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Full Length Research Paper

The impacts of unexpected changes in exchange rate on firms' value: Evidence from a small open economy

Jian-Fa Li, Yih-Bey Lin* and Cheng-Yih Hong

Department of Finance, Chaoyang University of Technology, Taichung County 41349, Taiwan.

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This study examined the exposure of firms to exchange rate fluctuations by both employing the Generalized Autoregressive Conditional Heteroskedasticity Model (GARCH) and the Classical Linear Regression Model (CLRM). To uncover the sensitivity of our results in the presence of the financial crisis, the sample period was classified into two sub-periods in which included pre- and post- Asian financial crisis. Panel regression analysis was used to find the determinants of exchange rate exposure, such as firm size, export ratio, quick ratio and long-term debt ratio. The empirical findings in the present study were summarized as follows: It was positive and significant exposure of foreign exchange risk. It suggested that currency movements matter the firm's value. The empirical results matched Taiwan as an export-oriented small open economy. Firms with a larger size, a higher quick ratio or a higher long-term debt ratio were inclined to have a lower exposure in exchange rate. However, the export ratio of a firm had little impacts on the firm's exchange rate exposure.

Key words: Exchange rate exposure, Asian financial crisis, Generalized Autoregressive Conditional Heteroskedasticity Model, panel regression analysis.

INTRODUCTION

After the collapse of the Breton Woods System, the fixed exchange rate system was abandoned and the floating exchange rate system was adopted in most countries. The Central Bank in Taiwan took highly control on the exchange rate and had managed to keep the fluctuation in exchange rates relatively small. Taiwanese corporations engaging in importing and exporting goods paid little attention to the fluctuation in exchange rate. In order to follow the global trend, the monetary authorities of Taiwan have adopted a managed floating exchange rate system from a pegged exchange rate system since 1979. Ever since the change fluctuation in the exchange rate has been higher than that experienced in the past. Until 1989 the Central Bank in Taiwan adopted a floating exchange rate system, ever since a change in exchange rate played a dominant role in operational strategies of multinational corporations.

Given the trend of globalization, fluctuations in foreign exchange rate are sources of uncertainty for many firms across countries. Some theoretical models predict that many firms should have significant exchange rate exposure (Bodnar et al., 2002). In empirical studies, some show significant effects of exchange rate changes on firm profits and competition (Hung, 1992; Williamson, 2001). Alternatively, other empirical studies present weak relationships between exchange rate changes and firms' stock prices (Griffin and Stulz, 2001; Dominguez and Tesar, 2006). On the other hand, Bartram et al. (2010) and Bartram and Bodnar (2007) present a phenomenon of foreign exchange exposure puzzle. That is, there exists the discrepancy between theoretical predictions and observed levels of exchange rate exposure. As Taiwan is a small open economy, its natural resources are relatively deficient and the domestic demand is small. In order to elevate the economic growth and increase economies of scale, export-oriented industries play a significant role on the growth of Taiwan. Besides, Bartram and Bodnar (2009) show evidence of the significant return impact on firm-level currency exposure when "conditioning" on the exchange rate change. Accordingly, we might anticipate that exchange rate exposure matter the firm's value. One of our research issues was to evaluate an exchange rate exposure on the firm's value.

*Corresponding author. E-mail: yblin@cyut.edu.tw. Tel: 886-4-23323000#7092. Fax: 886-4-23742333.

The exchange rate exposure might vary across firms due to firm-specific factors such as operating characteristics, hedging activities and diversification strategies. Nevertheless, most prior literature ignores the serial correlation and heterogeneity problems of the exchange rate exposure. In the present study, following Tai (2005), we employed the generalized autoregressive conditional heteroskedasticity model (GARCH hereafter) to effectively explore exchange rate exposure. Given the dramatic and volatile movements in the exchange rate during the periods of Asian financial crisis in most Asian countries, (For example, Hahm (2004) shows that along with the negative exposure of banking institutions, the sharp depreciation of the Korean won at the end of 1997 further deteriorated the banking sector's capital adequacy worsening during the Asian financial crisis.) it was important to examine the exchange rate exposure of firms during the two sub-periods of pre and post – Asian financial crisis. Finally, the present study attempted to find how firm characteristics affected exchange rate risk exposure and further provided the corporations' managers with a current situation of exchange rate exposure as hedging in a small open economy, such as Taiwan. The empirical findings were that movements in currency mattered the firm's value. Firms with a larger size, a higher quick ratio or a higher long-term debt ratio were inclined to having a lower exposure in exchange rate. However, the export ratio of a firm had little impact on the firm's exchange rate exposure.

LITERATURE REVIEW

Definitions and measurement of exchange rate exposure

The basic understanding of exchange rate exposure is the sensitivity of a firm's market value to a change in exchange rate. An unexpected change in exchange rate might have impacts on firm's value. The impacts include firm's cash flow, foreign sales, foreign competition and so on (Williamson, 2001; Bartram and Karolyi, 2006). Accordingly, a change in exchange rate could create gain or loss and make a change in firm's value.

Adler and Dumas (1984) develop a measure of exchange rate risk exposure. They point out that the concept of exposure is arbitrary in sense that stock prices and exchange rates are determined jointly. The exchange rate exposure could be measured by the slope coefficient in a regression of corporations' stock returns on changes in exchange rate. Jorion (1990) investigates the relationship between the exchange rate and the value of Multinational Corporation**.** He employs a two-factor model, which combines market's rates of returns and exchange rates, to analyze the exchange rate exposure of 287 U.S. multinational corporations with large foreign exchange. He finds that only 15 firms (5.2%) have significant exposure coefficients. Besides, Bodnar and Gentry (1993) examine exchange rate exposure for Canada, Japan, and the USA at the industry level and find that the coefficients of exchange rate exposures are not significant in many individual industries.

Choi and Prasad (1995) develop a model of firm valuation to examine the exchange risk sensitivity of 409 U.S. multinational corporations during the period from 1978 to 1989, and classify the data into 20 SIC-based industry groups. Choi and Prasad (1995) show that 15% of 409 multinational corporations have significant exchange rate exposure. However, only 2 out of 20 (10%) industries exhibit significant exchange rate exposure. This might be explained by the fact that although corporations in a given industry are in the same primary line of business, they are still heterogeneous in terms of their operational and financial characteristics. Since industry groups might include firms with positive and negative exchange risk exposure, aggregating firms would result in a non-significant exposure coefficient for the industry group. In addition, Choi and Prasad (1995) suggest that it is appropriate for the study to employ the firm level data to investigate the exchange rate exposure.

Tai (2005) applies the GARCH to estimate exposure coefficient. He shows that more than 80% of the sample corporations are significantly exposed to exchange rate changes in an asymmetric way. In addition, it is shown that complete hedging is less likely for US banks. It provides strong evidence of asymmetric currency exposure. Therefore, it suggests that both asymmetry and conditional heteroskedasticity play important roles in estimating an exchange rate exposure. Lin et al.(2008) also apply a GARCH (1,1) to capture the time-varying volatility of stock returns and risk, and find that Taiwanese firms are able to construct strategic resources to manage economic exposure to decrease the fluctuation of cash flows and boost the market value of a firm. Moreover, Bartram (2008) characterizes exposure as the elasticity of corporate cash flows with regards to changes in unexpected exchange rate and the estimated regression coefficients of the exchange rate variable to capture the sensitivity of the respective cash flow to an exchange rate change, which represents a measure of foreign exchange rate exposure.

Owing to the exchange rate exposure might vary across firms due to firm-specific factors such as operating characteristics, hedging activities and diversification strategies. The serial correlation and heterogeneity problems of the exchange rate exposure might exist. Therefore, following Tai (2005), the present study employed the GARCH model to effectively explore exchange rate exposure.

Determinants of exchange rate exposure

Jorion (1990) finds that exchange exposure is positively

related to the ratio of a firm's foreign sales to total sales. This implies that a firm having a larger foreign involvement, has larger degree of influence of the exchange rate change on firm's valuation. Chow et al. (1997) argue that larger firms are less exposed to long-term exchange rate effects than the smaller firms. Their results are consistent with the hypothesis that larger firms hedge exposure risk more than smaller firms do. The larger firms exhibit significant economies of scale in terms of both capital and human resources. Consequently, larger firms are more likely to attempt economic exposure management than the smaller firms do. He and Ng (1998) investigate whether the value of Japanese multinational corporations are affected by exchange rate changes. They document that firms with lower liquidity or a higher quick ratio have little incentive to hedge. Firms with higher debt ratio are more incentive to hedge and hence have smaller exchange rate exposures. Smaller Japanese multinational firms tend to have lower exposure to exchange rate risk.

Martin et al. (1999) focus on the economic exchange rate exposure of multinational corporations with foreign operations primarily in Europe. They find that the more involvement in foreign markets, the lower the exchange rate exposure and the more sensitive the companies are to exchange rate fluctuations. Finally, corporations with increasing export rates are more exposed to changes in exchange rates. Other studies, for example, Williamson (2001) shows that firms with higher levels of foreign sales and facing more foreign competition would have higher foreign exchange rate exposure. Bartram and Karolyi (2006) show that the foreign exchange rate exposure of firms is systematically related to firm and industry characteristics. Bodnar (2008) find evidence of a significant return impact to firm-level currency exposures when conditioning on the exchange rate change. Parsley and Popper (2006) examine the association between foreign exchange exposure, macroeconomic conditions, and firm activities.

Referring to literature above, the present study considered the determinants of exchange rate exposure such as firm size, export rate, quick rate and long-term debt ratio. The following section would discuss in detail.

METHODOLOGY

Data sources and sample selection

The data in the present study were drawn from the database of Taiwan Economics Journal and the database of Securities and Futures Institute. Prior studies' results have met with little success in identifying significant exchange rate exposure. Bartov and Bondar (1994) argue that those studies might be problem of sample selection procedures. Referring to Bartov and Bondar (1994), the selection criteria in the present study were: (i) Firms reported a significant foreign currency gain or loss in their annual financial statements (more than 5 percent of pretax income in absolute value) (ii) Firms had intact data of stock price in sample period. Therefore, there were 111 firms in the present study. We employed data on the weekly closing price of shares of the listed company in Taiwan Stock Exchange. The sample period was from January 1992 to December 2004. Given the dramatic and volatile movements in the foreign exchange rate during the period of Asian financial crisis, we divided full sample period into two sub-periods of pre-Asian and post-Asian financial crisis. That helped us to unveil the impact of foreign exchange fluctuations on the firms' exchange exposure.

Empirical model

Following Choi and Prasad (1995), we replaced the expected exchange rate with the forward exchange rate to examine the relationship between change in unexpected exchange rate and change in values of firms. Since the U.S. is the biggest export partner for Taiwan and US dollar is an international vehicle currency, we employed the NT$/US$ as an exchange rate to investigate exposure of Taiwanese corporations. Following Jorion (1990), the regression model was constructed as

$$R_{it} = \beta_{0i} + \beta_{1i} MR_t + \beta_{2i} UXR_t + \varepsilon_{it} \quad (1)$$

where R_{it} was the rate of return on the corporation i 's stock at period t, MR_t was the return of market at period t, UXR_t was the change ratio of exchange rate at period t (NT$/US$), ε_{it} was an error term assumed to have zero mean and to be uncorrelated with all other explanatory variables. The factor sensitivities (i.e., loadings) $ß_{1i}$ and $ß_{2i}$ were the slope coefficients in the time-series regression, and $ß_{2i}$ was the measure of the exchange rate exposure. However, the variance of the errors of financial time series would be little constant over time. In the present study, we employed the GARCH, which allowed the conditional variance to be dependent upon previous own lags. The model could be written as

$$R_{it} = \beta_{0i} + \beta_{1i} MR_t + \beta_{2i} UXR_t + \varepsilon_{it} \quad (2)$$

$$\varepsilon_{it} \left| \Psi_{t-1} \sim N(0, h_{it}) \right.$$

$$h_{it} = c + \delta h_{it-1} + b \varepsilon^2_{it-1}$$

where ε_{it} was a error term and h_{it} was characterized as the conditional variance at period t.

$(\varepsilon_{it} \left| \Psi_{t-1} \sim N(0, h_{it}) \right.)$ stated that a zero mean normally distributed random variable given the information set at period t-1. The negative (positive) exposure coefficients (β_{2i}) obtained suggest that firms benefit when the NT dollar appreciates (depreciates).

Determinants of exchange rate exposure

In this section, we discussed the determinants of exchange rate exposure such as firm size, export rate, quick rate and long-term debt ratio. First, The firm size was measured by the total assets. There are two alternative views on size effect: (i) The big size of firms has the efficiency of scale economies on the cost of hedging, and thus leads to reduction of cost in hedging. Therefore, firms have an incentive to hedge, and make them exposed to less exchange risks. As a result, bigger corporations should be less exposed to exchange rate. (e.g., Chow et al., 1997) (ii) Warner (1997) claims that smaller companies have bigger cost of bankruptcy, so they are more likely to engage in hedging activities to make

the firms exposed to less exchange rate risks. He and Ng (1998) are consistent with the notion. He and Ng (1998) find out smaller Japanese multinational firms tend to have lower exposure to exchange rate risk. Hence the effect of firm size on exchange rate exposure is ambiguous and would be empirically determined. Second, the export ratio was defined as the ratio of foreign sales to total sales. Jorion (1990), Choi and Prasad (1995), He and Ng (1998) and Martin et al. (1999) are all investigate relationship between exchange rate exposure and foreign involvement. Jorion (1990) finds that dollar depreciation exposure is positively related to the ratio of a firm's foreign sales to total sales. The present study used export ratio (Export) as a proxy for foreign involvement. Moreover, Nance et al. (1993) point out a firm can mitigate the possibility of financial crisis by maintaining a larger short-term liquidity position. He and Ng (1998) use quick ratio as a proxy for liquidity. They find out that firms with higher quick ratio have less of an incentive to hedge, and hence have bigger exchange rate exposures. This study also applied quick ratio (QR) as a proxy for liquidity.

Finally, the financial leverage means that firms borrow the funds to invest, and thereby earn the expected rates of returns which are higher than costs. While firms make large-scale investment case, they usually utilize the financial leverage in order to control funds. However, improper financial operations or excessive use of financial leverage can increase possibility of financial crisis. Smith and Stulz (1985) argue that hedging can reduce the probability that a firm will go bankrupt and thereby reduce the expected costs of financial distress. He and Ng (1998) indicate that Japanese multinational firms with high financial leverage are less exposed to fluctuations in exchange rates. Therefore, we employed a firm's long-term debt ratio (DE) as a proxy for financial leverage. The long-term debt ratio was defined as the ratio of long-term to total asset. According to Jorion (1990) and the discussion above, the model of determinants of exchange rate exposure was constructed as following:

$$\hat{\beta}_{2i} = \alpha_0 + \alpha_1 SIZE_{it} + \alpha_2 EXPORT_{it} + \alpha_3 QR_{it} + \alpha_4 DE_{it} + \varepsilon_{it} \quad (3)$$

where β_{2i} was a exposure coefficient, $SIZE_{it}$ was the firm's size of firm i at period t, $EXPORT_{it}$ was the export ratio of firm i at period t, QR_{it} was the quick ratio of firm i at period t and DE_{it} was the long-term debt ratio of firm i at period t.

As shown in the preceding section, β_{2i} are found to be positive and negative. In order to eliminate the effect, the present study considered two alternatives. First, refer to Martin et al. (1999), we adopted absolute value of the estimated exposure as the dependent variable, and analyzed the influence degree of each factor exposed to the exchange rate. The regression model was

$$\left|\hat{\beta}_{2i}\right| = \alpha_0 + \alpha_1 SIZE_{it} + \alpha_2 EXPORT_{it} + \alpha_3 QR_{it} + \alpha_4 DE_{it} + \varepsilon_{it} \quad (4)$$

where $\left|\hat{\beta}_{2i}\right|$ was the absolute value of exposure coefficient; the explanatory variables were the same as those of equation (3). Besides, to alleviate the problem of aggregating exchange rate exposure might be cancelled out each other, the present study refer to He and Ng (1998), we adopted a dummy variable, the regression model could be written as:

$$\hat{\beta}_{2i} = a_0 + a_1 DSIZE_{it} + a_2 DEXPORT_{it} + \alpha_3 DQR_{it} + \alpha_4 DDE_{it} + a_{d1}(1-D)SIZE_{it}$$

$$\hat{\beta}_{2i} = a_0 + a_1 DSIZE_{it} + a_2 DEXPORT_{it} + \alpha_3 DQR_{it} + \alpha_4 DDE_{it} + a_{d1}(1-D)SIZE_{it} + a_{d2}(1-D)EXPORT_{it} + \alpha_{d3}(1-D)QR_{it} + \alpha_{d4}(1-D)DE_{it} + \varepsilon_{it} \quad (5)$$

where, D was a dummy variable that took the value of one if $\hat{\beta}_{2i}$ was positive and zero otherwise.

Most of the prior studies analyze determinants by using ordinary least squares model, but this way might produce biased results. The panel data approach was employed in this study in order to mitigate the problem of biased estimation, promote efficiency and solve the question of neglecting of important variable in model.

RESULTS

The present study investigated the exposure of firms to exchange rate fluctuations by both employing the GARCH and the Classical Linear Regression Model (CLRM), respectively. Additionally, a panel regression analysis was used to find the determinants of exchange rate exposure. The empirical findings were described as follows.

Measuring exchange rate exposure of Taiwanese corporations

This study estimated the exchange rate exposure of Taiwanese 111 corporations using CLRM and GARCH. Table 1 reported significant exposure of Taiwanese 111 corporations for the full sample period (from January 1992 to December 2004). At the 0.1 significance level, we found that 23 out of 111 firms (20.72%) had significant exposure coefficients by using CLRM. There were 22 out of 111 firms with significantly positive exposure coefficients and only 1 firm with negative coefficient. Using GARCH, we found that 32 out of 111 firms (28.83%) had significant exposure coefficients. There were 29 firms with significantly positive exposure coefficients and 3 firms with negative coefficients. The result suggested that the firms with benefits when the New Taiwanese dollar depreciates. Taiwanese corporations' exposure to exchange rate changes was predominately positive, indicating that firms' export competitiveness rose when the NT dollar depreciated. This would reflect on market value of corporations, and hence increased stock returns. This is inconsistent with Muller et al. (2007), which show that a depreciating (appreciating) currency of some Asian country against foreign currencies has a net negative (positive) impact on stock returns. However, our results evidenced that Taiwan as an export-oriented country. Solakoglu (2005) presents that net-exporters or net-importers firms are more likely to have a significant exposure to exchange rate movements.

Measuring exposure of Taiwanese corporations for the two sub-periods

Table 2 reported significant exposures of sample for the

Table 1. Significant exposure of 111 Taiwanese corporations for the full sample period (1992 –2004).

Exposure	Significant exposure		Positive exposure		Negative exposure	
Model	**CLRM**	**GARCH**	**CLRM**	**GARCH**	**CLRM**	**GARCH**
Number of firms	23	32	22	29	1	3
Percentage	20.72	28.83	19.82	26.13	9	2.70

CLRM denotes the classical linear regression model and GARCH is the generalized autoregressive conditional heteroskedasticity model.

Table 2. Significant exposure of 111 Taiwanese Corporations for the full sample period and two sub-periods.

Period	Full sample (1992 to 2004)		Pre-Asian financial crisis (1992 to 1997)		Post-Asian financial crisis (1997 to 2004)	
Model	**CLRM**	**GARCH**	**CLRM**	**GARCH**	**CLRM**	**GARCH**
Statistic						
Average	0.198383	0.198949	0.382430	0.343130	0.164733	0.158545
Median	0.194000	0.210900	0.355100	0.288300	0.168000	0.166200
Standard Error	0.278224	0.283911	0.605843	0.570284	0.302496	0.303709
Maximum	0.930300	0.904400	2.078500	1.754800	0.913800	0.894700
Minimum	-0.489000	-0.493800	-1.602600	-1.036300	-0.713500	-0.685600
Firms	23	32	24	28	9	17
Percentage	20.72	28.83	21.62	25.23	8.11	15.32

CLRM denotes the classical linear regression model and GARCH is the generalized autoregressive conditional heteroskedasticity model.

two sub-periods. The first sub-period spanned from January 1992 to June 1997. The second one spanned from July 1997 to December 2004. We found that number of firms whose exposures was significant and the value of the coefficients measuring the degree of influence of the exchange rate on firm's value decreased after Asian financial crisis. Using CLRM, the number of significant coefficients decreased from 24 to 9, and the average degree of influence declined from 0.382 to 0.165. Using GARCH model, the number of significant coefficients declined from 28 to 17 and the degree of influence decreased from 0.343 to 0.159. From this result we could guess, after suffering influence of Asian financial crisis, the number of firms with using the financial derivatives were rising in order to reduce the fluctuation of exchange rate change.

We further investigated the situation of sample in using the financial derivatives. There were about 27.03% of sample using financial derivatives in 1997. These companies chose the financial derivatives in order to hedge the exchange rate risk. There were about 41.14% of sample using the financial derivatives in 1998. Our results showed that the number of firms using the financial derivatives actually rose after Asian financial crisis, and thence reduced the sensitivity of a firm's value to exchange rate movements. This result was similar to Kiymaz (2003), which finds that the post-crisis exposure of all industries seem to be lower than those of the pre-crisis period. It implies that firms likely paid more attention to their foreign exchange exposure following the crisis.

Analysis on determinants of exchange rate exposure

In this section, we investigated the relationship between exchange rate exposure and four variables including firm size, export ratio, quick ratio and long-term debt ratio. We used panel data regression approach to estimate the determinants of exchange rate exposure. Table 3 reported the Pearson Correlation Coefficients of 4 factors above. Except the firm size and long-term debt ratio were intermediately related, other variables were mostly low related. Therefore, we excluded the multicollinearities problem. Since there was one extreme value in the sample, we estimated 31 and 30 corporations respectively separately. The results were shown in Table 4.

Table 4 evidenced that exposure was negatively and significantly related to a firm size. Larger firm had experience and ability to hedge exchange rate risk, and thereby were less exposed to exchange rate change. The smaller firm didn't have this advantage, it was less likely to hedge, and hence had bigger exchange rate exposure. Additionally, we applied dummy variable to estimate relationship between exposure and firm size. Our evidence was robust to negatively impact on firm size. Consequently, larger firms were more likely to attempt exposure management than smaller firms. The result was consistent with Chow et al. (1997), in which a larger firm

Table 3. Pearson correlation coefficients for explanatory variables.

Variable	Firm size (SIZE)	Export ratio (EXPORT)	Quick ratio (QR)	Long-term debt ratio (DE)
Firm size (SIZE)	1.0000	-0.0515	-0.1618	0.4469
Export ratio (EXPORT)	-0.0515	1.0000	0.0377	-0.3503
Quick ratio(QR)			1.0000	-0.1490
Long-term debt ratio (DE)				1.0000

SIZE was the firm's size of firm, EXPORT was the export ratio of firm, QR was the quick ratio of firm i at period t and DE was the long-term debt ratio of firm.

Table 4. Results of Panel Data Regression (Full Sample Period: 1992 - 2004)

# of firm	31-firm panel			30-firm panel		
Parameter	Model 3	Model 4	Model 5	Model 3	Model 4	Model 5
α_1	-0.2421***	-0.0715*	-0.0410	-0.2119***	-0.0697*	-0.0415
α_2	0.0024	-0.0001	0.0009	0.0014	0.0001	0.0007
α_3	-0.0017***	-0.0009**	-0.0011	-0.0019***	-0.0008**	-0.0011*
α_4	0.0793	-0.9167*	-0.6238	-0.1713	-0.9219*	-0.6364
α_{d1}			-0.1992***			-0.2019***
α_{d2}			0.0017			0.0022
α_{d3}			0.0004			0.0003
α_{d4}			2.0156*			2.1949**

*denotes a statistical significance at 0.1 level. ** denotes a statistical significance at 0.05 level, ***denotes a statistical significance at the 0.01 level.

had economy of scale on the cost of hedging. Dominguez and Tesar (2006) also confirm that exposure is more prevalent in small-sized firms rather than large- or medium- sized firms.

In conventional wisdom, that a firm having larger export ratio have larger exposure (e.g., Jorion, 1990). Nevertheless, our results indicated that export ratio (the ratio of foreign sales to total sales) of corporation didn't have impacts on the firm's exchange rate exposure. This result was different from some earlier studies, for example, Williamson (2001) shows that firms have a higher foreign exchange rate exposure if they have higher levels of foreign sales. Bartram and Karolyi (2006) find that the foreign exchange rate exposure of firms is systematically related to the fraction of firm's foreign sales. There were two possible reasons for this: (i) A firm with larger export ratio in Taiwan might incline to use the financial derivatives to hedge even more. If we considered the reciprocation with the financial derivatives at the same time, exchange rate change might only have less influence on firm's valuation. (ii) In our sample, there were some Taiwanese corporations having zero or close to zero export ratio, and hence export ratio of corporation didn't have impacts on exposure.

Nance et al. (1993) point out a firm could mitigate the possibility of financial crisis by maintaining a larger short-term liquidity position. He and Ng (1998) find that firms with higher quick ratios have less of an incentive to hedge, and hence have bigger exchange-rate exposures. However, our results indicated that exposure was negatively related to a firm's quick ratio. Our results implied that Taiwanese listed company did not reduce motive of hedge when a firm having higher liquidity.

With regard to long-term debt ratio, from models (3) and (4) in Table 4, we found out a firm which held higher financial leverage were less exposed to fluctuations in exchange rates, which was consistent with He and Ng (1998). Further, we employed a dummy variable to estimate relationship between exposure and Long-term debt ratio. It was surprising to find, the long-term debt ratio of corporation did not have influence on firm which had positively exchange rate exposure. However, firms having negative exposure were negatively and significantly related to long-term debt ratio. It showed that they would not adopt the hedging behavior so that they faced a higher exchange rate exposure as the long-term debt ratio increased. We empirically identified that firms with different exchange rate exposure would adopt the different hedging behavior as the exchange rate changed.

Robustness check

To examine the exchange exposures whether a change in structure existed, we also ran the panel data regression during the two sub-periods of pre- and post- Asian

Table 5. Panel data regression analysis - Two sub-periods.

	Panel A			Panel B		
Sample period	**1992 to 1997**			**1998 to 2004**		
Variable	**Model 3**	**Model 4**	**Model 5**	**Model 3**	**Model 4**	**Model 5**
Size	-0.2595***	-0.0735	-0.1503**	-0.1761**	-0.0451	0.0260
EXPORT	0.0022	0.0028	0.0020	0.0004	-0.0018	-0.0015
QR	-0.0010	-0.0001	-0.0001	-0.0030***	-0.0016***	-0.0020**
DE	-0.3437	-0.6335	0.0560	-0.0962	-1.3437*	-1.4261
(1-D)SIZE			-0.2707***			-0.1718***
(1-D)EXPORT			-0.0032			0.0048
(1-D)QR			-0.0002			0.0010
(1-D)DE			0.1000			3.6226**

*denotes a statistical significance at 0.1 level. **denotes a statistical significance at 0.05, level, ***denotes a statistical significance at the 0.01 level.

financial crisis.

Table 5 provided that exchange exposure was negatively and significantly related to firm size for the two sub-periods. Our evidence was robust to negatively impact on firm size for the full sample period and two sub-periods. Larger firms were glad to hedge, and made them exposed to less exchange risks. The present study also found that export ratio of corporation didn't have impacts on the firm's exposure. Our result was robust across two sub-periods. In other words, a firm having high foreign sales, the exchange rate risk didn't increase apparently. Furthermore, before Asian financial crisis, we docu-mented that quick ratio of corporation did not have impacts on the firm's exposure. However, it evidenced that firms having high quick ratio were less exposed to fluctuations in exchange rates after Asian financial crisis. This implied that (i) Before Asian financial crisis, the fact that listed companies had abundant funds, didn't reduce their incentive to hedge. However, after Asian financial crisis, when NT dollar urgently depreciatory also caused the value of company's assets to fall. Therefore, listed companies paid attention to hedge even more. (ii) After Asian financial crisis, the structural change of Taiwanese listed companies might occur.

Before Asian financial crisis, the results (in Panel A of Table 5) shown that long-term debt ratio of corporation didn't have any impact on the firm's exposure. However, we could find that, from model (4), long-term debt ratio had significant negative effect on exchange exposure. After Asian financial crisis (shown in Panel B of Table 5), because New Taiwanese dollar urgently depreciated in which caused an increase in corporation's debt. Since the possibility of financial crisis also increased, there was an incentive to hedge. The results were consistent with He and Ng (1998). The firms with higher long-term debt ratio, they had larger incentive to hedge and less exposed to fluctuations in exchange rates.

Further, we applied a dummy variable to estimate relationship between exposure and long-term debt ratio (in model (5) of Table 5). It was surprising to find that a firm with a negative exposure was positively and significantly related to long-term debt ratio, but it was not for a firm with a positive exposure. Since local currency debt could be effectively converted to foreign currency debt with exchange rate derivatives, and vice-versa (Allayannis et al., 2003), firms could utilize an array of financial products, such as foreign currency denominated debt and exchange rate derivatives, as exchange rate risk management tools. Those instruments might play important roles in mitigating observed exchange rate exposure (Bartram et al., 2010). A firm with a negative exposure owned greater exposure as it holds a great debt. The reason could be that the capital structure of a firm with a negative exposure would worsen since the long-term debt ratio and/or the cost of imported raw materials and equipment were rising after the financial crisis. The exchange rate exposure increased if it didn't adopt or insufficiently adopt the hedging due to the high cost of risk management.

Conclusion

At the firm level, the present study focused on the measurement of exchange risk exposure of Taiwanese listed companies and examined the determinants of exchange rate exposure. The overall sample period was from January 1992 to December 2004. Since the exchange exposure of the firms might be different after the financial crisis, the full sample period was then further divided into two sub-periods that included sub-period I (from January 1992 to June 1997) and sub-period II (from July 1997 to December 2004). Taiwanese 111 corporations' exchange rate exposure was estimated by employing CLRM and GARCH. A panel data set was employed to estimate the determinants of exchange rate exposure in terms of firm size, export ratio, quick ratio and long-term debt ratio.

It was found that for the first period 20.72% (28.73%) of the 111 Taiwanese corporations had significant exposure by employing CLRM (GARCH). On the average, Taiwanese corporations' stock returns had significant positive economic exposure effects. This notion matched Taiwan as an export-oriented country. The positive exposure coefficients suggested that corporations benefited as the NT dollar depreciated.

We also found that the number of firms using the financial derivatives actually rose after Asian financial crisis, and hence reduced the sensitivity of a firm's value to exchange rate movements. After Asian financial crisis, the corporation's manager paid attention to the operation of the financial derivatives even more.

The exposure was negatively and significantly related to a firm size. A larger firm had more ability to hedge exchange rate risk than smaller firms did, and thereby were less exposed to exchange rate change. Our empirical results also provided that quick ratio was significant to exchange rate exposure. However, the sign of influence was not consistent to those of the previous studies. For the full period, our results implied that Taiwanese listed companies didn't reduce the motive of hedge as a firm with high liquidity. After Asian financial crisis, Taiwanese listed companies encountered a structural change. We documented that a firm with a higher long-term debt ratio was less exposed to fluctuations in exchange rates.

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