EXCHANGE RATE EFFECTS ON A SMALL OPEN ECONOMY: EVIDENCE FROM TAIWANESE FIRMS

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ABSTRACT

Previous empirical research discovered only mild, if any, sensitivity of firm value to exchange rate fluctuation. Chen et al. (2004) provided some insights by focusing on a small and open economy and found evidence that New Zealand that exchange rate movement affects firm value. This study reexamines firm value sensitivity to exchange rate fluctuation by focusing on individual firms as well as on three industry Taiwan sectors, high-tech, service, and manufacturing industries. By using the two-factor model with residual regression, we find consistent results that volatility of exchange rates affects the value of Taiwanese firms. The results hold regardless of the exchange rate exposure to US dollar, Japanese Yen, or Euro. In addition, the positive association between exchange rate exposure and firm value is significant and consistent for all firm samples and three industry-specific samples.

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KEYWORDS: Foreign exchange exposure, Residual regression, Exchange rate fluctuations, Firm value

INTRODUCTION

With the ever increasing tempo of economic globalization, more firms face international competition. It is widely accepted that fluctuations in exchange rates affect the competitive position of firms in the global market, and eventually impacts cash flows and firm value. Moreover, even for a domestic firm that is not actively involved in international trade, variations in exchange rates may indirectly affect firm value. This is especially true if the firm relies on imports to obtain raw materials, if its suppliers are subject to exchange rate exposure, or if the firm's competitors are from overseas.

Presumably, only unanticipated fluctuations in exchange rates affect firm value. According to the efficient market hypothesis, the expected change in exchange rate should be priced into a firm's stock price. Therefore the relation between unexpected exchange rate change and share price should be observed. However, previous studies failed to document a strong relationship between unexpected movement of foreign exchange rates and changes in share price. Many studies only discovered weak or insignificant associations between firm value and exchange rate exposure (Jorin, 1990; Gao, 2000; Griffin and Stulz, 2001; Di Iorio and Faff, 2002). Even if a significant sensitivity was found, the mean sensitivity values were far below what is predicted by theories (Booth and Rotenberg, 1990; Choi and Prasad, 1995; Frennberg, 1994).

A few empirical studies found significant exchange rate risk sensitivity under certain conditions. Bartov and Bodnar (1994) found that abnormal returns are related to lagged changes of exchange rates, which supports market inefficiency. The studies by Chow et al. (1997) and Bodnar and Wong (2000), show the association between firm value and exchange rate changes becomes significant when the time horizon is increased. According to Jorion (1990) and Shin and Soenen (1999), the magnitude of exchange rate exposure varies by firm size.

These mixed results are typically attributed to three causes. First, different models were employed and different firm sample sizes were selected. Usually different methodologies lead to divergent results.

Second, the fundamental cash flow models available might not be a good match to reality. Third, firms in an open economy may have a higher exchange rate exposure than those in a closed economy (Chen et al., 2004; Huston and Stevenson, 2010).

Chen et al. (2004) argued that there could be a serious problem in the data selection process of previous studies that focus on large capital markets. For example, in the US stock market, domestic factors dominate the pricing of consumer goods and stocks, dwarfing the international factors, such as exchange rate changes. US multinational firms could be so globally diversified that a causal relationship between firm value and exchange rate exposure is difficult to detect. In addition, Huston and Stevenson (2010) argue that a country-specific governance environment could provide incentives to enhance shareholder value in response to reducing exchange rate exposure.

We take into account both the country's economy openness and country-specific governance, in our attempt to investigate the relation between exchange rate movement and firm value. By employing a sample of firms from Taiwan, a small and open economy, our study investigates whether an association between exchange rate exposure and firm value exists. In comparison to the New Zealand market used in Chen et al. (2004), our sample of Taiwanese firms is unique in several ways: (1) Prior studies employ monthly exchange rate changes to measure exchange rate exposure. Our study uses daily exchange rate changes. The application of a shorter horizon to capture the exchange rate change is intended to provide a more powerful test setting with lower noise. (2) International trade in the Taiwan economy is essential and well known for its electronics manufacturing and high-tech industries.

Listed firms in these industries account for approximately half of Taiwan stock market as measured by market capital. (3) In general, the Taiwan market is bigger in total capital and more open than most other markets in the Asia-Pacific region. However, it has a few restrictions and the market is much smaller than major markets in the US, UK and Japan. The exchange rate in Taiwan has been volatile since the New Taiwan Dollar (NTD) began to float in 1989, when the upper/lower 2.5% limit on daily exchange rate fluctuation and other important financial regulations were lifted. The movement of exchange rates is based on market demand and supply. The Taiwan Central Bank only executes appropriate interventions on seasonal or abnormal floating when needed. (4) Most Taiwanese firms are foreign currency denominated price-takers rather than world market leaders, which implies that Taiwanese firms may be more susceptible to the influence of exchange rate fluctuations than those in large major markets.

Our study investigates firm value sensitivity to exchange rate daily fluctuations by focusing on a sample of individual firms in Taiwan from three different industry sectors, rather than from a market portfolio. We find consistent results that a positive association between foreign exchange rate exposure and firm value exists in Taiwan. Of the three industry sectors, the high-tech industry is most affected by exchange rate fluctuations.The rest of the paper is organized as follows. Section 2 reviews the recent literature. Section 3 describes the data and samples. Section 4 presents the methodology. Finally, empirical results analysis and discussion are presented in Section 5. The last two sections conclude our research and discuss the research limitation.

LITERATURE REVIEW

According to Dumas (1978), and Adler and Dumas (1984), foreign exchange exposure can be measured by the sensitivity of firm value to unexpected foreign exchange rate changes. To find the relationship between exchange rate changes and firm value, most research (such as Jorion, 1990; Bartov and Bodnar, 1994; Choi and Prasad, 1995) used stock price as the proxy of firm value and examine the connection between exchange rate fluctuations and stock prices by regression. However, early studies found limited and mixed evidence of foreign exchange exposure. Jorion (1990) investigated monthly stock returns of 287 U.S. multinationals from 1971 to 1987 and found that only some firms showed statistically

significant foreign exchange exposure. In the following study, Jorion (1991) examined the exposure at the industrial level and discovered that most industry groups of stocks traded on the New York Stock Exchange do not exhibit significant exposure. Choi and Prasad (1995) also studied 409 US multinationals from 1978 and 1989 at industrial level and documented limited foreign exchange exposure for the industries. They further tested the association between foreign exchange exposure and firm-specific characteristics and found a positive relation between the scope of foreign operation and exposure. Consistent with this finding, Bartov and Bodnar (1994) suggested that in the sample selection process, those firms reporting significant impacts from changes in the value of dollars should be included. Despite this procedure they did not find significant foreign exchange exposure. In their further test, though, a significant association between abnormal stock returns and lagged dollar exchange rate changes was documented. They argue it took time for investors to price exchange exposure into stock prices.

Some other studies also target firms with likelihood of high exchange exposure. Amihud (1994) examined the 32 largest U.S. exporting firms from 1982 to 1988. They failed to document any significant contemporaneous association between stock returns and exchange rate fluctuation. Similarly, Donnelly and Sheehy (1996) selected only the largest UK exporters and found a weak contemporaneous exchange exposure. Apart from the scope of foreign operation, some other factors are associated with exchange exposure. Theoretically, exchange exposure can be due to short-term transaction exposure or long-term economic exposure. Usually, transaction exposure can be reduced to minimum by hedging while economic exposure is harder to hedge. Compared to small firms, large firms have more resources and are more capable of hedging economic exposure efficiently.

Chow et al. (1997) found that the exposure magnitude is inversely related to firm size. Also, by employing a longer horizon for stock returns and exchange rates, they found the significance of exchange exposure increases as the length of the horizon increases. The type of economy has been argued to play a role in the magnitude of foreign exchange exposure. Studies, such as Nydahl (1999), De Jong et al. (2002), Kiymaz (2003) and Moran (2005) examine several countries and document a larger number of significantly exposed firms with higher exposure coefficients than in prior studies. Chen et al. (2004) suggested that large markets like the U.S. should be less vulnerable to the exchange rate fluctuations, with domestic factors playing a predominant role in the determination of both share and consumer goods prices. Therefore, it could be difficult to identify significant exchange exposure for a large economy like the U.S. Instead, they selected 164 listed firms on the New Zealand Stock Exchange for the period from January 1994 to December 1999, and found significant relation between the change of exchange rate and firm value.

Most prior studies of exchange rate exposure are focused on the correlation of monthly stock returns and change in exchange rates. However, as Frennberg (1994) pointed out, the market is believed to react very fast to new information and the focus should be on immediate reactions to exchange rate changes. Compared to the monthly settings employed by prior research to test exchange exposure, we believe that a shorter horizon of one day to capture the variation of exchange rate provides an opportunity for a more powerful test with less noise.

METHODOLOGY

Data and Sample

Considering the characteristics of the Taiwan's economy, we selected our firm samples from two industry sectors: manufacturing and service. The manufacturing industry is the driver of Taiwan's economy, valued at $259 billion in 1999 and accounted for 98.6% of its exports in 2000. Electronics, textiles and plastics are three major exporting industries in Taiwan. Statistics shows that the electronics industry accounts for the largest share of Taiwan's manufacturing industry, totaling $101 billion in 1999. Due to the rapid

growth in this subsector, Taiwan has become one of the largest producers of information technology hardware, and ranks first in the production of laptop computers, monitors and electronics related peripherals. Given the distinctions between electronics and traditional manufacturing industries and the predominant position of the electronics industry in Taiwan's economy, we set this industry aside from the other two major manufacturing industries and categorize it as the high-tech industry. In doing so, we expect to find evidence that the electronics industry may have different sensitivity to exchange rate exposure than traditional manufacturing industries. Firms newly listed or delisted during the time frame of our study between January 1, 2001 and December 31, 2002 are eliminated. From a total of 305 listed Electronics firms and 73 listed Textile or Plastics firms, the top ranked 60 firms for the former and top ranked 40 firms for the latter are selected. Excluding firms with missing data, our final sample consists of 59 companies from the high-tech industry, and 37 firms from the traditional manufacturing industries.

In addition to the test for the manufacturing sector, this study also examines whether the relationship between exchange rate movements and change in firm value still holds in the service industry. Following Fama and French (1992), we did not include financial service firms due to their distinct financial structures and unique characteristics. As an important element in Taiwan's future economic development, the tourism industry has called for investment totaling over NT$75 billion. Therefore, 14 top ranked firms from the tourism and department store industry are selected for inclusion in the service industry sample.

Eaily share returns adjusted for dividends for the selected firms listed on the Taiwan Stock Exchange (TSE) and the composite daily index for Taiwan stock market are obtained from the Global Data Stream database for the period between January 1, 2001 and December 31, 2002. The market index is used to capture the influence of general economic conditions on firm value. In addition, daily exchange rates for the New Taiwan Dollar (NTD) relative to three major world three currencies including US Dollar, Euro and Japanese Yen, are also obtained from the Global Data Stream database for the same period. After excluding the non-trading days, there are 508 days in the two-year window.

Based on the market efficiency hypothesis, the effect of unexpected changes in exchange rates should be impounded into a firm's stock price and reflect on its firm value quickly. Adler and Dumas (1984) suggest that a firm's foreign exchange exposure can be measured by the sensitivity of equity returns to exchange rate changes. In other words, a firm is subject to exchange rate exposure if exchange rate fluctuations affect future cash flows and eventually firm value. Thus, we adopt the regression models for exchange rate exposure from the prior studies (Adler and Dumas, 1984; Jorion, 1991; Choi and Prasas, 1995; Dumas and Sonik, 1995; De Santis and Gerard, 1998; Chen at el. 2004). Equation (1) is the direct model adopted from Adler and Dumas (1984), which aims to capture the average sensitivity of firm value to unexpected exchange rate fluctuations.

$$R_{it} = \alpha_{i0} + \alpha_{i1} R_{xt} + e_{it} \quad (1)$$

where R_i is the stock return of the ith firm and R_x is the change of exchange rate. The exchange rate is expressed in the units of foreign currency per unit of domestic currency of Taiwan (NTD).

Application of the model includes the assumption that the firm valuation effect is influenced by macroeconomic conditions. Foreign exchange rates are one of these conditions. Chen et al. (2004) suggests that this model is an appropriate foreign exchange exposure measure if other general macroeconomic factors are not only (or nearly) normally distributed, but also stable over the testing period. Our study employed a short time frame of two years from 2001 to 2002, which is characterized by relatively stable economic developments in Taiwan. Model (1) is included in our study to test the sensitivity of stock returns to exchange rate movement.

To improve the specification of the model, Jorion (1991) proposed an enhanced two-factor model which

is widely used in prior studies (Choi and Prasas, 1995; Moran, 2005; Huston and O'Driscoll, 2010). Augmented by the market return factor, Equation (2) controls for macroeconomic market conditions. Accordingly, the coefficient on the term of exchange rate change is to measure the risk sensitivity of idiosyncratic exchange rate exposure for individual firm.

$$R_{it} = \beta_0 + \beta_1 R_{xt} + \beta_2 R_{mt} + e_{it} \quad (2)$$

where R_m is market index return, R_i is the stock return of firm i, and R_x is the change of exchange rate expressed in the unit number of foreign currency per unit of domestic currency.

Chen et al. (2004) analyze the two-factor model and partition the effect of exchange rate movement on firm value into two components: (1) the indirect effect of exchange rate movement on firm value through its effect on the market index, and (2) the direct effect on stock returns of individual firms. The paper concludes that both effects will be reflected in the firm's market value (Chen et al., 2004). Thus model (2) attempts to capture the sensitivity of stock returns to both components of exchange rate movement and market return. However, the two-factor model doesn't take into consideration that the market index itself has substantial foreign exchange exposure. Therefore, Chen et al. (2004) derive a model by residual regression as specified in model (3), with aims to capture the total effect (including general and unique effect) of exchange rate fluctuation on the market movement.

Based on the derivation from Chen et al. (2004), the first regression is a residual model of market index.

$$R_{mt} = \delta_{m0} + \delta_{m1} R_{xt} + e_{mt} \quad (3)$$

where R_m is market index return, and R_x is the change of exchange rate expressed in the unit number of foreign currency per unit of domestic currency.

Then the residual term replaces the market index return in Jorion's (1991) model as presented in (2). Therefore, stock return is regressed on the residual of market index return and exchange rate exposure.

$$R_{it} = \gamma_{i0} + \gamma_{i1} R_{xt} + \gamma_{i2} e_{mt} + e_{it} \quad (4)$$

The component e_{mt} is the residual item of the residual model and is orthogonal to the market index return. The exchange rate coefficient γ_{i1} in Equation (4) is a measure of total effect, which is the net of general influence and unique influence (Chen et al., 2004).

We use all three models to measure the effect of foreign exchange exposure on firm value and test whether Taiwanese firms experienced a significant foreign exchange rate exposure to most common foreign currencies, including US dollars, Japanese Yen, and Euro, during 2001-2002. It is likely that the value of exchange rate coefficient will vary across different models.

ANALYSIS

Statistical Analysis for the Full Sample

Table 1 presents descriptive statistics for the full sample of 110 firms. It reports the distribution of firm size measured by total assets, total sales, and market value, respectively, as well as some firm-specific ratios. The mean (median) total assets is over 43 (15) million NTDs. The mean (median) total sales is over 27 (11) million NTDs. The mean (median) market value is over 45 (13) million NTDs. The mean (median) sales growth rate is around 25% (16%), the mean (median) gross profit ratio is 18% (16%), and the debt ratio is 0.40 on average. The mean (median) market to book ratio is 1.885 (1.558).

Table 1: Descriptive Statistics for All Firms

	Mean	Median	Max	Min	25%	75%	Std Dev
Total Assets (in thousand NTD)	43,685	15,985	465,863	740.44	7,429.4	49,694	71,813
Total Sales (in thousand NTD)	27,068	11,235	245,009	593.49	5,362.3	30,257	39,535
Market Value (in thousand NTD)	45,167	13,530	793,335	2,065.0	6,033.8	39,632	99,264
L-T Investment (in thousand NTD)	11,116	3,730.8	114,848	7.0680	1,253.6	12,145	17,838
Sale growth rate	0.2548	0.1577	3.234	-0.2798	0.0139	0.3638	0.4336
Gross profit ratio	0.1833	0.1565	0.7752	-0.3116	0.1052	0.2166	0.1367
Debt ratio	0.4027	0.4082	0.7422	0.0922	0.3090	0.4852	0.1424
Market to Book ratio	1.885	1.558	7.006	0.4248	1.003	2.160	1.316

This table presents the descriptive statistics for all firms based on the annual data in 2002. Market value is based on the multiplication of number of shares outstanding at the end of 2002 and the stock price on the last trading day of the calendar year of 2002. Debt ratio is based on total liabilities divided by total assets.

Table 2 presents the Pearson correlations between the variables for the 55,769 firm-day sample. As expected, daily stock returns and market returns are highly correlated, with the correlation coefficient of 0.5269. However, the exchange rate variables for US Dollar, Japan Yen, and Euro are not highly correlated with daily stock returns in the sample. Similar results are found in the test for Spearman's correlation. Further, we break down the full sample into industry sectors, and find that the correlation matrix for high-tech, service, or manufacturing industry is qualitatively the same as presented in Table 2.

Table 2: Pearson Correlation between Variables for All Firms

Pearson Correlation	R_{it}	R_{mt}	Euro	Yen	USD
R_{it}	1.000	0.5269 (0.0001)***	0.0978 (0.0001)***	0.0364 (0.0001)***	0.0673 (0.0001)***
R_{mt}		1.000	0.2000 (0.0001)***	0.0792 (0.0001)***	0.1673 (0.0001)***
Euro			1.000	0.2063 (0.0001)***	0.0870 (0.0001)***
Yen				1.000	-0.0246 (0.0001)***
USD					1.000

*This table presents the Pearson correlation between the variables for the full sample of 55,769 firm-days. R_{it} is the daily return adjusted for dividend for individual firms. R_{mt} is the composite daily return for Taiwan stock market. Euro is the change in daily exchange rate of New Taiwan Dollar (NTD) to Euro. Yen is the change in daily exchange rate of New Taiwan Dollar (NTD) to Yen. USD is the change in daily exchange rate of New Taiwan Dollar (NTD) to USD. The figure in parentheses in each cell is the p-value. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Table 3 reports the regression results by model. As our hypothesis predicts, the exchange rate fluctuation should positively associate with firm value change. The test results from Equation (1) and Equation (4) support this conjecture. The coefficient on the exchange rate change for USD is 35.03 at the 1% significance level in Equation (1), and 35.03 at the 1% significance level in Equation (4). The results for Yen and Euro are similar. Equation (2) doesn't show the same results. The Euro is negatively associated with stock returns, with a coefficient of -1.290 (p-value, 0.0359). Such results are not as predicted by our hypothesis but are consistent with the results of the sensitivity and robustness tests in Chen at el. (2004), indicating that Equation (2) is the least sensitive model and measures the exchange rate exposure in a different degree.The regression analysis also supports the above argument for Table 3. The R^2 and adj-R^2

levels in Equation (2) and Equation (4) have exactly the same values across all findings in Table 3. It is noteworthy that the coefficient of market returns to USD in Equation (2) is 0.9926, identical with the residual variable coefficient in Equation (4). Both are significant at 1% level. The results suggest that Equation (4) has eliminated the mingling effect of exchange rate exposure to daily returns through market return while capturing the same effect from Equation (2).

The signs of exchange rate exposure from Equation (2), however, are very different from Equation (4). For example, the only significant exchange rate exposure in Equation (2) is from the Euro, which is -1.290 (significant at 0.0359 level). In Equation (4), however, the exposures to all major currencies are positive and significant. The only difference between these two models is the use of different market return measures. Equation (2) uses the market return itself while Equation (4) uses the residual market return, which is orthogonal to exchange rate fluctuations. The coefficients on the residual market return in Equation (4) are very similar to the respective coefficients on market return in Equation (2). Therefore, by using the residual market model, Equation (4) is able to capture most of the influence of market return on individual stock returns. After comparing the results from Equation (2) with that from Equation (4), we argue that the orthogonalization in Equation (4) does not distort our results, but only improves its precision. In summary, we find that the relation between exchange rate change and firm value is significantly positive for the Taiwanese firms in the sample.

Table 3: Regression Results for the Firms in the Full Sample on USD/Yen/Euro Exposure

All firms N=55,769		**Model 1: Equation (1)**		
Variable	**Prediction**	**Coefficient (p-value)**	**Coefficient (p-value)**	**Coefficient (p-value)**
Intercept	?	0.0010*** (0.0001)	0.0009*** (0.0001)	0.0010*** (0.0001)
US	+	35.031*** (0.0001)		
Yen	+		0.0594*** (0.0001)	
Euro	+			16.379*** (0.0001)
R^2		0.0076	0.0013	0.0096
Adj-R^2		0.0076	0.0013	0.0095
		Model 2: Equation (2)		
Intercept	**?**	**0.0008*** (0.0001)**	**0.0008*** (0.0001)**	**0.0008*** (0.0001)**
US	+	-0.3459 (0.8133)		
Yen	+		-0.0088 (0.1361)	
Euro	+			-1.290** (0.0359)
R_{mt}	+	0.9926*** (0.0001)	0.9931*** (0.0001)	0.9952*** (0.0001)
R^2		0.2776	0.2777	0.2777
Adj-R^2		0.2778	0.2776	0.2777
		Model 3: Equation (4)		
Intercept	**?**	**0.0010*** (0.0001)**	**0.0009*** (0.0001)**	**0.0010*** (0.0001)**
US	+	35.031*** (0.0001)		
Yen	+		0.0594*** (0.0001)	
Euro	+			16.379*** (0.0001)
Residual	+	0.9926*** (0.0001)	0.9930*** (0.0001)	0.9952*** (0.0001)
R^2		0.2776	0.2777	0.2777
Adj-R^2		0.2778	0.2776	0.2777

*This table reports the regression results for the full sample by models. Model 1 is $R_{it} = \alpha_{i0} + \alpha_{i1}R_{xt} + e_{it}$, Model 2 is $R_{it} = \beta_0 + \beta_1 R_{xt} + \beta_2 R_{mt} + e_{it}$, while Model 3 is $R_{it} = \gamma_{i0} + \gamma_{i1}R_{xt} + \gamma_{i2}e_{mt} + e_{it}$, where $R_{mt} = \delta_{m0} + \delta_{m1}R_{xt} + e_{mt}$. The dependent variable R_{it} is the daily return adjusted for dividend for individual firms. R_{mt} is the composite daily return for Taiwan stock market. R_{xt} is the change in daily exchange rate of New Taiwan Dollar (NTD) to a foreign currency, which is Euro, Yen or USD The figure in parentheses in each cell is the p-value. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Statistical Analysis for the Industry Specific Samples

We divide the full sample into sub-samples by industry. The Taiwanese economy is famous for its

high-tech electronics industry, which plays a major role in economic growth and accounts for most imports/exports of Taiwan. The service industry in Taiwan is highly subject to exchange rate exposure due to the significant portion of revenues from overseas customers.

There are three industry samples in the following investigation. The high-tech industry sample includes 60 firms selected with 29,912 firm-days, from the areas of semiconductor and related, PC and its peripheral and other electronics. The service industry sample includes 14 firms with 7,097 firm-days, from the areas of department stores, tourism and international trading. The manufacturing industry sample includes 37 firms with 18,758 firm-days from the areas of textiles and plastics manufacturing. We expect a positive correlation between exchange rates and firm value for the two industries of high-tech and service. The manufacturing industry in Taiwan tends to be domestic-oriented. Although we still expect a positive correlation between exchange rate movement and firm value for this industry, the magnitude of the correlation might not be as strong as for the prior two industries.

Tables 4, 5 and 6 present the regression results by industry: high-tech industry, service industry and manufacturing industry. The results for high-tech industry in Table 4 are consistent with those for the full sample. Similarly, Equation (1) and Equation (4) both provide better results in term of precision than in Equation (2). The results from Equation (2), however, show significant negative association between exchange rate exposure across all major foreign currencies. For example, the coefficient is -8.900 (p-value 0.0001) in USD in Equation (2) and -3.720 (p-value 0.0001) in Euro in Equation (2).

The high-tech industry in Taiwan is highly export-oriented and dispersed in worldwide markets. Therefore, a significant and positive relationship with exchange rate exposure is expected. However, we fail to find a positive exchange rate exposure from Yen in Equation (2). Further study of this issue is warranted. An interesting observation is that Equation (2) and Equation (4) in Table 4 share the same values of R^2 and adj-R^2, which supports that Equation (4) has the same explanatory power as Equation (2). In addition, the adj-R^2 in Table 4 in Equation (4) is always higher than that in Equation (1), suggesting that Equation (4) has a higher explanatory power than Equation (1) by adding the term of residual market return. Further, we find that high-tech industry exhibits the highest adj-R^2 among all industries. This is consistent with the fact that the high-tech firms in Taiwan have partnered with big names in the US, Japan and Europe, and "made in Taiwan" PCs, electronics components, and semiconductors are widespread across the world.

Table 5 presents the results on exchange rate exposure for firms in the service industry. We detect a positive relation between exchange rate fluctuation and firm value in this industry, in both Equation (1) and Equation (4), across all major foreign currencies.

For the manufacturing industry sector, we find consistent results in Table 6 that a positive association exists between exchange rate movement and firm value for this industry, for USD and Euro. Our results from Table 6, however, do not support that exchange rate changes of Japanese Yen directly affect firm value (p-value 0.3296) in Equation (2). The possible explanation is that the Japanese government has been restricting imports of textile products and thus the textile industry in Taiwan is not subject to a high exchange rate exposure to Japanese Yen.

Table 4: Regression Results for the Firms in Hi-tech Industry on USD/Yen/Euro Exposure

Hi-tech firms N=29,912			**Model 1: Equation (1)**	
Variable	**prediction**	**Coefficient (p-value)**	**Coefficient (p-value)**	**Coefficient (p-value)**
Intercept	?	0.0008*** (0.0001)	0.0007*** (0.0001)	0.0009*** (0.0001)
US	+	36.752*** (0.0001)		
Yen	+		0.0800*** (0.0001)	
Euro	+			19.045*** (0.0001)
R^2		0.0078	0.0022	0.0012
Adj-R^2		0.0078	0.0022	0.0012
			Model 2: Equation (2)	
Intercept	**?**	**0.0006*** (0.0001)**	**0.0006*** (0.0001)**	**0.0006*** (0.0002)**
US	+	-8.900*** (0.0001)		
Yen	+		-0.0075 (0.3123)	
Euro	+			-3.720*** (0.0001)
R_{mt}	+	1.281*** (0.0001)	1.275*** (0.0001)	1.282*** (0.0001)
R^2		0.4263	0.4259	0.4263
Adj-R^2		0.4263	0.4259	0.4263
			Model 3: Equation (4)	
Intercept	**?**	**0.0008*** (0.0001)**	**0.0007*** (0.0001)**	**0.0009*** (0.0001)**
US	+	36.752*** (0.0001)		
Yen	+		0.0800*** (0.0001)	
Euro	+			19.046*** (0.0001)
Residual	+	1.281*** (0.0001)	1.275*** (0.0001)	1.282*** (0.0001)
R^2		0.4263	0.4259	0.4263
Adj-R^2		0.4263	0.4259	0.4263

*This table reports the regression results by models for the sample of firms in the high-tech industry. Model 1 is $R_{it} = \alpha_{i0} + \alpha_{i1}R_{xt} + e_{it}$, Model 2 is $R_{it} = \beta_0 + \beta_1 R_{xt} + \beta_2 R_{mt} + e_{it}$, while Model 3 is $R_{it} = \gamma_{i0} + \gamma_{i1}R_{xt} + \gamma_{i2}e_{mt} + e_{it}$, where $R_{mt} = \delta_{m0} + \delta_{m1}R_{xt} + e_{mt}$. The dependent variable R_{it} is the daily return adjusted for dividend for individual firms. R_{mt} is the composite daily return for Taiwan stock market. R_{xt} is the change in daily exchange rate of New Taiwan Dollar (NTD) to a foreign currency, which is Euro, Yen or USD. The figure in parentheses in each cell is the p-value. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Table 5: Regression Results for the Firms in Service Industry on USD/Yen/Euro Exposure

Service industry N=7,097			**Model 1: Equation (1)**	
Variable	**prediction**	**Coefficient (p-value)**	**Coefficient (p-value)**	**Coefficient (p-value)**
Intercept	?	0.0004 (0.2431)	0.0003 (0.3464)	0.0004 (0.2268)
US	+	24.183*** (0.0001)		
Yen	+		0.0482*** (0.0001)	
Euro	+			9.351*** (0.0001)
R^2		0.0059	0.0014	0.0051
Adj-R^2		0.0058	0.0013	0.0049
			Model 2: Equation (2)	
Intercept	?	0.0003 (0.3181)	0.0003 (0.3506)	0.0003 (0.3420)
US	+	6.575* (0.0655)		
Yen	+		0.0140 (0.3296)	
Euro	+			0.5080 (0.7349)
R_{mt}	+	0.4940*** (0.0001)	0.4979*** (0.0001)	0.4981*** (0.0001)
R^2		0.1143	0.114	0.1139
Adj-R^2		0.1141	0.1138	0.1137
			Model 3: Equation (4)	
Intercept	?	0.0004 (0.2162)	0.0004 (0.2162)	0.0004 (0.2003)
US	+	24.183*** (0.0001)		
Yen	+		0.0481*** (0.0008)	
Euro	+			9.351*** (0.0001)
Residual	+	0.4940*** (0.0001)	0.4940*** (0.0001)	0.4981*** (0.0001)
R^2		0.1143	0.1143	0.1139
Adj-R^2		0.1141	0.1141	0.1137

*This table reports the regression results by models for the sample of firms in the service industry. Model 1 is $R_{it} = \alpha_{i0} + \alpha_{i1}R_{xt} + e_{it}$, Model 2 is $R_{it} = \beta_0 + \beta_1 R_{xt} + \beta_2 R_{mt} + e_{it}$, while Model 3 is $R_{it} = \gamma_{i0} + \gamma_{i1}R_{xt} + \gamma_{i2}e_{mt} + e_{it}$, where $R_{mt} = \delta_{m0} + \delta_{m1}R_{xt} + e_{mt}$. The dependent variable R_{it} is the daily return adjusted for dividend for individual firms. R_{mt} is the composite daily return for Taiwan stock market. R_{xt} is the change in daily exchange rate of New Taiwan Dollar (NTD) to a foreign currency, which is Euro, Yen or USD. The figure in parentheses in each cell is the p-value. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Table 6: Regression Results for the Firms in Manufacturing Industry on USD/Yen/Euro exposure

Manufacturing Industry N=18,758			**Model 1: Equation (1)**	
Variable	**prediction**	**Coefficient (p-value)**	**Coefficient (p-value)**	**Coefficient (p-value)**
Intercept	?	0.0007*** (0.0001)	0.0007*** (0.0001)	0.0007*** (0.0001)
US	+	13.935*** (0.0001)		
Yen	+		0.0050 (0.5360)	
Euro	+			6.045*** (0.0001)
R^2		0.0026	0	0.0028
Adj-R^2		0.0026	0	0.0028
			Model 2: Equation (2)	
Intercept	?	0.0007*** (0.0001)	0.0007*** (0.0001)	0.0007*** (0.0001)
US	+	1.271 (0.5102)		
Yen	+		-0.0196**	
Euro	+			-0.2878
R_{mt}	+	0.3550*** (0.0001)	0.3578*** (0.0001)	0.3567*** (0.0001)
R^2		0.078	0.0783	0.078
Adj-R^2		0.0779	0.0782	0.0779
			Model 3: Equation (4)	
Intercept	?	0.0007*** (0.0001)	0.0007*** (0.0001)	0.0007*** (0.0001)
US	+	13.925*** (0.0001)		
Yen	+		0.0050 (0.5192)	
Euro	+			6.045*** (0.0001)
Residual	+	0.3550*** (0.0001)	0.3578*** (0.0001)	0.3567*** (0.0001)
R^2		0.078	0.0783	0.078
Adj-R^2		0.0779	0.0782	0.0779

*This table reports the regression results by models for the sample of firms in the manufacturing industry. Model 1 is $R_{it} = \alpha_{i0} + \alpha_{i1}R_{xt} + e_{it}$, Model 2 is $R_{it} = \beta_0 + \beta_1 R_{xt} + \beta_2 R_{mt} + e_{it}$, while Model 3 is $R_{it} = \gamma_{i0} + \gamma_{i1}R_{xt} + \gamma_{i2}e_{mt} + e_{it}$, where $R_{mt} = \delta_{m0} + \delta_{m1}R_{xt} + e_{mt}$. The dependent variable R_{it} is the daily return adjusted for dividend for individual firms. R_{mt} is the composite daily return for Taiwan stock market. R_{xt} is the change in daily exchange rate of New Taiwan Dollar (NTD) to a foreign currency, which is Euro, Yen or USD. The figure in parentheses in each cell is the p-value. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.*

CONCLUSION

Based on the two-factor model of firm valuation, this study examines the sensitivity of firm value to foreign exchange rate movement using a sample of 110 listed firms in Taiwan. In contrast with most prior studies employing the market portfolio only, this study investigates the firm value sensitivity to exchange rate fluctuation by focusing mainly on individual firms as well as on three industries of high-tech, service, and manufacturing. The exchange rate exposure to the major foreign currencies, including US dollars, Japanese Yen, and Euro is examined separately. Our study finds consistent results of a positive association exists between foreign exchange rate movement and firm value in a small and open economy body of Taiwan, both for the full sample and three industries. Unlike prior studies, our study uses the daily exchange rate change. The application of a short horizon to capture the exchange rate change is expected to provide a more powerful test setting with reduced noise.

We believe that Equation (4) with residual regression is superior to two other testing models by including both direct and indirect effects of exchange rate movement on firm value. We find that, out of our three industries, the high-tech industry is most influenced by fluctuation in exchange rates. Finally, compared to Japanese Yen, the exchange rate exposure to US dollars and Euro is much prominent.

The study includes 110 major listing firms in Taiwan during 2001-2002 in the sample. The small sample size and a relatively short time frame may limit the generalizability of our results. We suggest future studies including more firms with a longer time horizon, and expanding to other small and open economy bodies, such as Hong Kong, Singapore and Korea in the investigation.

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