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Impacts of Exchange Rate Movements on Share Prices of Individual Firms in The New Zealand Headline Index: Exploration with the Autoregressive Distributed Lag Model

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Te Kunenga ki Pūrehuroa

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IMPACTS OF EXCHANGE RATE MOVEMENTS ON SHARE PRICES OF INDIVIDUAL FIRMS IN THE NEW ZEALAND HEADLINE INDEX: EXPLORATION WITH THE AUTOREGRESSIVE DISTRIBUTED LAG MODEL

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ABSTRACT

Concern in New Zealand in recent years that the sustained appreciation of the NZ dollar would undermine the viability of several NZ firms, especially the exporters, has heightened interest in exchange rate sensitivity. Empirical findings, mostly of mild or insignificant sensitivity, vary depending on the firm sample selection and models employed. Notable methodological issues include data aggregation, omitted variables, ignoring lagged responses and single-exchange-rate focus. This paper adopts the cointegration approach to the autoregressive distributed lag model to capture the lagged responses of the share prices of the individual firms in the NZ headline index to changes in five key exchange rates plus the share market index and interest rate.

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

1. INTRODUCTION

Between 1999 and 2005, the New Zealand (NZ) dollar trade weighted index (TWI)[1] increased from 56.71 to 70.42, representing an average appreciation rate of 4% per annum of the NZ dollar (NZD). During the same period, the NZ Stock Exchange All-Share Capital Index (NZSX-All) rose from 762 to 1,012, indicating an average growth rate in share prices of 5.5% per annum. NZ is a small open economy with a relatively clean float and high exchange rate pass through. Theory does suggest that appreciation of the domestic currency can hurt exporters but benefit importers. Understandably, after the TWI appreciated by nearly 17% in 2002, a lot of concern was raised about the continuing viability and therefore the share prices of both exporting and non-exporting NZ firms. However, most empirical studies investigating the responsiveness of share prices and exchange rate movements report only mild or insignificant sensitivity. Findings vary depending on the firm sample selection and models employed.

Typically, exchange rate exposure is measured with the slope coefficient of the regression of changes in firm value on changes in an exchange rate. Well known criticisms of such an approach are that variables other than exchange rate affect share prices, focus on single-currency changes rather than multiple-currency changes, use of aggregated data that obscure or mask the heterogeneous or differentiated responses by firms, and the use of static models ignores lagged responses which have been found to be significant. Where cointegration among the time series variables has not been ascertained the studies risk reporting spurious regression results. This paper addresses some of the methodological problems of previous studies by adopting the cointegration approach to the autoregressive distributed lag (ARDL) model to capture lagged responses of the share prices of the individual firms in the NZ headline index to changes in the five exchange rates in the TWI plus the share market index and interest rate.

There are at least a couple of reasons why such a study is important. First, to the extent that the adopted approach constitutes a methodological improvement, the parameters generated should be more sanguine than comparable results from previous studies. Second, the results should be of interest not only to local investors but also to foreign investors as well. Foreign ownership of the NZ share market was reported to be 55% in the year 2000 (Newman and Briggs, 2000) and 48% in 2005 (Stuff, 2006). With such a high rate of foreign ownership, the NZSE and how the share prices of its leading firms respond to movements in New Zealand’s key exchange rates should be of special interest to foreign portfolio investors concerned about the foreign exchange rate exposure of those individual firms. The focus of attention is put on the firms in the headline index because that index is the most reported, watched and studied. Presumably, the constituent firms of the headline index are the ones that attract the most attention from foreign investors.

[1] The NZ TWI is constructed from the NZ dollar exchange rates with five key currencies given the following weights as at the end of the study period: US dollar, 0.3171; Euro, 0.2559; Australian dollar, 0.1861; Japanese yen, 0.1740; and the British pound, 0.0667.

In the study, weekly data from 1999 to 2006 were analysed. Weekly data were used because the author believes data of higher frequency such as daily data would contain too much noise whilst data of lower frequency such as monthly or quarterly data would not capture the information content of changes of stock prices and exchange rates. Error-correction and long-run equilibrium models were estimated for each of the firms; the models were found to be dynamically stable. Plausible short-run and long-run parameters for the respective firms were obtained allowing the characterisation of the magnitude and direction of response of the share price of each of the firms to changes in each of the five exchange rates. The speed of adjustment ranged from 1.1% to 16.9% with an average of 7.9% per week; the long-run multipliers are larger than their short-run counterparts, as expected. The responses do not seem to be sector driven but more by individual firm characteristics.

The rest of the paper is organised as follows. Section 2 presents a review of the relevant literature. Section 3 deals with the data and methodology. Section 4 presents the analytical results and Section 5 summarises and concludes the paper.

2. LITERATURE REVIEW

It is widely known that traders use their assessment of an asset's risk and return characteristics to determine its value. Assuming efficient securities market, the fundamentals-based valuation posits that the price of a stock is the net present value NPV of the cash flows (i.e., the dividends and capital gains expected during the holding period) discounted at the required rate of return which in turn can be assessed from the risk variable beta and the capital asset pricing model CAPM. In an open economy, changes in foreign exchange rates lead to changes in the relative prices of domestic and foreign goods impacting on the cash flows of primarily exporters and importers and also on domestically oriented firms through price linkages with their suppliers and competitors. Essentially, exchange rate fluctuations introduce an extra element of risk in the market valuation of firms that is expressed as the responsiveness of share prices to the changes in exchange rate. Empirically, the exchange rate exposure of a firm is captured with the slope coefficient of the exchange rate variable in the regression of changes in firm value on changes in an exchange rate (Adler and Dumas, 1984; Jorion, 1990). The value of the firm may be proxied by either the price of the stock or the rate of return on the stock.

The discounted cash flow model and efficient market hypothesis predict significant and immediate responsiveness of share prices to changes in exchange rates. However, empirical studies report mixed results of mild or no significant sensitivity which seem to depend on the firm sample selection and models employed. Studies reporting significant but lower-than-expected sensitivity include Booth and Rotenberg (1990), Frennberg (1994) and Choi and Prasad (1995); those reporting weak or insignificant sensitivity include Jorion (1990), Amihud (1994), Doidge *et al*. (2000), Gao (2000), Griffin and Stulz (2001) and Di Iorio and Faff (2002). On the speed of response, Bartov and Bodnar (1994) discovered insignificant contemporaneous but significant lagged responses whilst Donnelly and Sheehy (1996) found significant contemporaneous and lagged responses. Others found significant responsiveness only over a long horizon (e.g., Allayannis, 1997; Chow *et al*., 1997; and Bodnar and Wong, 2000). Jorion (1990) and Choi and Prasad (1995) found variation in exchange rate exposure across firms driven by the scope of foreign transactions when individual firm data were analysed but insignificant sensitivity when grouped data were utilised.

The limited empirical success in finding significant and contemporaneous exchange rate sensitivity of share prices has been attributed to methodological weaknesses in the various studies and/or a failure of the underlying theory. Frennberg (1994) pointed out that the slope coefficient from the simple regression models used as a measure of exchange rate exposure suffers from omitted variable bias since factors other than exchange rate affect share price. In addition, the use of aggregated data masks the heterogeneous responses by firms. Frennberg's prescription was to concentrate analysis on large exchange rate movements. The discovery of significant lagged responses by Jorion (1990, 1991), Bartov and Bodnar (1994) and Donnelly and Sheehy (1996) casts doubt on the efficient market hypothesis. That would imply that the use of static OLS regression models may be inappropriate. Lately, Chen *et al*. (2004) have argued that the finding of insignificant sensitivity is a peculiarity of studies on large markets such as the US and UK where the companies are fairly diversified and are influenced more by domestic factors than international factors. They show that for a small open economy such as New Zealand with a high exchange rate pass through and relatively less diversified companies whose cash flows are vulnerable to international developments, exchange rate movements do affect the value of listed firms; the direction and degree of sensitivity is dependent on the currency.

Given the mixed and disappointing empirical findings and the noted methodological weaknesses of past studies, newer studies must demonstrate that they have addressed the lingering contentious issues. These have been outlined by Chen *et al*. (2004). In their review of the empirical literature the authors summarise that there are two methodological problems contributing to the findings of insignificant sensitivity: the sample selection hypothesis (i.e., the sampling together of firms with contrasting characteristics in relation to the direction and intensity of exposure, hedging activities and breadth of diversification); and the lagged response hypothesis (i.e., there is some amount of inertia in the market owing to difficulties and uncertainty in sorting out the responses of individual firms, the permanency of the change in the exchange rate, the impact of hedging and the multifaceted nature of the impact of multi-currency changes). Out of these flow five methodological issues: (i) there are significant lagged responses that imply inefficiencies in the market rendering the use of static regression models questionable; (ii) aggregation of firms or use of portfolios masks individual firm responses; (iii) major data selection problems owing to the complexity of the response of a firm's NPV to an exchange rate change; (iv) the indirect effect of the exchange rate change via its effect on the overall market index is often not separated from its direct effect on the firm's value; (v) focus on response to single-currency changes ignores the fact that reality is characterised by multiple-currency changes.

In their own approach Chen *et al*. (2004) specified a menu of four alternative equations repeated here with slightly modified notation as Equations (1a) to (1d):

$$SP_t = a_{10} + b_1 ER_t + e_{t1} \quad (1a)$$

$$SP_t = a_{20} + b_2 ER_t + cSMI_t + e_{t2} \quad (1b)$$

$$SMI_t = a_{30} + b_3 ER_t + e_{t3} \quad (1c)$$

$$\begin{aligned} SP_t &= a_{20} + b_2 ER_t + c(a_{30} + b_3 ER_t + e_{t3}) + e_{t2} \\ &= [a_{20} + ca_{30}] + (b_2 + cb_3)ER_t + ce_{t3} + e_{t2} \\ &= a_{40} + b_4 ER_t + c\hat{e}_{t3} + u_t \quad (1d) \end{aligned}$$

where SP stands for share price; ER stands for exchange rate; SMI stands for share market index; the a's, b's and c are parameters to be estimated; and the e's and u are error terms. Equation (1a) is the basic simple regression model as employed in older studies but which suffers from omitted relevant variables; b_1 is a measure of exchange rate exposure. Equation (1b) extends (1a) by adding SMI to capture the indirect effect of market influences on the share price whilst ER captures the direct effect. But as it is known that exchange rate movements can impact on the whole market, Equation (1b) does suffer from multicollinearity. The extent of the correlation between SMI and ER is captured with Equation (1c). To ameliorate the multicollinearity problem and still reflect the direct and indirect effects, Equation (1c) is substituted into Equation (1a) to yield Equation (1d) where the estimated residual from Equation (1c), $\hat{e}_{t3}$, which is orthogonal to SMI replaces the latter in Equation (1d). The authors used Equations (1a), (1b) and (1d) to estimate and test hypotheses on the exchange rate exposure of NZ firms. Different exchange rates in turn (i.e., the NZD TWI, the NZD-US dollar rate and the NZD-Australian dollar rate) and pooled share returns of different horizons were used. They found that sensitivity was relatively higher in the representative small open economy than in large economies like the US and UK. Although time series variables were utilised, the analytical approach adopted by Chen *et al*. (2004) did not allow a check for unit roots and cointegration to ascertain that the regressions were not spurious.

The current study takes a different route to address the issues. On the single-currency focus issue, this study proposes to simultaneously consider changes in the five currencies on which the NZD TWI is based. This will allow the model to reflect the influences of cross rates. To capture the direct and indirect effects of exchange rate movements this study will retain the overall share market index SMI and add an interest rate variable as an extra determinant of share price in a bid to moderate the omitted variables issue. To address the aggregation problem, disaggregated or individual firm data will be used. In the estimation of the parameters the study takes the cointegration approach to the autoregressive distributed lag model in order to capture the lagged responses on the way to establishing the long-run relationship between share prices and the exchange rates. The next section spells out how all this will be accomplished.

3. DATA AND METHODOLOGY

3.1 The Data

Data on the weekly share prices of firms covered by the headline index from January 1999 to September 2006 were purchased directly from the New Zealand Stock Exchange (NZSE), Wellington. The start of the study 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 that data could be obtained prior to the commencement of the analysis. The relevant headline index was the NZSE 40 (from January 1999 to April 2003) covering 40 firms and the NZX 50 (since May 2003) covering the top 50 firms. In all, 116 different firms were involved. However, for a variety of reasons, not all firms stayed on the lists for significantly long periods: there were late entries, early exits and gaps in the data for some firms over the study period. For the study's analytical purposes, it was desirable to have the largest number of firms with continuous data for the longest period. It was found that only 24 firms had continuous data from January 1999 to September 2006, yielding 392 observations per firm. The remaining firms either featured continuously at different sub-periods or had gaps in their price series. Using the above-mentioned sampling criterion, an examination of the raw data matrix showed that the optimal sample was for 41 firms covering the period January 2000 to March 2006, yielding 316 observations for each of those firms. For comparability of the analytical results the model estimation was effected for each of the 41 firms using data covering January 2000 to March 2006. The company names and the NZSE codes of the sampled firms are provided in Table 1. The exchange rate and interest rate data were sourced from the website of Global Financial Data.

During the study period, the NZD averaged 55.53 US cents, 85.58 Australian cents, 63.35 Japanese yen, 33.54 British pence and 0.515 euro. The TWI averaged 59.34 with a low of 46.47 and a high of 73.52. The nominal interest rate fluctuated between 4.0% and 7.7% averaging 6.1% whilst the NZSX-All wiggled upwards from 644 to 1107. For an appreciation of the movements of these variables each has been transformed into an index series with the first observation in the sample taking the value of 1.00. Those stylised indices have been graphed in Figures 1 and 2. Figure 1 depicts the changes in the interest rate NIR, the TWI and the share market index NZSX-All. There seems to be reasonably close positive association between TWI and NZSX-All for most of the time but an inverse relationship between those two variables and interest rate. The TWI falls gradually through 1999 and 2000 and climbs steadily thereafter peaking at end of 2005 and falls steeply the first half of 2006 but reverses during the second half of 2006. Figure 2 demonstrates broad co-movements among all the exchange rates consistent with a general depreciation of the NZD from 1999 to 2000, a sustained appreciation from 2001 to 2005, a brief depreciation the first half of 2006 and recovery through the second half of that year. An examination of the share prices of the firms reveals unique historical time paths that are difficult to generalise. Owing to space limitation it is not practical to illustrate the individual time paths of the share prices of all the 41 firms.

Figure 1: The New Zealand TWI, Share Market Index and Interest Rate 1999-2006

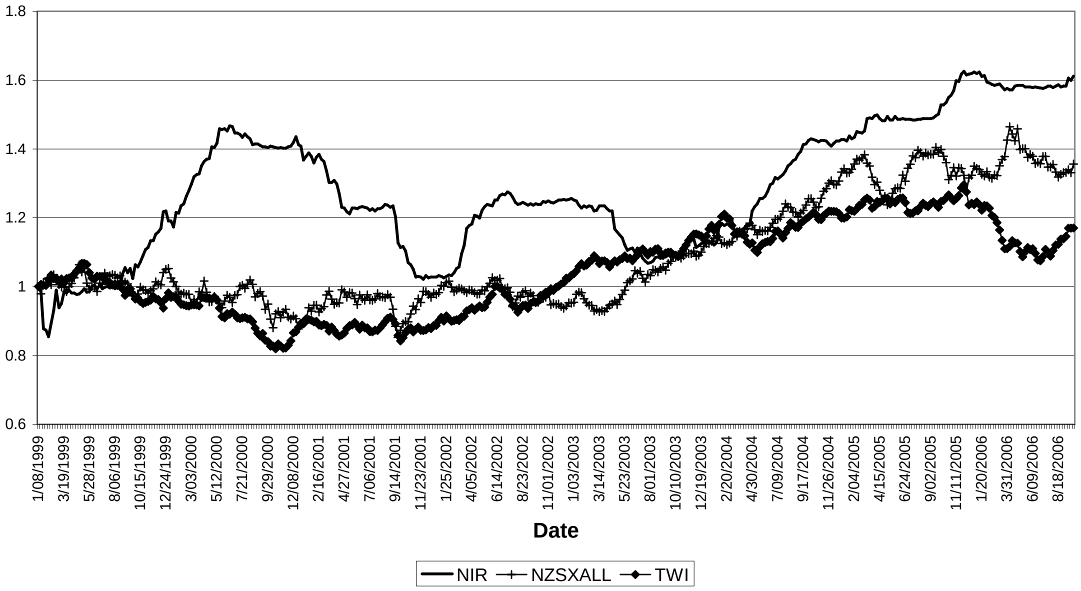
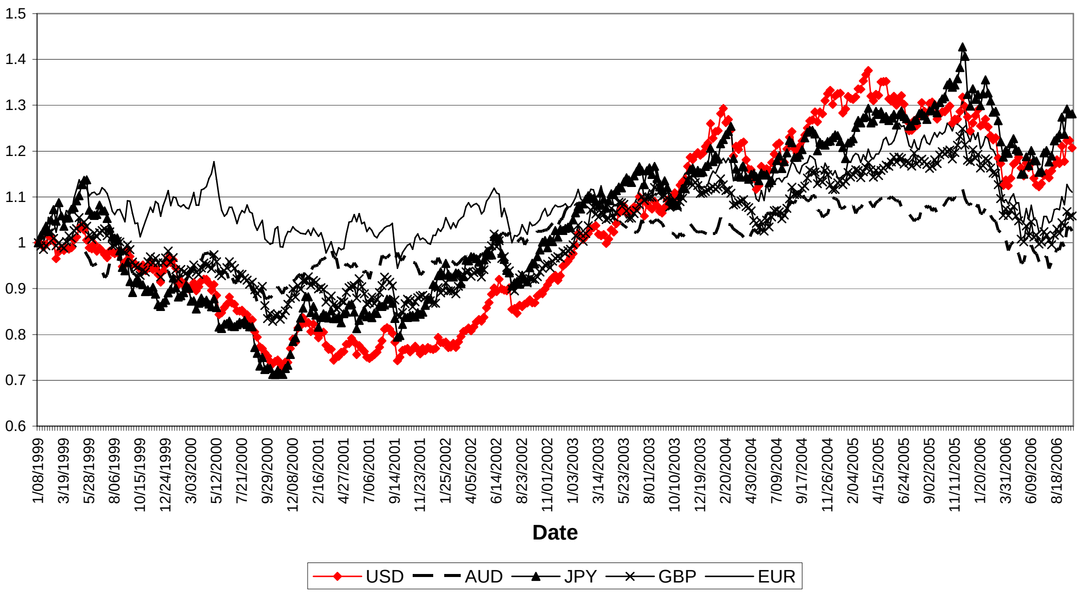


Figure 2: The Five Key Exchange Rates in New Zealand 1999-2006



3.2 The Methodology

3.2.1 The Model and Specification Issues

Most economic time series have been found to be nonstationary or to have unit roots. Since the seminal work of Engle and Granger (1987) it has become customary when specifying regression models involving time series to check that the different variables are integrated of the same order, otherwise the regression might not make sense. A variable is said to be integrated of order d (i.e., I(d)) if it must be differenced d-times before it can be rendered stationary. Stationary variables are integrated of order zero (i.e., I(0)) and nonstationary variables are integrated of order equal to or greater than one (i.e., I(1) or I(>1)). A regression of one nonstationary variable on other nonstationary variables is deemed spurious unless the variables are cointegrated. A set of I(1) variables are said to be cointegrated if there exists a linear combination of them which is I(0).

Assume that $Y_t = f(X_{1t}, \ldots, X_{mt})$ and each variable is I(1). If the variables are cointegrated, the static regression,

$$Y_t = \beta_0 + \sum_{j=1}^{m} \beta_j X_{jt} + e_t \qquad (2)$$

known as the cointegrating regression, does make sense and represents the long-run equilibrium relationships between the dependent variable and the independent variables. The coefficients (the β's) represent the independent variables' long-run impacts on the dependent variable. The concept of equilibrium here is that of no tendency to change. However, because of lagged responses among economic variables it is very likely that the short-run impacts of the independent variables will be different from their long-run impacts and therefore the short-run value or behaviour of the dependent variable may be different from its long-run value or behavior resulting in a short-run disequilibrium captured by the error term e_t. How the disequilibrium is eliminated from the short run to the long run needs to be modeled. One approach to dealing with the nonstationary variables is to difference the variables but the differencing procedure leads to the loss of important information pertaining to the long-run relationships. According to the Granger representation theorem (Harvey 1993, p. 260), if I(1) variables are cointegrated the short-run dynamics corresponding to the long-run equilibrium can be described by the error correction model (ECM). The ECM can be estimated in the two-step procedure suggested by Engel and Granger (1987). After establishing that the variables are cointegrated, the long-run cointegrating regression is estimated and the lagged residuals saved. Then the ECM is estimated by regressing the first difference of the dependent variable on its own lags, the distributed lags of the first differences of the independent variables plus the lagged residuals from the cointegrating regression used as the error correction term. At the most general level the ECM[2] may be represented as

$$\Delta Y_t = \alpha_0 + \sum_{k=1}^{p-1} \alpha_k \Delta Y_{t-k} + \sum_{j=1}^{m} \sum_{i=0}^{q_j - 1} \gamma_{ji} \Delta X_{j,t-i} + \lambda \hat{e}_{t-1} + u_t \qquad (3)$$

where p is the optimal lag of the dependent variable; q_j is the optimal lag of the j^{th} independent variable; $\hat{e}_{t-1}$ is the error correction term and its coefficient, λ, is the

[2] Some variants of the ECM may not incorporate lags of the (first difference of the) dependent variable. Here, we ignore the possibility of apposite deterministic variables such as time trend and seasonal variables in order to simplify the exposition and concentrate on the key variables.

speed-of-adjustment coefficient. It must be noted that λ, which gives the proportion of the disequilibrium eliminated in one period, has the range $-1 \leq \lambda < 0$. The optimal lag structure may be selected based on the scores from one or more of the conventional model selection criteria such as the Akaike Information Criterion (AIC) or the Schwarz Bayesian Criterion (SBC).

Bewley (1979) and Wickens and Breusch (1988) have shown that the two-step estimation procedure suggested by Engle and Granger of sequentially estimating the long-run and the short-run parameters is unnecessary (Maddala 1992 p. 263). They argue that more efficient long-run parameters can be obtained if the long-run and short-run parameters are estimated simultaneously. Banerjee *et al*. (1986) have also suggested that it is better to estimate the long-run parameters through a dynamic model. It will be realized that the static long-run model can be turned into a dynamic short-run model by adding lags of the dependent variable (making it autoregressive) and lags of the independent variables (thus imparting distributed-lag characteristics) and yielding an equation such as:

$$Y_t = a_0 + \sum_{k=1}^{p} a_k Y_{t-k} + \sum_{j=1}^{m} \sum_{i=0}^{q_j} b_{ji} X_{j,t-i} + \varepsilon_t \qquad (4)$$

that is termed the autoregressive distributed lag (ARDL) model[3] with the optimal lag structure ARDL($p, q_1, \ldots. q_m$). The selection of the optimal lag structure of the ARDL model can also be based on model selection criteria such as the AIC or the SBC (Pesaran and Shin, 1995). The short-run or impact multiplier of the j^{th} independent variable is given by the estimated coefficient b_{j0} in the ARDL or, equivalently, by the estimated coefficient γ_{j0} in the ECM. The long-run coefficients contingent on the ARDL estimates can be calculated from the following formulae:

the long-run intercept: $\beta_0 = \dfrac{a_0}{\left(1 - \sum_{k=1}^{p} a_k\right)}$;

the long-run multiplier of the j^{th} independent variable: $\beta_j = \dfrac{\sum_{i=0}^{q_j} b_{ji}}{\left(1 - \sum_{k=1}^{p} a_k\right)}$; and

the adjustment coefficient: $\lambda = \left(\sum_{k=1}^{p} a_k - 1\right)$.

An econometric/time series software that automatically and conveniently selects an optimal ARDL lag structure for each of several model selection criteria after the researcher has set the maximum lag length is Microfit (Pesaran and Pesaran, 1997). An additional advantage of the Microfit approach is that it can be applied without needing to know the order(s) of integration of the variables even when the variables

[3] The ARDL can equivalently be re-specified as the ECM or formulated as the Bardsen transformation or the Bewley transformation each of which incorporates both the short-run and long-run impacts. For these specifications see, for example, Maddala and Kim (1998, Ch. 2), Banerjee *et al*. (1993, Ch. 2), Hendry (1995, Ch. 6) and Patterson (2000, Ch. 8).

are a mixture of I(0)'s and I(1)'s. As enunciated by the authors, the Microfit ARDL procedure involves two stages. At the first stage an F-test is done to ensure that a long-run relationship exists between the variables. To operationalize this non-standard F-statistic, Pesaran *et al*. (1996) have tabulated the appropriate critical values for different numbers of regressors when all the variables are I(1) and when all the variables are I(0), thus catering for fractionally integrated variables as well. If the computed F-statistic is greater (smaller) than the upper (lower) critical value, it can be inferred that the variables are cointegrated (not cointegrated) irrespective of whether the variables are I(0) or I(1). If the computed F-statistic falls within the critical value band, the "inconclusive zone", the order(s) of integration of the variables need to be checked before the correct inference can be made. After ascertaining that a genuine long-run relationship exists between the variables the procedure moves to the second stage where the ARDL option is implemented and inferences made about the resulting short-run and long-run coefficients. In the current empirical exercise where there was ambiguity concerning the outcome of the F-test, the hypothesis of long-run relationship was tested via the standard Johansen cointegration test.

3.2.2 Functional Form

For the NZ data, if we let SP = the share price of the firm, USD = the NZD-US dollar exchange rate, AUD = the NZD-Australian dollar exchange rate, JPY = the NZD-Japanese yen exchange rate, GBP = the NZD-British pound exchange rate, EUR = the NZD-Euro exchange rate, SMI = [stock market index] the NZSX All Index, NIR = the NZ 90-day bank bill rate, we can express the relationship between each firm's share price and the other variables in a general way as: $SP_t = f(USD_t, AUD_t, JPY_t, GBP_t, EUR_t, SMI_t, NIR_t)$. To capture the proportional effects on the share price by the relative changes in the explanatory variables we postulate the following theoretical long-run equilibrium model[4]:

$$SP_t = USD^{\beta_1} AUD^{\beta_2} JPY^{\beta_3} GBP^{\beta_4} EUR^{\beta_5} SMI^{\beta_6} NIR^{\beta_7} \quad (5)$$

which simplifies to

$$\begin{aligned} ln\, SP_t = \beta_0 + \beta_1\, ln\, USD_t + \beta_2\, ln\, AUD_t + \beta_3\, ln\, JPY_t + \beta_4\, ln\, GBP_t \\ + \beta_5\, ln\, EUR_t + \beta_6\, ln\, SMI_t + \beta_7\, ln\, NIR_t + e_t \end{aligned} \quad (6)$$

where the β's are the parameters to be estimated and e_t is the random error term. And from the foregoing, it can be inferred that the theoretical ARDL($p, q_1, q_2, q_3, q_4, q_5, q_6, q_7$) can be written as:

[4] Many economic theories have log-linear long-run equilibrium solutions.

$$\ln SP_t = a_0 + \sum_{k=1}^{p} a_k \ln SP_{t-k} + \sum_{i=0}^{q_1} b_{1i} \ln USD_{t-i} + \sum_{i=0}^{q_2} b_{2i} \ln AUD_{t-i}$$
$$+ \sum_{i=0}^{q_3} b_{3i} \ln JPY_{t-i} + \sum_{i=0}^{q_4} b_{4i} \ln GBP_{t-i} + \sum_{i=0}^{q_5} b_{5i} \ln EUR_{t-i} + \sum_{i=0}^{q_6} b_{6i} \ln SMI_{t-i}$$
$$+ \sum_{i=0}^{q_7} b_{7i} \ln NIR_{t-i} + \varepsilon_t \tag{7}$$

The equivalent ECM can be written as:

$$\Delta \ln SP_t = \alpha_0 + \sum_{k=1}^{p-1} \alpha_k \Delta \ln SP_{t-k} + \sum_{i=0}^{q_1-1} \gamma_{1i} \Delta \ln USD_{t-i} + \sum_{i=0}^{q_2-1} \gamma_{2i} \Delta \ln AUD_{t-i}$$
$$+ \sum_{i=0}^{q_3-1} \gamma_{3i} \Delta \ln JPY_{t-i} + \sum_{i=0}^{q_4-1} \gamma_{4i} \Delta \ln GBP_{t-i} + \sum_{i=0}^{q_5-1} \gamma_{5i} \Delta \ln EUR_{t-i} + \sum_{i=0}^{q_6-1} \gamma_{6i} \Delta \ln SMI_{t-i}$$
$$+ \sum_{i=0}^{q_7-1} \gamma_{7i} \Delta \ln NIR_{t-i} + \lambda \hat{e}_{t-1} + u_t \tag{8}$$

The empirical model should yield estimates of the various coefficients and optimal lags.[5] Needless to add, the empirical model should pass some diagnostic tests for the statistical inferences to be valid.

4. ANALYTICAL RESULTS

4.1 Pre-modelling Tests: Stability F-statistic, Unit Root and Cointegration

The results of the Microfit F-test to check for the existence of long-run relationship between the variables are reported in Table 1 where it can be seen that at the 5% level, cointegration is confirmed for only one firm out of the 41 (i.e., for CAH) and is either absent or uncertain for the other firms. At the 10% level the confirmed cointegration cases increases to 2 (i.e., for CAH and NZO). These disappointing results led us to consider a more powerful test for cointegration – the Johansen test. To check the order of integration of each of the variables prior to the Johansen tests, the suite of unit root tests in Eviews5 (the Augmented Dickey-Fuller, ADF; Phillips-Perron, PP; Kwiatkowski-Phillips-Schmidt-Shin, KPSS; and the Dickey Fuller test with GLS detrending, DF-GLS) was implemented. Although the results were not uniform, each of the variables was assessed to be I(1) by at least one of the tests. In a few cases there were mixtures of I(0) and I(1) and mixtures of I(1) and I(2). For brevity, however, it was assumed that all the variables are I(1). The numbers of cointegrating relationships selected by the trace and max-eigenvalue test statistics[6] at the 5% level from the

[5] The optimal empirical ARDL model would be selected from $N = h(h+1)^m$ regressions where h is number of lags and m is number of explanatory variables. With 7 variables and 2 lags, N = 4,374; with 7 variables and 3 lags, N = 49,152. Results could be generated for lag 2 but not for lag 3.

[6] In the Johansen cointegration test the trace statistic (λ_{trace}) 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 (λ_{max}) tests the same null hypothesis against the alternative that the number of cointegrating vectors is equal to r+1 (i.e., $\lambda_{max} \Rightarrow$

Johansen tests are reported in Table 1 also; all the entries are either 1 or 2. These results confirm cointegration for all the 41 firms.

4.2 Regression Results

After cointegration was confirmed for the firms, the ARDL routine in Microfit was implemented for each firm. Because of space limitation only the optimal lag structures and R-squares of the respective ARDL models are reported. These are juxtaposed to the pre-modelling test results in Table 1. The most popular models are ARDL(1,0,0,0,0,0,0,0) and ARDL(1,0,0,0,0,0,1,0). All the ARDL models seem to have a good fit. The equivalent long-run equilibrium and error-correction model results for the 41 firms are presented in the Appendix Table A1. The parameters that are significant at the 5% level are indicated in bold font. It must be remembered that the dependent variable in the ECM is the differenced share price and the dependent variable in the long-run model is the share price. The discussion will firstly consider the stability of the models and go on to treat the impacts of the non-exchange rate variables and finally deal with the impacts of the exchange rates.

In connection with the stability of the models it will be realised that in the Appendix Table A1 the coefficients of the error correction term (ECT_{-1}) are properly [negatively] signed in all the models and are statistically significant at the 5% level except in 3 out of the 41 cases (i.e., for CEN, STU and TEL). These imply the models are dynamically stable. The estimated values imply speeds of adjustment ranging from 1.1% (for TEL) to 16.9% (for TTP) with an average of 7.9% per week. It may be inferred that among the sampled firms TEL (Telecom) is the slowest and TTP (Trans Tasman Properties) is the fastest to adjust to exchange rate changes. By and large, the share prices take anywhere from 6 weeks to 91 weeks (with an average of 13 weeks or 3 months) to adjust fully to exchange rate shocks. The long-run multipliers are larger than their counterpart short-run multipliers, as expected.

H_0: rank(Π) ≤ r; H_1: rank(Π) = r+1). When it becomes necessary to choose between the two tests, both Johansen and Juselius (1990) and Maddala and Kim (1998, p. 211) suggest that λ_{max} may be better.

Table 1
The Pre-modelling Stability and Johansen Tests and the ARDL Model Results

Company		Stability F-stat[a/]	Joh Coint Test[b/]	ARDL Model	
NZSE Code	Name			Optimal lag structure based on the SBC	R^2
AIA	Auckland I'national Airport	1.672	1; 1	ARDL(1,0,0,0,0,0,1,1)	0.9667
AIR	Air New Zealand Ltd	1.953	1; 1	ARDL(1,0,0,0,0,0,1,0)	0.9666
AMP	AMP Ltd	1.976	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9922
ANZ	ANZ Banking Group Ltd	1.631	1; 1	ARDL(1,0,2,0,0,0,1,0)	0.9764
APT	AMP NZ Office Trust	2.100	2; 2	ARDL(2,0,0,0,0,0,0,0)	0.8592
AXA	AXA Asia Pacific Holdings	1.016	2; 1	ARDL(1,0,1,0,1,0,0,0)	0.9804
BRY	BIL International Ltd	3.105	1; 1	ARDL(1,0,0,0,0,0,0,1)	0.9737
CAH	Carter Holt Harvey Ltd	3.660	2; 1	ARDL(2,0,0,0,0,0,1,0)	0.9486
CAV	Cavalier Corp Ltd	2.279	2; 1	ARDL(1,0,0,0,0,0,1,0)	0.9523
CEN	Contact Energy Ltd	0.939	1; 1	ARDL(1,0,0,0,0,0,1,0)	0.9936
CHP	Calan Healthcare Properties	2.335	1; 1	ARDL(2,0,0,0,1,0,0,0)	0.9708
FBU	Fletcher Building Ltd	2.148	1; 1	ARDL(1,0,0,0,0,0,1,0)	0.9947
FPH	Fisher & Paykel Healthcare	1.578	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9667
GPG	Guinness Peat Group Plc	0.903	1; 2	ARDL(1,0,0,0,0,0,1,0)	0.9738
HBY	Hellaby Holdings Ltd	1.407	2; 1	ARDL(2,0,0,0,0,0,1,0)	0.9956
HLG	Hallenstein Glasson Hold'gs	1.712	2; 3	ARDL(2,0,0,0,0,0,0,0)	0.9863
IFT	Infratil Ltd	0.317	1; 1	ARDL(1,0,0,0,0,0,1,1)	0.9953
KIP	Kiwi Income Property Trust	1.655	1; 2	ARDL(2,0,0,0,0,0,0,0)	0.9498
LNN	Lion Nathan Ltd	1.300	2; 2	ARDL(1,0,0,0,1,0,0,0)	0.9864
MFT	Mainfreight Ltd	1.807	1; 1	ARDL(1,0,0,0,0,0,2,0)	0.9897
MHI	Michael Hill I'national Ltd	1.285	2; 1	ARDL(2,0,0,0,1,0,0,0)	0.9909
NAP	The National Property Trust	0.994	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9351
NPX	Nuplex Industries Ltd	1.088	1; 1	ARDL(1,0,0,0,0,0,2,0)	0.9797
NZO	NZ Oil and Gas Ltd	3.268	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9852
NZR	The NZ Refining Co Ltd	1.429	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9221
PFI	Property for Industry Ltd	1.144	2; 1	ARDL(2,0,0,0,1,0,0,0)	0.9830
PGW	PGG Wrightson Ltd	0.987	2; 1	ARDL(2,0,0,0,0,0,1,0)	0.9867
POT	Port of Tauranga Ltd	1.816	2; 1	ARDL(2,0,0,0,0,0,0,0)	0.9383
RYM	Ryman Healthcare Ltd	2.140	2; 1	ARDL(2,0,0,0,0,0,0,0)	0.9927
SAN	Sanford Ltd	1.977	1; 1	ARDL(2,0,0,0,0,0,1,0)	0.9333
SKC	Sky City Entertainment Ltd	2.540	2; 2	ARDL(1,0,0,0,0,0,1,0)	0.9607
SKY	Sky Network Television Ltd	2.718	2; 1	ARDL(1,0,0,0,0,0,2,0)	0.9782
STU	Steel & Tube Holdings Ltd	1.086	1; 1	ARDL(1,0,0,0,0,0,1,0)	0.9961
TEL	Telecom Corp of NZ Ltd	1.906	1; 1	ARDL(2,0,0,0,0,0,2,0)	0.9645
TEN	Tenon Ltd	2.447	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9883
THL	Tourism Holdings Ltd	1.882	1; 1	ARDL(1,0,0,0,0,0,2,0)	0.9794
TLS	Telstra Corp Ltd	1.527	1; 1	ARDL(1,0,1,0,0,0,1,0)	0.9858
TTP	Trans Tasman Properties Ltd	2.157	1; 1	ARDL(1,0,0,0,0,0,0,0)	0.9803
TWR	Tower Ltd	1.290	1; 1	ARDL(1,0,0,0,0,0,1,0)	0.9885
WAM	Waste Management NZ Ltd	2.470	1; 1	ARDL(1,0,0,0,0,1,1,0)	0.9891
WHS	The Warehouse Group Ltd	2.764	2; 1	ARDL(1,0,0,0,0,0,0,0)	0.9540

[a/] In the Microfit F-test, for Case II (intercept with no trend) and 7 forcing variables, the critical value bounds are: 2.035 and 3.153 (at the 10% significance level); and 2.365 and 3.553 (at the 5% significance level).
[b/] Johansen cointegration test: entries show numbers of cointegrating relationships selected by the trace and max-eigenvalue test statistics, respectively, at the 5% significance level.

Concerning the non-exchange rate variables, the share market index SMI obtained the expected positive sign in all cases except one [FPH, insignificant] in the ECM and three in the long-run model [FPH, SKC and TEL, all insignificant]. It may be concluded that the inclusion of the overall share market index is warranted. The interest rate variable NIR takes the expected negative sign in only 21 out of the 41 cases; and even among those only about a quarter are significant. Five out of the 20 unexpected positive signs of NIR are significant. When estimated coefficients do not accord with *a priori* economic expectations the reason is often but not always to be found in omitted relevant variables. In those cases, it may be argued that interest rate increases lead to upward revisions in expectations about capital gains and dividends which reverse the downward effect on share prices. The unexpected sign of the interest rate variable in roughly one-half of the cases may therefore be attributed to the omission of expectations in the model. At any rate, it can be inferred that response to interest rate increases cannot be assumed to be unidirectional for all firms.

A readily discernible observation about the coefficients of the exchange rate variables in the Appendix Table A1 is that no firm has the same sign for all the five exchange rates. Fourteen firms showed no significant sensitivity in both the short run and long run to all the exchange rates; two firms (PGW and TTP) switched from showing no significant sensitivity to all the exchange rates in the short run to showing significant sensitivity to at least one of the exchange rates in the long run; four firms (ANZ, IFT, STU and TLS) showed significant sensitivity to some of the exchange rates in the short run but in the long run showed no significant sensitivity to any of the exchange rates. The mixtures of positive and negative and significant and insignificant responses buttress the conclusions in previous empirical studies that the direction and degree of sensitivity is dependent on the currency. In the event, a firm's share price responsiveness to exchange rate movements has more to do with whether the firm is explicitly an importer or exporter and on its exchange rate hedging policy.

Focussing now on the exchange rate coefficients in the estimated long-run models, it will be realised that USD has a positive coefficient in 12 cases (none of which is significant at the 5% level) and a negative coefficient in 29 cases (13 of which are significant at the 5% level). This implies the share price of none of the sampled firms is significantly boosted by appreciation of the NZD against the US dollar; 32% of the sample share prices are significantly dampened by appreciation of the NZD against the US dollar. About one-third of the firms may be characterised as significant net exporters in the US dollar.

AUD has a positive coefficient in 19 cases (4 of which are significant at the 5% level) and a negative coefficient in 22 cases (4 of which are significant at the 5% level). An implication of this result is that about 10% of the sample share prices are significantly boosted by appreciation of the NZD against the Australian dollar; another 10% of the sample share prices are significantly dampened by appreciation of the NZD against the Australian dollar. It may be inferred that about one-tenth of the firms are significant net exporters and another one-tenth are significant net importers in the Australian dollar.

JPY has a positive coefficient in 24 cases (4 of which are significant at the 5% level) and a negative coefficient in 17 cases (none of which is significant at the 5% level) which connotes that about 10% of the sample share prices are significantly boosted by appreciation of the NZD against the Japanese yen; and no share price is significantly dampened by appreciation of the NZD against the Japanese yen. About one-tenth of the firms may be described as significant net importers in the Japanese yen.

GBP has a positive coefficient in 30 cases (3 of which are significant at the 5% level) and a negative coefficient in 11 cases (none of which is significant at the 5% level). From this it may be inferred that about 7% of the sample share prices are significantly boosted by appreciation of the NZD against the British pound; and no share price is significantly dampened by appreciation of the NZD against the British pound. About 7% of the firms may be described as significant net importers in the British pound.

EUR has a positive coefficient in 11 cases (3 of which are significant at the 5% level) and a negative coefficient in 30 cases (8 of which are significant at the 5% level). This implies that about 7% of the sample share prices are significantly boosted by appreciation of the NZD against the euro; and about 20% of the sample share prices are significantly dampened by appreciation of the NZD against the euro. It may be inferred that about 20% of the firms are significant net exporters and another 7% are significant net importers in the euro.

To facilitate further comprehension of the configuration of parameters in Appendix Table A1, Table 2 summarises the degree and direction of long-run sensitivity to the various currencies for the individual firms grouped according to sectors. The share of the market capitalisation as at the end of the study period is also indicated for each firm in Table 2. There is not sufficient basis to conclude that the magnitude of the sensitivity is sector-driven. The differentiated outcomes would suggest that more specific detailed information about the firms (e.g., the exchange rate hedging policy) is needed to account for those results. A little less than half (19 out of 41) of the firms posted ‘insignificant sensitivity to all the exchange rates’ in the long run. Those firms include ‘big players’ such as TEL, CEN, AIA and SKY as well as relatively ‘small players’ such as TEN, TLS, MHI and CAV. A relatively big player whose share price is depressed by appreciation of the NZD against the US dollar and the euro but boosted by appreciation against the Australian dollar is the building company FBU. It is the biggest of the firms registering nontrivial responsiveness to exchange rate movements in the long run.

Table 2
Long-Run Sensitivity of Share Prices to Exchange Rate Changes

Sector/Firm Code/Firm Size[a/]		Sensitivity of Share Price[b/]
Primary sector		
Agric & Fishery		
PGW	(0.50%)	Boosted by appreciation against the AUD
SAN	(0.59%)	Depressed by appreciation against the USD & EUR
Forestry		
CAH	(1.10%)	Depressed by appreciation against the USD; boosted by appreciation against the EUR
Mining		
NZO	(0.41%)	Insignificant sensitivity to all the exchange rates
Secondary sector		
Interm & Durables		
FPH	(4.23%)	Insignificant sensitivity to all the exchange rates
Building		
FBU	(8.36%)	Depressed by appreciation against the USD & EUR; boosted by appreciation against the AUD
NPX	(0.98%)	Depressed by appreciation against the EUR
STU	(0.38%)	Insignificant sensitivity to all the exchange rates
Textile		
CAV	(0.27%)	Insignificant sensitivity to all the exchange rates
Food		
GPG	(4.15%)	Insignificant sensitivity to all the exchange rates
LNN	(0.51%)	Insignificant sensitivity to all the exchange rates
Tertiary sector		
Fin & Other Services		
AMP	(0.90%)	Depressed by appreciation against the USD; boosted by appreciation against the EUR
ANZ	(1.30%)	Insignificant sensitivity to all the exchange rates
RYM	(1.18%)	Depressed by appreciation against the USD & EUR; boosted by appreciation against the GBP
TEN	(0.14%)	Insignificant sensitivity to all the exchange rates
TWR	(1.48%)	Depressed by appreciation against the USD; boosted by appreciation against the EUR
Investment		
AXA	(0.63%)	Depressed by appreciation against the USD & AUD
BRY	(0.30%)	Depressed by appreciation against the USD & EUR; boosted by appreciation against the JPY & GBP
HBY	(0.31%)	Depressed by appreciation against the EUR; boosted by appreciation against the AUD
Property		
APT	(0.57%)	Depressed by appreciation against the USD; boosted by appreciation against the JPY
CHP	(0.24%)	Depressed by appreciation against the AUD
KIP	(1.83%)	Depressed by appreciation against the USD; boosted by appreciation against the JPY
NAP	(0.10%)	Boosted by appreciation against the AUD

PFI (0.53%)	Depressed by appreciation against the USD & EUR
TTP (0.28%)	Boosted by appreciation against the JPY
Media & Comm SKY (5.04%)	 Depressed by appreciation against the AUD
TEL (21.14%)	Insignificant sensitivity to all the exchange rates
TLS (0.20%)	Insignificant sensitivity to all the exchange rates
Energy CEN (8.89%)	 Insignificant sensitivity to all the exchange rates
IFT (1.90%)	Insignificant sensitivity to all the exchange rates
NZR (0.41%)	Insignificant sensitivity to all the exchange rates
Transport AIR (0.54%)	 Insignificant sensitivity to all the exchange rates
MFT (0.72%)	Insignificant sensitivity to all the exchange rates
Ports AIA (5.05%)	 Insignificant sensitivity to all the exchange rates
POT (0.64%)	Insignificant sensitivity to all the exchange rates
Leisure & Tourism SKC (4.42%)	 Insignificant sensitivity to all the exchange rates
THL (0.32%)	Boosted by appreciation against the USD
Consumer HLG (0.48%)	 Depressed by appreciation against the USD
MHI (0.23%)	Insignificant sensitivity to all the exchange rates
WHS (1.11%)	Depressed by appreciation against the USD
Waste WAM (1.69%)	 Depressed by appreciation against the AUD & EUR; boosted by appreciation against the GBP

Notes
[a/] Firm size: figures in parentheses after the firm codes are the percentage shares of the firms of total market capitalisation at the end of the study period.
[b/] Statistical significance of the sensitivity is with reference to the 5% level.

5. SUMMARY AND CONCLUSIONS

Concern in New Zealand in recent years about the potentially detrimental effect of the sustained appreciation of the NZ dollar on NZ firms, especially the exporters, has sharpened interest in the sensitivity of share prices to exchange rate movements. Past empirical findings, mostly of mild or insignificant sensitivity, vary depending on the firm sample selection and models employed. Notable methodological issues include use of aggregated stock prices, omitted variables, disregard of lagged responses and a single-exchange-rate focus. Where cointegration among the time series variables has not been ascertained the studies risked reporting spurious regression results. This paper addresses some of the methodological problems of previous studies by using disaggregated stock prices, additional share price determinants and adopts the cointegration approach to the autoregressive distributed lag model to capture the lagged responses to changes in five key exchange rates for the firms in the NZ headline index. Weekly data from 1999 to 2006 were analysed. Error-correction and long-run equilibrium models were estimated, yielding plausible estimates of the magnitude and direction of the short-run and long-run responses of the share price of each of the 41 firms to each of the five exchange rates. The speed of adjustment towards equilibrium share price following a shock ranged from 1.1% to 16.9% with an average of 7.9% per week; the long-run multipliers are larger than their short-run counterparts, as expected. A little more than half of the firms showed significant sensitivity to exchange rate movements in the long run. It was discovered that the biggest of the firms registering nontrivial responsiveness to exchange rate movements in the long run is the building company Fletcher Building Ltd, FBU. Overall, the sensitivities of the firms do not seem to be sector driven but may be associated with a factor which was not modelled in this study: exchange-rate hedging policy. However, in some cases the results allowed the identification of the importer/exporter trading status of the firms without recourse to balance sheet information.

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APPENDIX

Table A1

The Error-Correction and Long-Run Equilibrium Model Results

Variable	AIA	AIR	AMP	ANZ	APT	AXA	BRY	CAH	CAV	CEN
E-C Model Own lag					**-0.176 (-3.14)**			**-0.149 (-2.96)**		
ΔUSD	0.033 (0.26)	-0.021 (-0.13)	**-0.385 (-4.19)**	-0.053 (-1.26)	**-0.094 (-2.91)**	**-0.130 (-2.34)**	**-0.348 (-3.61)**	**-0.135 (-2.87)**	-0.055 (-0.78)	-0.021 (-0.54)
ΔUSD_{-1}										
ΔAUD	0.230 (0.94)	-0.029 (-0.09)	-0.037 (-0.27)	**-0.609 (-4.04)**	-0.090 (-1.49)	**-0.841 (-3.89)**	-0.020 (-0.11)	-0.065 (-0.67)	0.064 (0.43)	0.103 (1.32)
ΔAUD_{-1}				**-0.472 (-3.14)**						
ΔJPY	-0.169 (-0.98)	-0.428 (-1.67)	-0.083 (-0.83)	0.008 (0.15)	**0.093 (1.97)**	0.118 (1.68)	**0.308 (2.22)**	0.054 (0.75)	-0.095 (-0.92)	0.003 (0.06)
ΔJPY_{-1}										
ΔGBP	0.263 (0.98)	0.359 (0.93)	-0.185 (-1.14)	0.008 (0.10)	0.070 (1.03)	**0.364 (2.23)**	**0.461 (2.08)**	-0.020 (-0.19)	0.108 (0.65)	0.070 (0.80)
ΔGBP_{-1}										
ΔEUR	-0.339 (-1.30)	0.378 (1.19)	**0.430 (2.97)**	0.058 (0.78)	-0.052 (-0.90)	0.008 (0.09)	**-0.441 (-2.19)**	**0.290 (3.15)**	-0.140 (-1.00)	-0.115 (-1.44)
ΔEUR_{-1}										
ΔSMI	**1.145 (3.71)**	**1.301 (3.02)**	**0.251 (3.92)**	**0.328 (3.52)**	0.047 (1.77)	**0.301 (4.55)**	**0.214 (2.39)**	**0.985 (7.83)**	**0.748 (3.91)**	**0.682 (6.62)**
ΔSMI_{-1}										
ΔNIR	0.969 (1.19)	**0.295 (2.45)**	0.050 (1.22)	0.002 (0.11)	**0.067 (3.27)**	**0.064 (2.09)**	**1.442 (3.58)**	-0.010 (-0.36)	**-0.114 (-2.37)**	-0.007 (-0.33)
ΔNIR_{-1}										
ECT_{-1}	**-0.042 (-2.40)**	**-0.092 (-4.11)**	**-0.111 (-5.61)**	**-0.037 (-2.17)**	**-0.205 (5.20)**	**-0.123 (4.85)**	**-0.101 (-4.90)**	**-0.145 (-5.05)**	**-0.067 (3.42)**	-0.035 (-1.63)
R^2	0.0848	0.0948	0.1286	0.1474	0.1575	0.1369	0.1323	0.2945	0.1033	0.1379
Adj. R^2	0.0546	0.0680	0.1058	0.1163	0.1326	0.1084	0.1066	0.2712	0.0768	0.1124
L-R Model USD	0.789 (0.27)	-0.232 (-0.13)	**-3.472 (-5.60)**	-1.447 (-1.55)	**-0.459 (-3.19)**	**-1.053 (-2.81)**	**-3.431 (-3.36)**	**-0.928 (-2.67)**	-0.820 (-0.76)	-0.596 (-0.54)
AUD	5.430 (1.00)	-0.312 (-0.09)	-0.332 (-0.27)	1.068 (0.54)	-0.440 (-1.53)	**-1.877 (-2.41)**	-0.197 (-0.11)	-0.452 (-0.70)	0.955 (0.44)	2.986 (1.18)
JPY	-3.985 (-1.01)	-4.632 (-1.85)	-0.744 (-0.82)	0.225 (0.15)	**0.455 (2.19)**	0.957 (1.75)	**3.039 (2.21)**	0.376 (0.79)	-1.420 (-0.91)	0.097 (0.06)
GBP	6.210 (0.90)	3.880 (0.97)	-1.670 (-1.17)	0.215 (0.10)	0.340 (1.01)	-0.449 (-0.52)	**4.541 (2.02)**	-0.140 (-0.19)	1.622 (0.62)	2.033 (0.75)
EUR	-7.994 (-1.37)	4.084 (1.11)	**3.873 (3.12)**	1.577 (0.67)	-0.255 (-0.90)	0.069 (0.09)	**-4.350 (-2.16)**	**2.004 (2.85)**	-2.100 (-0.97)	-3.327 (-1.32)
SMI	0.337 (0.14)	1.247 (0.80)	**2.261 (3.83)**	1.124 (1.34)	0.229 (1.79)	**2.441 (7.24)**	**2.106 (2.57)**	**1.204 (3.87)**	**1.948 (1.97)**	1.864 (1.88)
NIR	-2.546 (-1.68)	**3.191 (3.32)**	0.450 (1.30)	0.058 (0.11)	**0.326 (4.12)**	**0.518 (2.48)**	0.882 (1.70)	-0.069 (-0.35)	**-1.705 (-2.88)**	-0.216 (-0.35)

Table A1 cont'd

Variable	CHP	FBU	FPH	GPG	HBY	HLG	IFT	KIP	LNN	MFT
E-C Model Own lag	**-0.208** **(-3.78)**				**-0.151** **(-2.72)**	**-0.165** **(-2.92)**		**-0.272** **(-4.87)**		
ΔUSD	-0.011 (-0.34)	**-0.099** **(-2.08)**	0.059 (0.44)	-0.065 (-1.77)	0.028 (0.57)	**-0.141** **(-2.74)**	-0.075 (-1.94)	**-0.090** **(-2.62)**	-0.030 (-0.81)	-0.041 (-0.77)
ΔUSD_{-1}										
ΔAUD	**-0.192** **(-2.49)**	**0.181** **(1.97)**	-0.194 (-0.72)	-0.084 (-1.15)	**0.217** **(2.21)**	**0.160** **(2.01)**	0.073 (0.91)	0.022 (0.33)	**0.183** **(2.42)**	-0.123 (-1.03)
ΔAUD_{-1}										
ΔJPY	0.063 (1.35)	0.096 (1.38)	0.103 (0.53)	0.084 (1.51)	-0.057 (-0.90)	-0.025 (-0.37)	-0.004 (-0.06)	0.098 (1.67)	-0.079 (-1.41)	0.066 (0.82)
ΔJPY_{-1}										
ΔGBP	**0.357** **(3.22)**	0.174 (1.62)	-0.100 (-0.32)	-0.006 (-0.07)	0.157 (1.53)	0.177 (1.89)	**0.211** **(2.29)**	0.106 (1.37)	-0.192 (-1.50)	0.009 (0.07)
ΔGBP_{-1}										
ΔEUR	-0.006 (-0.10)	**-0.300** **(-3.17)**	-0.208 (-0.79)	-0.022 (-0.30)	**-0.264** **(-2.82)**	-0.085 (-1.02)	**-0.198** **(-2.33)**	-0.066 (-0.95)	-0.041 (-0.49)	0.073 (0.70)
ΔEUR_{-1}										
ΔSMI	0.035 (1.26)	**0.922** **(7.58)**	-0.093 (-0.78)	**0.600** **(6.03)**	**0.517** **(4.37)**	**0.200** **(4.09)**	**0.565** **(5.34)**	0.042 (1.41)	**0.099** **(2.46)**	**0.877** **(6.29)**
ΔSMI_{-1}										**0.356** **(2.52)**
ΔNIR	0.030 (1.45)	0.014 (0.57)	-0.178 (-1.93)	-0.012 (-0.57)	**-0.080** **(-2.52)**	-0.014 (-0.63)	**0.394** **(2.32)**	0.017 (0.87)	-0.019 (-0.92)	0.021 (0.63)
ΔNIR_{-1}										
ECT_{-1}	**-0.069** **(-3.30)**	**-0.098** **(-4.42)**	**-0.073** **(-3.64)**	**-0.069** **(-3.20)**	**-0.053** **(-2.51)**	**-0.067** **(-2.98)**	**-0.043** **(-2.16)**	**-0.141** **(-3.97)**	**-0.041** **(-2.12)**	**-0.040** **(-2.12)**
R^2	0.1396	0.2128	0.0481	0.1478	0.1274	0.0823	0.1268	0.1673	0.0487	0.1690
Adj. R^2	0.1112	0.1895	0.0232	0.1226	0.0986	0.0551	0.0980	0.1427	0.0206	0.1416
L-R Model USD	-0.154 (-0.33)	**-1.013** **(-2.19)**	0.811 (0.44)	-0.944 (-1.64)	0.531 (0.62)	**-2.098** **(-3.34)**	-1.733 (-1.48)	**-0.634** **(-2.46)**	-0.744 (-0.80)	-1.013 (-0.77)
AUD	**-2.783** **(-2.96)**	**1.858** **(1.97)**	-2.656 (-0.71)	-1.217 (-1.08)	**4.108** **(2.25)**	2.388 (1.74)	1.684 (0.92)	0.159 (0.32)	4.497 (1.76)	-3.063 (-1.19)
JPY	0.916 (1.36)	0.979 (1.47)	1.406 (0.53)	1.213 (1.54)	-1.084 (-0.88)	-0.370 (-0.34)	-0.081 (-0.06)	**0.692** **(1.99)**	-1.948 (-1.04)	1.651 (0.88)
GBP	0.425 (0.40)	1.778 (1.66)	-1.372 (-0.33)	-0.092 (-0.07)	2.983 (1.44)	2.628 (1.75)	4.861 (1.49)	0.752 (1.35)	1.894 (0.85)	0.216 (0.07)
EUR	-0.093 (-0.10)	**-3.067** **(-3.11)**	-2.854 (-0.77)	-0.322 (-0.30)	**-5.012** **(-2.39)**	-1.265 (-1.09)	-4.568 (-1.81)	-0.466 (-1.00)	-0.995 (-0.54)	1.826 (0.70)
SMI	0.501 (1.19)	**2.762** **(6.39)**	-1.279 (-0.79)	**1.663** **(3.37)**	**2.511** **(3.15)**	**2.972** **(4.09)**	**3.331** **(3.59)**	0.295 (1.35)	**2.440** **(2.52)**	**2.369** **(1.99)**
NIR	0.431 (1.70)	0.145 (0.57)	**-2.438** **(-2.40)**	-0.169 (-0.57)	**-1.513** **(-2.98)**	-0.209 (-0.59)	-0.479 (-0.95)	0.118 (0.90)	-0.465 (-0.82)	0.513 (0.70)

Table A1 cont'd

Variable	MHI	NAP	NPX	NZO	NZR	PFI	PGW	POT	RYM	SAN
E-C Model Own lag	**-0.150 (-2.64)**					**-0.266 (-4.80)**	**-0.142 (-2.55)**	**-0.151 (-2.68)**	**-0.246 (-4.50)**	**-0.134 (-2.40)**
ΔUSD	0.013 (0.29)	-0.031 (-0.95)	0.022 (0.47)	0.039 (0.47)	0.342 (1.82)	-0.048 (-1.58)	-0.033 (-0.50)	-0.100 (-1.39)	**-0.135 (-2.87)**	**-0.180 (-3.43)**
ΔUSD_{-1}										
ΔAUD	0.007 (0.07)	**0.144 (2.18)**	**-0.214 (-2.54)**	0.112 (0.67)	0.492 (1.16)	-0.016 (-0.33)	0.249 (1.95)	-0.044 (-0.29)	-0.026 (-0.29)	-0.014 (-0.15)
ΔAUD_{-1}										
ΔJPY	0.087 (1.32)	-0.069 (-1.47)	**0.140 (2.28)**	-0.043 (-0.35)	-0.379 (-1.28)	0.063 (1.61)	-0.116 (-1.42)	0.053 (0.51)	0.050 (0.75)	0.033 (0.46)
ΔJPY_{-1}										
ΔGBP	0.180 (1.21)	0.079 (1.07)	0.015 (0.16)	-0.165 (-0.80)	-0.263 (-0.61)	**0.325 (3.96)**	0.038 (0.29)	-0.127 (-0.70)	**0.299 (2.93)**	**0.250 (2.18)**
ΔGBP_{-1}										
ΔEUR	-0.154 (-1.86)	-0.024 (-0.38)	**-0.246 (-2.60)**	-0.124 (-0.75)	-0.256 (-0.69)	**-0.121 (-2.38)**	-0.022 (-0.20)	-0.108 (-0.76)	**-0.356 (-4.04)**	**-0.276 (-2.82)**
ΔEUR_{-1}										
ΔSMI	**0.121 (2.53)**	**0.083 (2.49)**	**0.513 (4.51)**	**0.489 (4.90)**	0.189 (1.02)	0.044 (1.68)	**0.602 (3.97)**	**0.199 (2.87)**	**0.222 (3.91)**	**0.463 (3.49)**
ΔSMI_{-1}			**0.285 (2.49)**							
ΔNIR	-0.004 (-0.16)	**-0.079 (-3.35)**	0.039 (1.65)	-0.039 (-0.85)	-0.148 (-1.30)	**0.030 (2.16)**	**-0.064 (-2.02)**	-0.037 (-0.93)	**0.082 (2.85)**	-0.052 (-1.49)
ΔNIR_{-1}										
ECT_{-1}	**-0.039 (-2.11)**	**-0.099 (-3.68)**	**-0.055 (-2.63)**	**-0.097 (-4.95)**	**-0.058 (-2.85)**	**-0.059 (-2.20)**	**-0.060 (-2.78)**	**-0.088 (-3.68)**	**-0.059 (-3.46)**	**-0.127 (-4.24)**
R^2	0.0800	0.0608	0.1412	0.0994	0.0405	0.1484	0.0975	0.0990	0.1531	0.1591
Adj. R^2	0.0496	0.0361	0.1129	0.0758	0.0153	0.1203	0.0678	0.0723	0.1280	0.1314
L-R Model USD	0.323 (0.28)	-0.312 (-0.96)	0.394 (0.50)	0.401 (0.47)	5.917 (1.59)	**-0.815 (-2.01)**	-0.544 (-0.54)	-1.145 (-1.38)	**-2.304 (-2.74)**	**-1.411 (-3.28)**
AUD	0.191 (0.07)	**1.457 (2.09)**	-3.898 (-1.79)	1.148 (0.67)	8.514 (1.31)	-0.276 (-0.31)	**4.156 (2.19)**	-0.497 (-0.28)	-0.440 (-0.29)	-0.113 (-0.15)
JPY	2.231 (1.37)	-0.694 (-1.35)	2.548 (1.74)	-0.438 (-0.35)	-6.568 (-1.39)	1.070 (1.74)	-1.930 (-1.20)	0.605 (0.51)	0.859 (0.79)	0.258 (0.46)
GBP	-3.413 (-1.34)	0.802 (1.01)	0.282 (0.16)	-1.692 (-0.84)	-4.545 (-0.59)	1.128 (1.18)	0.637 (0.30)	-1.446 (-0.74)	**5.103 (2.24)**	1.963 (1.91)
EUR	-3.955 (-1.42)	-0.242 (-0.37)	**-4.492 (-2.51)**	-1.276 (-0.73)	-4.433 (-0.67)	**-2.064 (-2.08)**	-0.375 (-0.20)	-1.231 (-0.72)	**-6.081 (-2.81)**	**-2.169 (-2.33)**
SMI	**3.108 (2.65)**	**0.841 (2.87)**	0.615 (0.84)	**5.029 (6.14)**	3.268 (1.13)	**0.752 (2.09)**	**3.753 (4.29)**	**2.271 (2.90)**	**3.801 (4.92)**	**0.771 (2.13)**
NIR	-0.097 (-0.16)	**-0.798 (-4.21)**	0.706 (1.37)	-0.403 (-0.82)	-2.558 (-1.43)	0.505 (1.83)	-1.061 (-1.83)	-0.424 (-0.94)	**1.393 (3.17)**	-0.410 (-1.81)

Table A1 cont'd

Variable	SKC	SKY	STU	TEL	TEN	THL	TLS	TTP	TWR	WAM	WHS
E-C Model Own lag				**-0.300 (-5.34)**							
ΔUSD	-0.069 (-0.76)	0.025 (0.51)	-0.039 (-1.01)	0.043 (0.88)	0.264 (1.60)	**0.200 (2.56)**	0.078 (1.91)	-0.028 (-0.45)	-0.154 (-1.68)	-0.001 (-0.01)	**-0.166 (-2.25)**
ΔUSD_{-1}											
ΔAUD	0.065 (0.38)	**-0.234 (-2.73)**	**0.208 (2.45)**	-0.006 (-0.06)	0.127 (0.41)	-0.238 (-1.75)	**-0.504 (-3.04)**	-0.059 (-0.47)	0.143 (0.91)	**-0.259 (-2.95)**	0.042 (0.29)
ΔAUD_{-1}											
ΔJPY	0.090 (0.74)	0.103 (1.45)	0.200 (1.89)	0.045 (0.70)	-0.120 (-0.54)	-0.071 (-0.67)	-0.085 (-1.39)	0.177 (1.81)	-0.168 (-1.46)	0.010 (0.16)	-0.006 (-0.05)
ΔJPY_{-1}											
ΔGBP	0.055 (0.25)	0.009 (0.08)	0.058 (0.66)	-0.128 (-1.23)	0.156 (0.43)	-0.172 (-1.18)	0.035 (0.40)	0.139 (0.97)	-0.178 (-0.96)	**0.278 (2.94)**	0.103 (0.59)
ΔGBP_{-1}											
ΔEUR	-0.264 (-1.49)	0.141 (1.42)	-0.066 (-0.85)	0.011 (0.11)	0120 (0.40)	0.121 (0.94)	-0.101 (-1.25)	-0.106 (-0.87)	**0.439 (2.70)**	-0.052 (-0.41)	-0.060 (-0.41)
ΔEUR_{-1}											
ΔSMI	**0.652 (2.94)**	**0.748 (5.64)**	**0.703 (6.67)**	**1.231 (10.7)**	0.075 (0.55)	**0.729 (4.32)**	**0.317 (3.10)**	**0.186 (3.10)**	**1.012 (4.74)**	**0.691 (6.21)**	0.086 (1.24)
ΔSMI_{-1}		**0.405 (3.03)**		**0.458 (3.40)**		**0.505 (2.97)**					
ΔNIR	**0.121 (2.65)**	-0.035 (-1.22)	**-0.062 (-2.43)**	-0.010 (-0.42)	0.047 (0.54)	0.022 (0.61)	-0.006 (-0.30)	-0.040 (-1.16)	0.026 (0.56)	**0.119 (4.03)**	-0.067 (-1.61)
ΔNIR_{-1}											
ECT_{-1}	**-0.059 (-2.74)**	**-0.162 (-6.06)**	-0.026 (-1.81)	-0.011 (-0.57)	**-0.075 (-3.82)**	**-0.060 (-3.24)**	**-0.042 (-2.43)**	**-0.169 (-5.81)**	**-0.060 (-3.37)**	**-0.106 (-5.35)**	**-0.085 (-3.76)**
R^2	0.0898	0.2318	0.1884	0.3481	0.0650	0.1393	0.1129	0.1102	0.1086	0.2437	0.0742
Adj. R^2	0.0629	0.2064	0.1616	0.3243	0.0404	0.1109	0.0836	0.0869	0.0822	0.2187	0.0499
L-R Model USD	-1.180 (-0.83)	0.154 (0.51)	-1.470 (-0.92)	3.822 (0.65)	3.536 (1.74)	**3.348 (3.11)**	1.845 (1.90)	-0.164 (-0.44)	**-2.552 (-1.96)**	-0.004 (-0.01)	**-1.952 (-2.01)**
AUD	1.102 (0.39)	**-1.446 (-2.28)**	7.900 (1.90)	-0.493 (-0.06)	1.697 (0.40)	-3.991 (-1.88)	-2.108 (-1.15)	-0.350 (-0.48)	2.375 (0.88)	**-2.449 (-3.11)**	0.500 (0.29)
JPY	1.535 (0.67)	0.640 (1.41)	-2.147 (-0.75)	4.022 (0.39)	-1.612 (-0.54)	-1.181 (-0.74)	-2.004 (-1.51)	**1.043 (1.96)**	-2.779 (-1.37)	0.091 (0.16)	-0.066 (-0.05)
GBP	0.938 (0.26)	0.055 (0.08)	2.219 (0.61)	-11.34 (-0.59)	2.096 (0.44)	-2.879 (-1.13)	0.834 (0.38)	0.819 (0.95)	-2.957 (-0.97)	**2.632 (2.76)**	1.220 (0.56)
EUR	-4.513 (-1.61)	0.874 (1.44)	-2.513 (-0.83)	0.970 (0.12)	1.603 (0.39)	2.030 (0.97)	-2.392 (-0.98)	-0.627 (-0.87)	**7.275 (2.45)**	**-3.315 (-3.86)**	-0.707 (-0.40)
SMI	-1.960 (-1.40)	**0.806 (2.78)**	**4.359 (2.17)**	-1.073 (-0.27)	1.012 (0.56)	0.109 (0.11)	0.011 (0.01)	**1.098 (3.36)**	**2.498 (2.05)**	**1.707 (4.91)**	1.019 (1.07)
NIR	2.070 (1.79)	-0.214 (-1.26)	**-2.370 (-2.14)**	-0.894 (-0.32)	0.633 (0.56)	0.360 (0.62)	-0.149 (-0.30)	-0.235 (-1.15)	0.435 (0.59)	**1.123 (5.13)**	-0.786 (-1.59)

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