number of cointegrating vectors is greater than r (i.e., $\lambda_{trace} \Rightarrow H_0$: rank(Π) ≤ r; H_1: rank(Π) ≥ r+1). The maximal eigenvalue statistic tests the same null hypothesis against the alternative that the number of cointegrating vectors is equal to r+1 (i.e., $\lambda_{max} \Rightarrow H_0$: rank(Π) ≤ r; H_1: rank(Π) = r+1). Whereas the maximal eigenvalue test suggests there is only one cointegrating relationship among the variables, the trace test indicates there are two cointegrating relationships among the variables. From the discussions on the theoretical and empirical literature expounded in Section 2, there are two contending theories (the portfolio balance theory and the goods market theory) either of which is supported by empirical evidence from different studies. It may therefore be inferred that there are two types of relationship between exchange rates and share market indices based on these two theories. Consequently we accepted the trace test result and concluded there are two cointegrating relationships among the variables. This means we shall require to impose two restrictions and two normalisations so as to exactly identify the long-run model before testing over-identifying restrictions.

Table 4

The Johansen Cointegration Test Results

Eigenvalue	Null Hypothesis	Maximal Eigenvalue (λ_{max})		Trace Test (λ_{trace})	
		Test stat	5% CV	Test stat	5% CV
0.139937	r = 0	58.64148	48.87720	176.2255	143.6691
0.098242	r ≤ 1	40.22614	42.77219	117.5840	111.7805
0.056982	r ≤ 2	22.82241	36.63019	77.35784	83.93712
0.040299	r ≤ 3	16.00082	30.43961	54.53542	60.06141
0.039475	r ≤ 4	15.66719	24.15921	38.53460	40.17493
0.032351	r ≤ 5	12.79256	17.79730	22.86741	24.27596
0.021404	r ≤ 6	8.416435	11.22480	10.07485	12.32090
0.004254	r ≤ 7	1.658418	4.129906	1.658418	4.129906

Notes CV = critical value.

To operationalise the two cointegrating relationships, the first cointegrating vector, CV1, was used to reflect the portfolio balance model and the second cointegrating vector, CV2, was used to reflect the goods market model. In CV1, the relevant variables that are candidates for normalising on are the five exchange rates. Since USD is the most popular and the most important exchange rate, CV1 was normalised on USD. In CV2 the principal variable for normalising on is NZSXALL.

For some idea about the underlying causalities among the variables, the results of the pair-wise Granger causality tests on the unrestricted VAR(2) model of the variables are summarised in Table 5. We have employed the single-headed arrows '←' and '→' to indicate unidirectional causality and the double-headed arrow '↔' to indicate bidirectional causality. The applicable level of significance is 5%. There is bi-directional causality between each of the exchange rates USD, AUD and JPY and IDIFF and NZSXALL. For the other exchange rates, uni-directional causality runs from NZSXALL (the stock market) to GBP and EURO. We may infer that at the basic analytical level, there is evidence that the NZ share market has bi-directional causality with three exchange rates, and in the case of two other exchange rates the portfolio balance theory is supported.

Table 5

Results of the Pair-wise Granger Causality Tests

Variable	USD	AUD	JPY	GBP	EURO	IDIFF	NZSXALL	MCAP30
USD	N.A.				→	↔	↔	
AUD		N.A.	→	→	→	↔	↔	→
JPY		←	N.A.	→	→	↔	↔	
GBP		←	←	N.A.	→	→	←	
EURO	←	←	←	←	N.A.	→	←	
IDIFF	↔	↔	↔	←	←	N.A.	←	←
NZSXALL	↔	↔	↔	→	→	→	N.A.	
MCAP30		←				→		N.A.

Notes

The right-pointing arrow (→) implies the row variable Granger-causes the column variable and the left-pointing arrow (←) implies the row variable is Granger-caused by the column variable. The double-headed arrow (↔) means the row variable Granger-causes and is Granger-caused by the column variable (i.e., there is reverse or bidirectional causality between the row variable and the column variable).

In the subsequent empirical cointegrating VAR model, as mentioned earlier, CV1 was normalised on USD and CV2 was normalised on NZSXALL. For the restrictions that exactly identify the cointegrating relations, a zero restriction was imposed on AUD in CV1 (because USD had its lowest correlation with AUD among the exchange rates) and a zero restriction was imposed on MCAP30 in CV2 so as to focus on the long term influences of the different exchange rates on the overall performance of the NZ share market. An examination of the results from the just-identified restrictions showed that EURO and JPY in CV2 were not statistically significant leading to the imposition of the over-identifying restrictions of zero on both EURO and JPY in CV2. With the chi-square test statistic $\chi^2_{(2)}$ of 0.6453 and a p-value of 0.7242 from the LR test of the over-identifying restrictions, the restrictions are deemed to be binding and acceptable. Hence, the final cointegrating VAR model and the subsequent VECM reflect these restrictions.

In the notation of Granger's Representation Theorem, the vector of endogenous variables in our VAR system can be written as

$$\mathbf{X} = (\text{USD AUD JPY GBP EURO IDIFF NZSXALL MCAP30})'. \qquad (3)$$

And with reference to the arrangement of the variables in the vector, the β matrix containing the two CVs can be written as

$$\beta' = \begin{pmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} & \beta_{17} & \beta_{18} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} & \beta_{27} & \beta_{28} \end{pmatrix}' \qquad (4)$$

The imposition of the over-identifying restrictions to reflect the portfolio balance model and the goods market model means the β matrix to be estimated can be represented as:

$$\beta' = \begin{pmatrix} 1 & 0 & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} & \beta_{17} & \beta_{18} \\ \beta_{21} & \beta_{22} & 0 & \beta_{24} & 0 & \beta_{26} & 1 & 0 \end{pmatrix}' \qquad (5)$$

4.2 The Cointegrating (or Long-Run) Relations

Normalising on USD and NZSXALL and imposing over-identifying restrictions, the two long-run relationships were estimated to be:

$$\mathbf{USD} = \underset{(-5.15)}{-1.3410\ \text{JPY}} + \underset{(11.43)}{5.1048\ \text{GBP}} - \underset{(-6.95)}{3.8612\ \text{EURO}} + \underset{(2.51)}{4.1451\ \text{IDIFF}}$$

$$+ \underset{(5.25)}{1.9512\ \text{NZSXALL}} - \underset{(-3.17)}{0.6217\ \text{MCAP30}} \qquad (6)$$

$$\mathbf{NZSXALL} = \underset{(4.13)}{4.7138\ \text{USD}} + \underset{(4.90)}{23.4313\ \text{AUD}} - \underset{(-14.83)}{12.6181\ \text{GBP}} - \underset{(-3.80)}{38.7878\ \text{IDIFF}} \qquad (7)$$

The figures in parentheses are t-ratios of the estimated parameters; the parameters are all significant at the 5% level. In the equation for USD, the coefficient for NZSXALL suggests that an increase in the NZSXALL index leads to an appreciation of the NZD against the US dollar (which is consistent with the portfolio balance theory). If focus was shifted to MCAP30 as the share market index, then the portfolio balance theory would not be supported by the NZ data. The positive coefficient of GBP implies the NZD appreciates (and depreciates) jointly against the US dollar and the British pound; and the negative coefficients of JPY and EURO suggest the NZD's movements against the Japanese yen and the euro are opposite to its movements against the US dollar and the British pound. The positive coefficient of IDIFF means an increase in the interest rate differential leads to an appreciation of the NZD against the US dollar, which is consistent with theory.

The parameters in the equation for NZSXALL indicate that NZSXALL shares a long-run relation with IDIFF and some of the exchange rates. The euro and the Japanese yen exchange rates are shown not to have significant long-term relationship with the NZ share market. Appreciation of the NZD against the US or Australian dollars stimulates the share market whereas an appreciation against the British pound depresses the share market. An increase in the gap between the domestic and foreign interest rates dampens down the share market which is consistent with the theoretical inverse relationship between share prices and interest rate.

4.3 The Error Correction Models (or Short Run Relations)

The estimated vector error correction models are reported in Table 6. The first row contains the dependent variables and the first column contains the independent variables. The coefficients of the error correction terms $ECT1_{(-1)}$ and $ECT2_{(-1)}$ in the second and third rows, respectively, will be discussed first. Those adjustment coefficients measure the responses of the respective dependent variables to a previous period imbalance in the relevant long-run relation; a negative sign implies a response to restore the equilibrium and a positive sign implies a response that increases the imbalance. The negative sign of the coefficient of $ECT1_{(-1)}$ in the equation for ΔUSD, combined with the negative sign of the coefficient of $ECT2_{(-1)}$ in the equation for ΔNZSXALL, accord with a priori expectations (i.e., the relationships are error correcting) and indicate the model is dynamically stable. Those negative signs mean that following a deviation in their respective long run relations in a particular period/week, both USD and NZSXALL change the next period in a direction towards the restoration of the balance. However, only about 1% of the imbalance in the long-run USD relationship is corrected in a week, and less than 1% of the disequilibrium in the NZSXALL long run relation is corrected in a week; both responses are not significant at the 5% level. These results suggest that the speed of adjustment in both the foreign exchange and share markets is extremely slow. Commenting only on the remaining adjustment parameters that are significant at the 5% level (indicated in bold print in Table 6), we note that following a deviation in the share market long-run relation, EURO responds to restore the balance but AUD and IDIFF respond in a manner that increases the imbalance. The only variables that respond significantly to an imbalance in the long-run exchange rate relation are GBP and IDIFF but their responses are not restorative; they increase the imbalance. This finding about IDIFF is consistent with exchange rate over-shooting.

The rest of the parameters in Table 6 pertain to how much the change in the dependent variable in the current period depends on changes in the various variables from the previous period. The parameters show the short-run direct effects between variables but not the total effect resulting from both direct and indirect impacts. For brevity we shall comment only on those parameters that are significant at the 5% level; these are indicated in bold font in the relevant cells in the table. An increase in NZSXALL in one period leads to an appreciation of the NZD against all the currencies in the next period. Also, an increase in NZSXALL in one period is likely to be followed by a further increase the next period; a similar persistence is observed about each of the other variables. An increase in IDIFF in one period leads to a significant appreciation of the NZD against all the currencies, except the British pound, in the next period. The NZ share market performance generally decreases following an appreciation of the NZD against the Australian dollar. Attention is drawn to the differential impacts of NZSXALL and MCAP30 on AUD. Whereas an increase in NZSXALL is followed by an increase in AUD, an increase in MCAP30 induces a reduction in AUD. In summary, in the short term, the NZD appreciates against all five currencies with an increase in the domestic and foreign interest rate differential and with a rise in the overall share market index. An autonomous appreciation of the NZD against the Australian dollar depresses the NZ share market. This suggests that the firms exposed to the Australian dollar are mostly exporters.

Table 6

The Error Correction Model Results

Variable	ΔUSD	ΔAUD	ΔJPY	ΔGBP	ΔEURO	ΔIDIFF	ΔNZSXALL	ΔMCAP30
$ECT1_{(-1)}$	-0.0087 (-1.39)	0.0037 (0.99)	-0.0083 (-1.15)	**0.0128** (2.15)	-0.0099 (-1.56)	**0.0008** (2.62)	0.0034 (0.51)	-0.0063 (-1.00)
$ECT2_{(-1)}$	-0.0002 (-0.31)	**0.0011** (2.04)	-0.0010 (-1.03)	-0.0015 (-1.85)	**-0.0019** (-2.17)	**0.0002** (3.44)	-0.0005 (-0.50)	0.0017 (1.87)
$\Delta USD_{(-1)}$	**0.3518** (4.57)	0.0696 (1.50)	0.1056 (1.20)	0.0294 (0.40)	0.0779 (1.01)	-0.0002 (-0.05)	0.0266 (0.32)	0.1312 (1.70)
$\Delta AUD_{(-1)}$	0.0608 (0.65)	**0.2436** (4.30)	-0.0452 (-0.42)	0.0386 (0.44)	0.0327 (0.35)	0.0074 (1.50)	**-0.2844** (-2.83)	**-0.2256** (-2.40)
$\Delta JPY_{(-1)}$	-0.1018 (-1.72)	-0.0253 (-0.71)	**0.1633** (2.40)	-0.0536 (-0.96)	-0.0055 (-0.09)	-0.0016 (-0.52)	0.0030 (0.05)	-0.0690 (-1.16)
$\Delta GBP_{(-1)}$	0.0384 (0.41)	-0.0500 (-0.88)	0.0700 (0.65)	**0.1900** (2.14)	-0.0579 (-0.61)	0.0051 (1.03)	0.0588 (0.58)	-0.0190 (-0.20)
$\Delta EURO_{(-1)}$	-0.0719 (-0.91)	-0.0067 (-0.14)	-0.0477 (-0.53)	-0.0003 (-0.01)	**0.1615** (2.05)	-0.0026 (-0.62)	-0.0675 (-0.80)	-0.0373 (-0.47)
$\Delta IDIFF_{(-1)}$	**1.8616** (1.99)	**1.3332** (2.36)	**3.4138** (3.18)	1.4026 (1.59)	**2.8733** (3.07)	**0.2982** (6.02)	0.2172 (0.22)	-0.9552 (-1.01)
$\Delta NZSXALL_{(-1)}$	**0.1873** (2.80)	**0.1725** (4.28)	**0.2033** (2.65)	**0.2433** (3.86)	**0.1964** (2.93)	0.0050 (1.43)	**0.1792** (2.50)	0.0335 (0.50)
$\Delta MCAP30_{(-1)}$	-0.0265 (-0.38)	**-0.1141** (-2.68)	-0.0529 (-0.65)	-0.0168 (-0.25)	-0.0573 (-0.81)	-0.0020 (-0.54)	0.0458 (0.61)	**0.2158** (3.05)
R^2	0.1475	0.1410	0.1267	0.1317	0.1089	0.1734	0.0713	0.0995
Adj. R^2	0.1272	0.1206	0.1060	0.1111	0.0877	0.1538	0.0492	0.0781

Notes

Figures in parentheses are t-ratios of the estimated parameters. Values in bold print are significant at the 5% level. The first difference operator, Δ, is used to represent 'change in'.

4.4 Dynamic Properties of the Model: Generalised Impulse Response Functions

The results of the weak exogeneity and block Granger non-causality tests are reported in Table 7. All five exchange rates are shown to be weakly exogenous. The more interesting results, however, come from the block Granger causality tests. Taken one at a time, each exchange rate is deemed to be Granger caused by the block of the other variables including the share market indices. This evidence squarely buttresses the portfolio balance theory. On the other hand, each of the two share market indices is not block Granger caused by the other variables. This evidence throws doubt on the veracity of the goods market theory for NZ. In combining the properties of block Granger non-causality and weak exogeneity, NZSXALL and MCAP30 are shown to be strongly exogenous and thus they become the principal candidate variables to shock to generate the impulse responses. Beyond that, impulse responses were also generated from shocking USD and IDIFF. The generalised impulse responses to one positive standard deviation shock in USD, NZSXALL, IDIFF and MCAP30 are presented as Figures 3 to 6, respectively.

Table 7

Results of the Block Granger Non-Causality and Weak Exogeneity Tests

Variable	H_0: Variable is not block Granger-caused by the others		H_0: Variable is weakly exogenous		Exogeneity status
	$\chi^2_{(7)}$	p-value	$\chi^2_{(4)}$	p-value	
USD	19.0018	0.0082	2.1923	0.7004	Weakly exogenous
AUD	25.4312	0.0006	4.0474	0.3996	Weakly exogenous
JPY	23.8176	0.0012	2.1938	0.7002	Weakly exogenous
GBP	27.6315	0.0003	7.1633	0.1275	Weakly exogenous
EURO	21.9380	0.0026	4.2774	0.3698	Weakly exogenous
IDIFF	7.2022	0.4081	11.0717	0.0258	Not weakly exogenous
NZSXALL	11.1597	0.1198	1.1356	0.8886	Strongly exogenous
MCAP30	12.6203	0.0819	4.5015	0.3424	Strongly exogenous

As can be gleaned from Figure 3, the impact effect of the shock in USD is positive on all the other variables, with JPY responding relatively the greatest and IDIFF responding the least. Following the positive impact effects, all the exchange rates continue to rise in subsequent weeks and eventually settle at levels above their respective impact effects. Among the exchange rates, AUD responds the least to a shock in USD. IDIFF rises an infinitesimal amount and stabilises above its pre-shock level. Concerning the share market indices, the NZSXALL stabilises at the level of its impact effect but MCAP30 gradually falls to settle at a level below its pre-shock value by about the tenth week.

The generalised impulse responses to an innovation in NZSXALL plotted in Figure 4 clearly depict positive impact effects on the rest of the variables except on AUD and IDIFF. The exchange rates with positive impact effects (USD, JPY, EURO and GBP) rise quickly in the first two weeks. Whereas USD, JPY and EURO continue their climb at a reduced rate for three more weeks and stabilise after the fifth week, GBP falls after the second week to settle subsequently at a level still higher than its impact effect and pre-shock value. After the negative impact effect, AUD recovers by the second week and settles at a level slightly higher than the pre-shock value after the third week. IDIFF remains marginally below its pre-shock level for most part of one year. This behaviour is consistent with the theoretical negative relationship between equity prices and interest rates. Overall, a sudden increase in the NZ share market index would eventually lead to an appreciation of the NZD against all five currencies but in the case of the Australian dollar, the NZD depreciates first before appreciating; the net appreciation against the Australian dollar is relatively the weakest among the currencies. The domestic-foreign interest rate differential decreases only marginally.

Figure 3

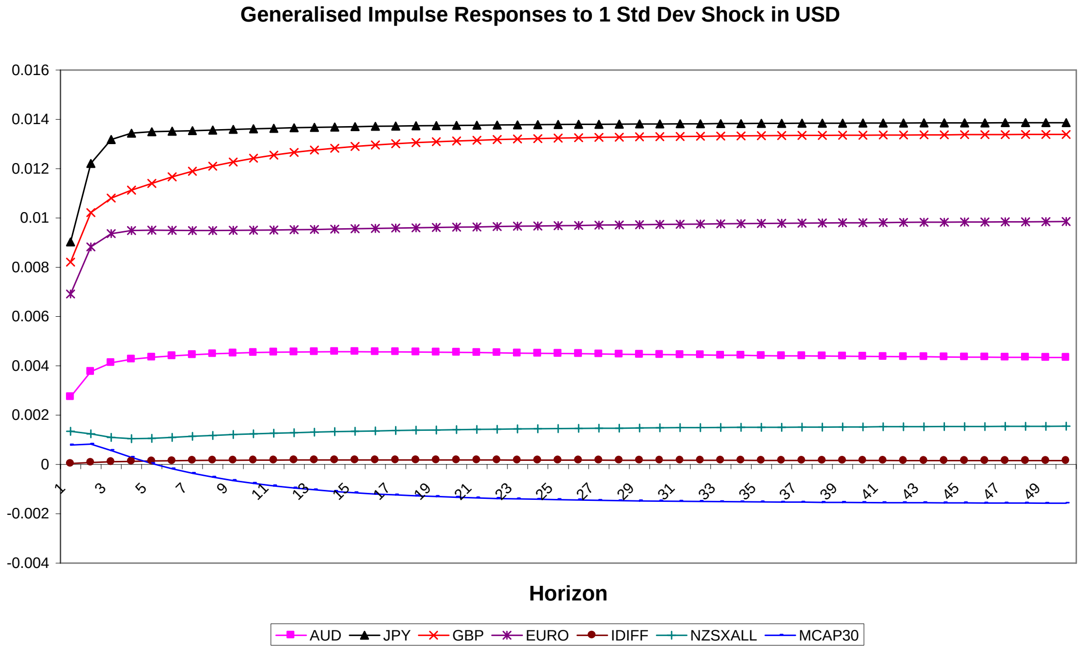
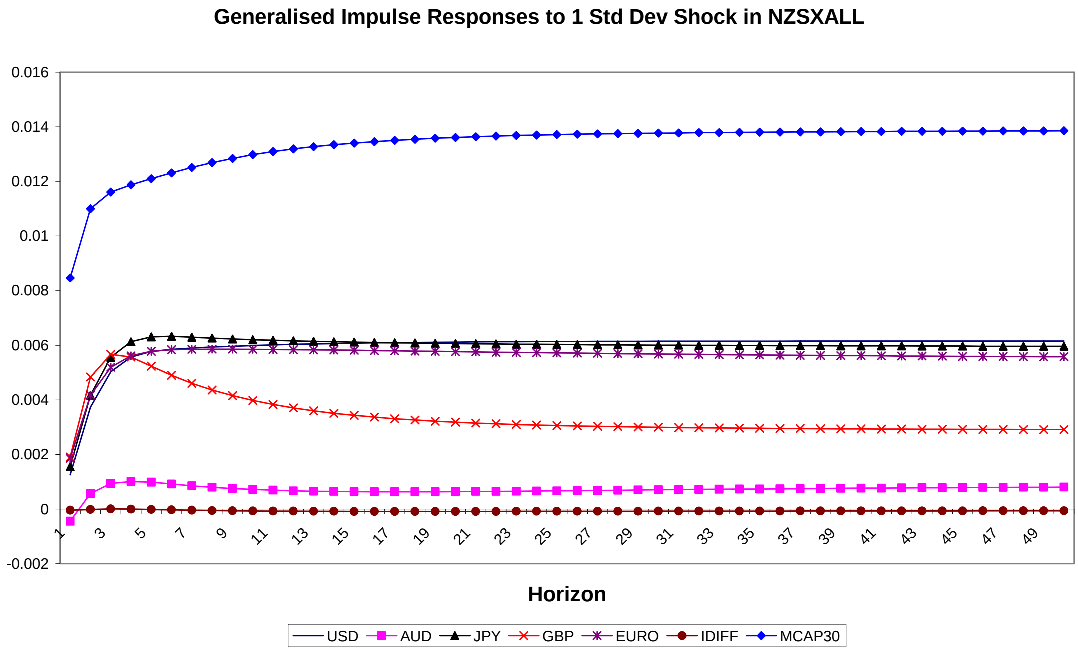
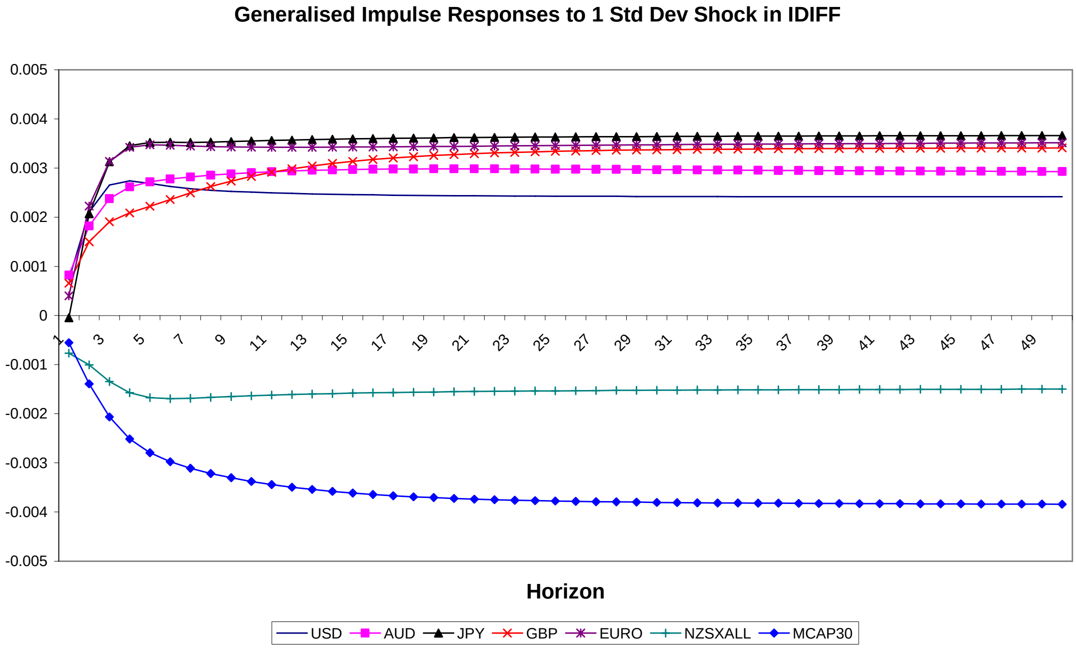


Figure 4



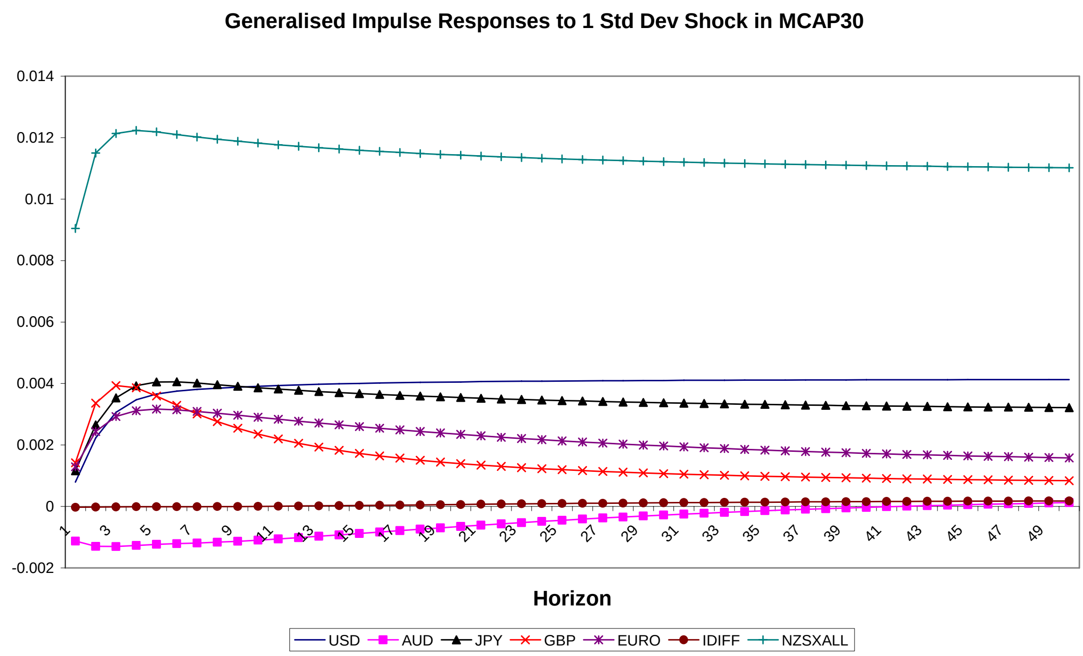
With reference to Figure 5, the impact effect of one positive standard deviation shock in IDIFF is positive for all the exchange rates except for JPY (for which it is zero) and negative for the two share market indices. All the exchange rates subsequently rise and stabilise at higher levels with GBP responding the slowest. After the initial drop, both share market indices continue to fall for some time and subsequently stabilise at levels below their respective pre-shock levels. In summary, an increase in the domestic and foreign interest rate differential leads to an appreciation of the NZD against all the currencies and decreases in the share market indices for extended periods.

Figure 5



As depicted in Figure 6, one positive standard deviation shock in MCAP30 has positive impact effects on all the variables except on AUD and IDIFF for which the impact effects are negative. IDIFF subsequently recovers after about fourteen weeks and stabilises at a level marginally higher than its pre-shock level. For its part, AUD takes more than thirty weeks before recovering to its pre-shock level. Just as in the results for shocking NZSXALL, the exchange rates with positive impact effects from an innovation in MCAP30 (i.e., USD, JPY, EURO and GBP) rise quickly in the first two weeks and exhibit different time paths thereafter. Whereas USD and JPY continue their climb at a reduced rate for three more weeks and stabilise after the fifth week, GBP and EURO gradually slide downwards after the third week to settle subsequently at levels equivalent to their respective impact effects.

Figure 6



5. SUMMARY AND CONCLUSION

Up until early 2006 many commentators had noted the high value of the NZ dollar in recent years has been hurting NZ exporters and many NZ companies faced ruin unless the currency depreciated quickly. It is to be expected that the shares of such exposed companies would be less desirable and affect the share market index. This presumes causality runs from exchange rates to the share market. But both the theory and empirical evidence are ambiguous whether it is the exchange rate that affects the share market or it is the other way round. The portfolio balance theory asserts that causality runs from the share market to the exchange rate, and the goods market theory asserts the opposite. Apart from the mixed results, the empirical studies are also ridden with methodological weaknesses such as omitted variables bias and possible spurious regression results because cointegration among the set of variables analysed was not ascertained.

The study set out to analyse the relationship between exchange rates and the share market in New Zealand using the cointegrating VAR approach that overcomes some of the problems of earlier studies. We discovered that there is bi-directional causality between the five exchange rates comprising the TWI and a couple of share market indices in both the short run and long run although different exchange rates are implicated. In the long run, the empirical results suggest both the portfolio balance and goods market theories are supported by the relationship between the NZ-US dollar exchange rate and the overall share market index. In the short run, the portfolio balance theory is supported by all the exchange rates but the goods market theory is supported significantly only by the NZ-Australian dollar exchange rate. Thus the evidence is predominantly in support of the portfolio balance theory and that the firms most at risk of foreign exchange rate exposure are those that export to Australia.

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