Volatility Spillovers between Stock Market Returns and Exchange Rate Changes: the New Zealand Case

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EXTENDED ABSTRACT

Kanas (2000) first examines volatility spillovers between stock market returns and exchange rate changes on six developed countries: the US, Canada, Japan, the UK, France, and Germany. He finds that, for all countries, spillovers from exchange rate changes to stock market returns are insignificant. On the other hand, spillovers from stock market returns to exchange rate changes are significant for all countries except Germany. New Zealand (NZ) is a small market which is characterized by down-markets and is impacted by international movements. In this paper, it is found that, for NZ data, when the exchange rate volatility is higher, the stock market volatility is lower before the 1997 stock market crash. However, this volatility spillover becomes significantly positive after the crash. On the other hand, we find significant volatility spillovers from stock market returns to NZ dollar movements in the foreign exchange market only before the1997 crash but not after, i.e., volatility spillovers between exchange rate changes and stock market returns change over time.

1. INTRODUCTION

International equity investments are increasing rapidly since mid-1980. Kanas (2000) studies volatility spillovers between exchange rate changes and stock market returns on six industrialized countries, not including New Zealand and Australia. His empirical evidence shows that, in general, stock return volatility spills over to exchange rate changes while the reverse is not significant. The US and Australia are the top two trading partners of NZ. Brailsford (1996) first investigates volatility spillovers between the NZ and Australian stock markets. He finds that, after controlling for the effects of the US volatility, the Australian market volatility spills over to the New Zealand market but not the reverse. Brailsford has not yet studied the volatility spillover between exchange rate changes and stock market returns within either NZ or Australia. Dungey (1999) points out that the NZ currency is mainly affected by the international factors as more than 50% of the decomposition of NZ dollar volatility in the foreign currency market are due to overseas impacts. Moreover, the NZ stock market is small, illiquid, limited to diversification, and exposed to exchange rate volatility. Chen et al. (2004) find that, in the New Zealand stock market, there is a lagged stock market reaction to exchange rate fluctuations. Their result indicates that the volatility of the stock market returns might not rise when the exchange rate uncertainty is higher. Unfortunately, Chen et al. have not further reported the volatility spillover of exchange rate changes to the stock market returns. This paper applies the same EGARCH model to volatility spillovers. It is found that there is significant volatility spillovers from exchanges rate changes to stock market returns; volatility spillovers from stock market returns to exchange rate changes is marginally significant and changes from negative before the 1987 stock crash to positive after the crash.

The rest of the paper is organized as follows: Section 2 provides a literature review, Section 3 details the data and the EGARCH methodology, Section 4 discusses the empirical results, and Section 5 concludes.

2. LITERATURE REVIEW

Exchange rate changes are critical to a stock market which is either import or export-oriented or both. This is particularly critical to the NZ market. Empirical results show that the exchange rate uncertainty has a significantly negative effect on investment. Applying a rolling standard deviations method, Goldberg (1993) finds evidence from the US industry-level investment that exchange rate uncertainty has significantly negative long-run effects on investment. Darby et al. (1999), using a single-equation estimation in their study, find a similar negative exchange rate effect on aggregate investment based on the data from five OECD countries. Carruth et al. (2000) and Serven (2003),

adopting a GARCH framework, find a highly significantly negative impact from the real exchange rate uncertainty on investment. Choudhry (2005) finds that the effects of exchange rate variability on real exports are, in general, significantly negative.

There are a few explanations proposed by classical economists on why equity prices are affected by exchange rate changes. The flow models (e.g., Dornbusch and Fisher 1980) suggest that the currency fluctuations impact on the international competitiveness of the firm as well as the balance of the trade position. The real output of a country is thus affected by exchange rate changes. Share prices of companies are eventually influenced due to the changes in the current and future cash flows of the firm. The exchange rate changes therefore should bear effects on stock returns. A recent study of Alaganar and Bhar (2007) indicates that the first- and second-order effects of exchange rate changes impact significantly on diversified portfolios in the US share market. They use weekly returns of 16 World Equity Benchmark Series (WEBS) in the study while each WEBS series represents a diversified portfolio of investing in foreign shares in a country outside of the United States. The diversification technique is efficiently applied in WEBS while tracking the performance of a foreign country's Morgan Stanley Capital International index though WEBS are traded only in U.S. Dollars. Alaganar and Bhar (2007) employ the GJR and GARCH-M models in testing the impacts of exchange rate volatility on returns of diversified country index portfolios. They find that the exchange rate uncertainty is priced as a factor in WEBS returns. Moreover, exchange rate volatility has lagged positive impacts on the volatility of WEBS. They point out that the second moment exchange rate information is important to diversifications in the stock market. The exchange rate risk is priced in returns and the exchange rate volatility is important to investors. The empirical findings provided in the above-mentioned studies are for large developed markets. Chen, Naylor, and Lu (2004) argue that NZ stock prices are closely tied to exchange rate movements compared to stocks in other countries. Their empirical result suggests all NZ firms' cash flows follow exchange rate fluctuations. Company foreign exchange exposures can be related to one single currency. In particular, their empirical results show that NZ firms are more sensitive to the NZD/USD and NZD/AUD exchange rate changes. Using these two exchange rates plus the TWI index in their study, the authors successfully identify significant effects of exchange rate fluctuations on the stock returns. However, such effect totally disappears if monthly data is used. In other words, their evidence suggests only delayed, but not contemporaneous, market reactions to exchange rate movements.

This study employs the EGARCH model to investigate the volatility behaviour in NZ stock returns and currency movements. The GARCH family has been widely used to capture and test the stock market volatility in the search of evidence how quickly the stock market reflects new information. Black (1976) and Christie (1982) notice that a stock price decline is followed by an increase in the subsequent stock volatility. This observation is termed as the leverage effect, which is tested in the GJR model developed by Glosten et al. (1993). Blair et al. (2002) explain that a decline in the stock price will increase the debt-equity ratio and hence the equity risk. If the leverage effect exists in the NZ stock market, we need to consider whether the exchange rate volatility effect is in fact a reflection of the leverage effect. Pinfold et al. (2001) point out that the NZ stock market is characterized by down market conditions. As a result, filtering away the leverage effect in volatility spillover tests is essential. The EGARCH model handles the leverage effect very efficiently.

Kanas (2000) first uses EGARCH models in investigating the volatility spillover effects between the equity market and the foreign exchange market in six industrialized countries. Based on the daily data of US, Canada, Japan, UK, France, and Germany for the period between 1986 and 1998, his study shows significant symmetric spillover effects from stock market returns to foreign exchange rate changes. Moreover, the effects of 'good' news in the stock market are the same in absolute terms as those of the 'bad' news for exchange rate volatilities. Sub-period tests show that spillover effects from the equity markets to the foreign exchange markets increase after the 1987 stock market. These results are consistent with the views that financial markets become more integrated after stock market crashes and the volatility relationship between stock returns and exchange rate movements change over time.

The significant volatility spillovers from stock returns to exchange rate changes have important implications for the 'asset approach' to exchange rate determination (Branson, 1983; and Frankel 1983), particularly when international equity investments have been rising since the mid-1980s. The higher level of cross-border financial assets flows between, for example, domestic and foreign share markets results in the changes of demand for and supply of currencies in which the international equities are priced in. Exchange rates have to be adjusted according to the international equity

flows. Therefore, the 'asset approach' to exchange rate determination suggests significant volatility transmission from the stock market to the foreign exchange market. While Kanas (2000) finds a significant volatility spillover from stock return changes to foreign currency fluctuations, it might not be the case for the NZ economy. Dungey (1999) argues that it is the international factor that mainly affects the volatility of NZ dollars. In other words, volatility shocks in the local NZ stock markets can have little effects on the movement of the NZ currency.

3. DATA AND METHODOLOGY

3.1. Data and descriptive statistics

We collect daily NZ total market index prices from Datastream. The exchange rates NZD/AUD and NZD/USD as well as the TWI index are collected from the Reserve Bank of New Zealand. The USA and Australia markets are the two largest export markets of NZ firms. Chen et al. (2004) use these exchange rates in their study. Our sample period spans from January 1990 to December 2004. There are 3,866 observations. Adopting NZ data for identifying spillover effects across stock and foreign exchange markets in fact provides a unique environment for examining the volatility relationship between stock returns and foreign currency movements. Dungey (1999) finds that it is the international factor that mainly affects the volatility of NZ dollars. In particular, his paper indicates that the total impact of international factors can account for more than 50% of the decomposition of volatility. The NZ currency starts floating independently on the international exchange market since 1985. The NZ dollar takes price-taker positions because of its relatively small capitalization in the foreign exchange market. The Reserve Bank of NZ has no intervening monetary policy or intensions to intervene for NZ dollar value within our testing period. Our research focuses on the period before that time. Furthermore, NZ is not a world leader in many industrial and commercial areas. The GDP figures determine that NZ is small and easily affected by international economical conditions. Local NZ firms are less diversified and they have exports or imports orientations. Because of the close linkage among local NZ companies, none of the firms can be exempted from international factors' influences. Moreover, although the NZ stock market is very small and illiquid, the NZ stock exchange is efficient with high market awareness, especially to the exchange rate uncertainty. All these unique and important characteristics of NZ well developed economy attract us to use her data for investigate how the NZ stock market volatility responds to the exchange rate variability. In this study, the stock market return and all exchange rate changes are defined as log relative returns.

Table 1 shows some descriptive statistics of stock and foreign exchange market returns. Jarque-Bera test is performed for stock market index and exchange rate returns in order to check the normality of each series. The results show that the distribution of stock index and exchange rate returns are not normal. We therefore can no longer assume normal distribution in our dataset. Ordinary least squared regression tests are not appropriate in testing the relationship between stock returns and exchange rate changes. In this paper, the EGARCH model is adopted to examine the dynamic volatility relationship between NZ stock return and foreign exchange rate changes. We also check the stationarity of stock returns and exchange rate returns. Table 1 contains the results of Augmented Dickey-Fuller (ADF) unit root test. The t-statistics are highly significantly at the 1% level. All stock and exchange return series are integrated with I(0), i.e., stationary.

Table 1. Descriptive Statistics. This table presents basic descriptive statistics of daily stock and foreign exchange return of New Zealand market. We report number of observations, mean, median, maximum and minimum value, standard deviation, skewness and kurtosis for each series. Results of Jarque-Bera and ADF test are provided as the follows.

	Total Market Index	NZD/ AUD	NZD/ USD	TWI Index
Observations	3867	3867	3867	3867
Mean	0.000129	5.01E-05	4.88E-05	2.96E-05
Median	0	9.14E-05	0.000169	0.000203
Maximum	0.091526	0.034076	0.042983	0.035465
Minimum	-0.127877	-0.036316	-0.036185	-0.03214
Std. Dev.	0.00955	0.004474	0.006132	0.004808
Skewness	-0.414249	-0.079955	-0.079385	-0.32546
Kurtosis	17.76697	7.771294	7.113779	7.111554
Jarque-Bera	35246.08 [0]	3672.171 [0]	2730.809 [0]	2792.065 [0]
ADF Test	-41.06723 [0]	-66.7584 [0.0001]	-37.83001 [0]	-38.334 [0]

3.2. The EGARCH model

We examine the relationships between the movements of the stock market volatility and exchange rate fluctuations within an EGARCH

model developed in Nelson (1991). The multivariate EGARCH models can effectively capture the asymmetric effects of innovation on volatility in stock returns while the conditional volatility of currency movements can be included in the model at the same time. This important feature of the model gives direct and explicit measurement of the role of exchange rate fluctuations in explaining the time series behaviour of stock return volatility. Similarly, EGARCH models can test whether the exchange rate volatility effects are asymmetrical in the foreign exchange market, that is, if the appreciations of NZ dollar in the past have the same impact on the future exchange rate volatility as the depreciations have. Although leverage effects are identified in the stock markets, the asymmetric volatility impacts in the foreign exchange market are not clear. The models are specified by the following equations:

$$R_t = \beta_{1,0} + \sum_{j=1}^{p} \alpha_{1,j} R_{t-j} + \sum_{j=1}^{p} \beta_{1,j} FX_{t-j} + \varepsilon_t^R \quad (1)$$

$$FX_t = \beta_{2,0} + \sum_{j=1}^{p} \alpha_{2,j} R_{t-j} + \sum_{j=1}^{p} \beta_{2,j} FX_{t-j} + \varepsilon_t^{FX} \quad (2)$$

$$h_t^R = \exp\left\{\alpha_{1,0} + \alpha_{1,1} f(Z_{t-1}^R) + \alpha_{1,2} f(Z_{t-1}^{FX}) + \gamma_1 \ell n(h_{t-1}^R)\right\} \quad (3)$$

$$h_t^{FX} = \exp\left\{\alpha_{2,0} + \alpha_{2,1} f(Z_{t-1}^R) + \alpha_{2,2} f(Z_{t-1}^{FX}) + \gamma_2 \ell n(h_{t-1}^{FX})\right\} \quad (4)$$

$$f(Z_{t-1}^R) = \left(\left|Z_{t-1}^R\right| - E\left(\left|Z_{t-1}^R\right|\right) + \delta_1 Z_{t-1}^R\right) \quad (5)$$

$$f(Z_{t-1}^{FX}) = \left(\left|Z_{t-1}^{FX}\right| - E\left(\left|Z_{t-1}^{FX}\right|\right) + \delta_2 Z_{t-1}^{FX}\right) \quad (6)$$

$$h_{R,FX,t} = \rho_{R,FX} \sqrt{h_t^R h_t^{FX}} \quad (7)$$

where R_t and FX_t denote stock return and exchange rate changes. We use the TWI index, NZD/AUD and NZD/USD, for FX_t respectively, to examine the exchange rate effects to stock returns. The number of lags, represented by *p* in the equation, is optimized by the AIC information criteria in the results. The analysis searches for dynamic relationship between stock returns and exchange rate changes. The Granger causality test is a joint test that examines the significance of relevant coefficients. The coefficients $\beta_{1,j}$ and $\beta_{2,j}$ in equation (1) and (2) show the effects of exchange rate changes to stock returns and the reverse effects respectively. The stochastic error terms (ε) are obtained in order to be used in the EGARCH models.

In equations (3) to (7), h_t^R and h_t^{FX} denote the conditional variance of stock returns and foreign exchange rates when h_{t-1}^R and h_{t-1}^{FX} denote lagged conditional variance included in the exponential function. Z_{t-1}^R and Z_{t-1}^{FX} denote the standardized innovations of NZ stock returns and exchange rate changes respectively ($Z_t^R = \varepsilon_t^R / \sqrt{h_t^R}$ and $Z_t^{FX} = \varepsilon_t^{FX} / \sqrt{h_t^{FX}}$). The coefficients $\alpha_{1,2}$ and $\alpha_{2,1}$ test whether there exist volatility spillovers across the stock market and the foreign exchange market. In particular, $\alpha_{1,2}$ ($\alpha_{2,1}$) indicates volatility spillover effects sourced from the foreign exchange (stock) market to the stock (foreign exchange) market. Moreover, coefficients $\alpha_{1,1}$ and $\alpha_{2,2}$ test the volatility clustering in the stock return and exchange rate series. Although volatility autocorrelations are often identified in international stock markets, it is not clear if volatilities in the NZ currency are autocorrelated. A statistically significant $\alpha_{2,2}$ can provide evidence that volatility in the foreign exchange market is significantly affected by the historical volatility changes in the exchange rates. Finally, coefficients γ_1 and γ_2 indicate volatility persistence in the stock and foreign exchange market respectively, indicating if an information shock in the market tends to have persist effects for the future volatility.

Using EGARCH models also allows us to examine the asymmetric effects in the volatility impacts. As mentioned above, the past volatility shocks can have asymmetric effects on future volatility changes in the market. δ_1 and δ_2 in equations (5) and (6) examine asymmetry effects in the stock market and foreign exchange market respectively. A positive (negative) and statistically significant δ_1 indicates good (bad) news in the stock market has greater impact on the volatility of stock index. Likewise, δ_2 tests if the appreciations in NZ dollar have the same impact to the exchange rate volatility as the depreciations do.

EGARCH models are estimated by using a maximizing log likelihood function that is specified by the following equation:

$$L(\varphi) = -0.5(NT)\ln(2\pi) - 0.5\sum_{t=1}^{T}(\ln|H_t| + \varepsilon_t' H_t^{-1} \varepsilon_t)$$

where φ is the 11×1 parameter vector to be estimated. N is the number of equations. As we analyse volatility spillover between stock and foreign exchange markets, N equals to two. T is the number of observations in the sample; H_t is a 2×2 time-varying conditional variance covariance matrix with diagonal elements given by equation (3) and (4). $\varepsilon_t' = [\varepsilon_t^R \varepsilon_t^{FX}]$ is the vector of innovations from stock and foreign exchange market at time t.

4. EMPIRICAL RESULTS

4.1. Full sample period results

We find the conditional variances of the stock returns and exchange rate changes are significantly impacted by their own standardized innovation in the past. Coefficients $\alpha_{1,1}$ and $\alpha_{2,2}$ appear to be statistically significant at the 1% level in all cases no matter what exchange rate measurements we apply in the equations. The significant coefficients $\alpha_{1,1}$ and $\alpha_{2,2}$ indicate volatility clustering in both NZ stock exchange and the fluctuations of NZ dollar in the international foreign exchange market. There also exists volatility persistence in stock returns and exchange rate movements. Volatility persistence coefficients γ_1 and γ_2 are all statistically significant at the 1% level while four out of six values are less than and close to one. Our results are consistent to the results of both Najand and Yung (1991) and Chen et al. (2001).

Looking at the volatility spillover coefficients, we notice significant volatility spillover effects from the stock market to the foreign exchange market. The coefficient $\alpha_{2,1}$ has high statistical significance for all exchange rate measurements. The value of $\alpha_{2,1}$ is the highest when the TWI index is used in the equation as the index represents the overall performance of the kiwi dollar. The volatility spillover from the stock returns to NZD/AUD is greater than that to NZD/USD. This attributes to the fact that Australia and New Zealand are closely tied in many economical aspects. Our results are consistent to the findings of Kanas (2000) that volatility changes in the stock returns have impacts on the movements of foreign currency. We therefore provide supportive evidence for the 'asset approach' to exchange rate determination (Branson 1983 and Frankel 1983). While the NZ stocks attract international investments, the NZ dollar has to be adjusted according to the international equity flows.

The foreign exchange rate volatility changes, on the other hand, can spill over to the stock volatility. The coefficient $\alpha_{1,2}$ is statistically significant at the 1% level when NZD/USD is applied as the foreign exchange rate in the model. This indicates that the volatility changes in NZD/USD exchange rate have spillover effects on the stock returns. However, the spillover effects are not significant when TWI index and NZD/AUD are used in the model.

We notice that the asymmetry coefficients δ_1 appear to be negative and statistically significant at the 1% level all the time. This suggests strongly significant leverage effects in the NZ stock exchange. Bad news that results in stock decline in the market leads to a more volatile stock movement. This finding is consistent to the general leverage effect evidence in the literature. At the same time, the asymmetry coefficient δ_2 is only statistically significant when NZD/USD is used in the model. This implies that currency depreciations in NZ dollar against the US currency result in more volatility in the international foreign exchange market. This case, however, is not applicable to other exchange rate variables for the NZ dollar.

Table 2 Volatility spillover between stock returns and exchange rate changes (full sample period).

Panel A: Stock volatility

	$\alpha_{1,0}$	$\alpha_{1,1}$	$\alpha_{1,2}$	γ_1	δ_1
NZD/AUD	-0.2472[a]	0.243[a]	-0.0001	0.973[a]	-0.141[a]
	(-10.07)	(28.24)	(-0.01)	(380.80)	(-5.38)
NZD/USD	-0.289[a]	0.164[a]	0.092[a]	0.969[a]	-0.348[a]
	(-14.16)	(30.28)	(14.74)	(466.89)	(-12.63)
TWI index	-0.142[a]	0.058[a]	-0.003	0.984[a]	-0.698[a]
	(-4.97)	(5.02)	(-0.21)	(310.26)	(-6.01)

Panel B: Exchange rate volatility

	$\alpha_{2,0}$	$\alpha_{2,1}$	$\alpha_{2,2}$	γ_2	δ_2
NZD/AUD	-4.518[a]	0.087[a]	0.309[a]	0.582[a]	-0.022
	(-11.93)	(4.16)	(14.64)	(16.73)	(-0.53)
NZD/USD	-0.078[a]	0.019[a]	0.194[a]	0.991[a]	-0.109[a]
	(-5.15)	(3.08)	(22.36)	(694.04)	(-4.94)
TWI index	-6.719[a]	0.177[a]	0.328[a]	0.396[a]	-0.012
	(-50.83)	(5.54)	(10.97)	(33.27)	(-0.20)

t-statistics in parentheses.
[a]statistically significant at 1% level
[b]statistically significant at 5% level
[c]statistically significant at 10% level

4.2. Sub-periods results

The 1997 stock market crash occurs in the middle of our full sample period. To check the robustness of our empirical results, we perform the tests for two sub-periods, i.e., before and after the 1997 stock market crash. Table 3 contains the results before the July 1997 and Table 4 presents the results after July 1997.

Table 3 shows significant volatility spillover effects from the foreign exchange market to the stock exchange when NZD/USD and TWI index are used. However, we notice that the coefficients

$\alpha_{1,2}$ appear to be negative in value. The spillover coefficients $\alpha_{1,2}$ after the 1997 stock market crash become positive in Table 4. This implies that the 1997 stock market crash causes the volatility transmission from the foreign exchange market to the stock market in NZ to change over time.

Comparing to the results for the whole period, we notice that the foreign currency spillover effects to stock returns are easier to be identified in sub-periods. In particular, the volatility impact caused by TWI index fluctuations to NZ stock returns is significant in the sub-periods testing while it is not the case in the whole period. Note that the spillover coefficients $\alpha_{1,2}$ for TWI parameters have different signs in sub-periods, indicating that the effects have changed over time and therefore make the volatility transmission hard to be identified in the whole period.

The volatility transmissions from the stock market to the foreign currency market, on the other hand, become insignificant for NZD/USD and TWI index after the 1997 stock market crash. Table 4 indicates that the volatility spillover from stock returns only has impacts on the NZ dollar against the Australian dollar. This again attributes to the close economical tie between two countries. However, table 3 shows that the volatility spillover from the stock returns to NZ dollar fluctuations is significant across all currency parameters. Empirical results suggest that the spillover effects from the stock market to the foreign exchange market seem to vanish after the 1997 crash. This is consistent to the view that NZ currency is driven by international factors instead of domestic factors. While the news in the local stock market had short term volatility effects on NZ dollar fluctuations, the volatility spillovers disappeared after the stock market crash in 1997. The sub-periods empirical results provide important insight of the volatility spillovers between the stock market and foreign exchange market in NZ. The volatility transmissions have changed over time.

Table 3 Volatility spillover between stock returns and exchange rate changes before 1997 stock crash.

Panel A: Stock volatility

	$\alpha_{1,0}$	$\alpha_{1,1}$	$\alpha_{1,2}$	γ_1	δ_1
NZD/AUD	-0.092[a]	0.123[a]	-0.010	0.990[a]	-0.025
	(-3.97)	(8.54)	(-1.02)	(395.56)	(-0.46)
NZD/USD	-0.490[a]	0.258[a]	-0.052[a]	0.969[a]	-0.284[a]
	(-8.10)	(9.96)	(-3.59)	(466.88)	(-6.68)
TWI index	-0.134[a]	0.141[a]	-0.025[a]	0.985[a]	-0.101[b]
	(-4.49)	(8.39)	(-2.35)	(304.96)	(-2.09)

Panel B: Exchange rate volatility

	$\alpha_{2,0}$	$\alpha_{2,1}$	$\alpha_{2,2}$	γ_2	δ_2
NZD/AUD	-8.418[a]	0.112[a]	0.380[a]	0.221[a]	0.181[a]
	(-9.24)	(3.52)	(11.41)	(2.65)	(3.18)
NZD/USD	-1.102[a]	0.064[a]	0.210[a]	0.991[a]	-0.095[a]
	(-10.67)	(3.47)	(11.50)	(694.04)	(-2.10)
TWI index	-2.437[a]	0.091[a]	0.222[a]	0.782[a]	-0.097[b]
	(-9.99)	(3.08)	(12.89)	(35.76)	(-2.13)

Table 4 Volatility spillover between stock returns and exchange rate changes after 1997 stock crash

Panel A: Stock volatility

	$\alpha_{1,0}$	$\alpha_{1,1}$	$\alpha_{1,2}$	γ_1	δ_1
NZD/AUD	-0.531[a]	0.280[a]	-0.033	0.945[a]	-0.353[a]
	(-5.92)	(18.63)	(-1.32)	(106.23)	(-8.31)
NZD/USD	-6.728[a]	0.056[a]	0.067[a]	0.288[a]	-0.460[c]
	(-12.16)	(5.42)	(2.53)	(4.79)	(-1.85)
TWI index	-1.015[a]	0.324[a]	0.053[a]	0.984[a]	-0.062[b]
	(-9.42)	(22.52)	(3.74)	(310.26)	(-2.19)

Panel B: Exchange rate volatility

	$\alpha_{2,0}$	$\alpha_{2,1}$	$\alpha_{2,2}$	γ_2	δ_2
NZD/AUD	-0.855[a]	0.081[a]	0.120[a]	0.921[a]	-0.103
	(-3.23)	(3.58)	(4.68)	(38.24)	(-1.1037)
NZD/USD	-4.935[a]	-0.007	0.121[a]	0.492[a]	-0.871[a]
	(-3.80)	-0.2975	(3.91)	(3.67)	(-3.67)
TWI index	-6.097[a]	-0.003	0.067[a]	0.396[a]	-0.635[a]
	(-2.39)	(-0.10)	(5.19)	(33.27)	(-3.12)

t-statistics in parentheses.
[a]*statistically significant at 1% level*
[b]*statistically significant at 5% level*
[c]*statistically significant at 10% level*

5. CONCLUDING REMARKS

In this paper, the EGARCH model is adopted to examine volatility spillovers between exchange rate changes and stock market returns in New Zealand. We effectively control the often down-

market effects in the NZ stock market by incorporating the leverage effect in the EGARCH framework. We then examine whether the effect of volatility spillover changes over time by performing the test in the sub-periods. Kanas (2000) suggests that the volatility spillover effects from the stock market to the foreign exchange market becomes significant after the 1987 crash as financial markets become more integrated. The NZ environment, however, is very different from the markets examined in Kanas (2000). Dungey (1999) points out that the NZ currency is mainly driven by international factors. We find that local stock market returns in NZ have marginal effects on the volatility of the NZ dollar. The volatility spillovers from the stock market to the foreign exchange market in NZ change over time. Before the 1997 stock crash, the spillover effects from stock returns to exchange rate changes are significant. However, the spillovers vanish after the crash. This paper provides empirical evidence that the "asset approach" to exchange rate determination does not fit to small markets like NZ, whose currency is driven by international factors. On the other hand, we find significant volatility spillovers from the foreign currency movements to stock returns in NZ. Our results are consistent to the argument of Chen et al. (2004) that all NZ firms are affected by NZ dollar fluctuations. The spillovers from the exchange rate to stock returns are significant before and after the 1997 crash when leverage effects in the NZ stock market are incorporated by the EGARCH framework in the analysis.

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