Financial Liberalization and the Foreign Exchange Exposure Effect: A Nonparametric Analysis of Taiwan*

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This article adopts a nonparametric approach to examine the exchange-rate exposure of Taiwanese firms between December 1979 and January 1995. The evidence indicates that financial liberalization that took place in July 1987 has introduced an important structural break to firms' foreign exchange exposure. In the pre-liberalization period, no industry shows significant exposure to changes in the exchange rate. By contrast, in the post-liberalization period, exchange-rate movements exert significant contemporaneous and lagged impacts on the value of firms, particularly those with high involvement in international trade (JEL C14, F31, G18).

Keywords: financial liberalization, foreign exchange exposure effect, nonparametric econometrics.

I. Introduction

The foreign exchange exposure effect is defined as the sensitivity of a firm's value to exchange-rate movements. A depreciation (appreciation) of the domestic currency would increase (decrease) the value of firms with foreign sales or operations when they translate cash flows from foreign into domestic currencies. This effect can be measured by the

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slope coefficient in a regression of firms' stock returns on changes in the exchange rate, e.g., Adler and Dumas (1984). This article examines the exchange-rate exposure of Taiwanese firms between December 1979 and January 1995.

The choice of Taiwan for this study is based on two considerations. First, international trade has been extremely important for the Taiwan economy. In the 1960s, exports and imports accounted for an average[1] 39.4% of Taiwan GNP. Since the beginning of the 1970s, the ratio of the total trade to GNP has increased drastically. In particular, this ratio exceeded 100% in 1978 and peaked at 110.1% in 1988. Consequently, Taiwan has become one of the world's largest international traders in terms of volume. It is therefore worthwhile to investigate firms' foreign exchange exposure in a country with such high trade involvement.

Second, Taiwan has recorded a huge trade surplus as a result of fast growth in international trade since the early 1970s. Its current account balance comprised 4.9% of GNP in 1982, increased to 8.9% in 1983, and reached 22.1% in 1986. Hence, Taiwan has accumulated a massive amount of foreign exchange reserves, which in turn generated tremendous pressure on its money supply. These events led the government to initiate a series of foreign exchange liberalization policies around July 1987. In 1979, Taiwan established a foreign exchange market and converted itself from a fixed-rate to a floating-rate system. However, its exchange rate was frequently sterilized by the Central Bank in order to absorb part of the excess supply of foreign exchange such that the New Taiwan dollar (NT dollar) fluctuated gradually and smoothly. In addition, local residents could not freely hold and utilize foreign exchange. In July 1987, the Central Bank relaxed its controls on capital account transactions, thus allowing remission or transfer abroad of foreign exchange up to a certain amount without any restriction.[2] This implies that the value of an individual firm would be more sensitive to exchange-rate movements. Moreover, the exchange rate's volatility increased by 66% after July 1987, which also enhanced firms' foreign exchange exposure. Given these historical events, a structural break in the foreign exchange exposure effect is likely to be detected around mid-1987.

1. See table 1 of Kuo (1990) for details.

2. In 1994, the annual maximum amount of unrestricted foreign exchange remittance was 5 million U.S. dollars per person.

Recently, several authors have examined the exchange-rate exposure of firms. The common practice in the literature is using the "market model" to remove the impacts of market-wide factors on individual stock returns.[3] The residuals of this linear regression, called the "abnormal stock returns", are then regressed on exchange-rate movements. These studies have yielded limited success in identifying significant foreign exchange exposure effect. For example, Jorion (1990) investigated the exchange-rate exposure of U.S. multinationals and found that most exposure coefficients are small and insignificant. Amihud (1994) reported a similar result for the 32 largest U.S. exporting firms from 1982 to 1988. Bartov and Bodnar (1994) found no evidence of exchange-rate exposure for U.S. firms that reported notable foreign currency gains or losses in their annual financial statements between 1978 and 1989. Loudon (1993) showed that only eight out of twenty-three Australian industries exhibit significant foreign exchange exposure. Finally, He and Ng (1998) found that about 25% of 171 Japanese multinationals experienced economically significant positive exposure effects.

One explanation for this failure is that previous studies do not take into account the possibility of non-linearities in the market model. Ferson and Harvey (1991), Bos and Fetherston (1992), and Evans (1994) have documented the existence of non-linearity in the market model for the U.S. and Korean stock markets. As a result, using the linear market model to derive abnormal stock returns is no longer valid. In light of these findings, the analysis in this article begins by showing that linearity is rejected at the 5% significance level for the Taiwan stock market. Instead of working on a particular nonlinear specification, a nonparametric estimation technique–the local linear regression method–is employed to obtain the series of abnormal stock returns, and then the foreign exchange exposure effect is estimated.[4] Moreover, following Amihud (1994), Bartov and Bodnar (1994), and He and Ng (1998), a one-period lagged exchange–rate movement is also incorporated in the nonparametric regression to capture investors'

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3. The market model is written as $R_{i,t} = b_0 + b_1 R_{m,t} + \varepsilon_{i,t}$, where $R_{i,t}$ and $R_{m,t}$ represent the excess return of stock i and the entire market, respectively. Notice that R_i and $R_{m,t}$ represent deviations of individual stock and market returns from the risk-free interest rate.

4. ARCH and GARCH model are alternative methods, but they are based on ad hoc specifications of covariances. By contrast, the nonparametric approach is robust to model misspecification because it does not depend on any functional form in the estimation.

delayed responses.

The remainder of this article is organized as follows. Section II describes the data. Two econometric techniques, the Li-Wang linearity test and the local linear regression method, are summarized in section III. Section IV discusses the estimation procedure and presents the results. Section V concludes.

II. The Data

The Taiwan Stock Exchange (TSE) was established in late 1961 and its actual trading began in February of the following year. The market is regulated by the Securities and Exchange Commission (SEC), which was set up in September 1960 and is now under the administration of the Ministry of Finance. All listed companies on the TSE are classified into three categories–A, B, and full-delivery– based on their total paid-in capital, profitability, and distribution of shares. The largest and most profitable companies fall into category A. Corporations with serious financial problems are listed in the full-delivery category and the rest are placed in category B. The oldest and most popular stock market index is the Taiwan Stock Exchange Weighted Index (TSE Index), which was first compiled in 1967 with the 1966 price as the base level. It includes almost all listed stocks except those of government-owned companies and full-delivery stocks. Table 1 presents annual summary statistics of the Taiwan stock market from 1979 to 1994.

The data consists of time series of monthly stock prices between December 1979, when Taiwan adopted a managed floating exchange rate, and January 1995.[5] Using monthly data avoids the problems of thin trading and price limits that have been imposed in the Taiwan stock market.[6] In this article, stocks that have been continuously listed in the TSE categories A or B for more than four years are chosen. This results in a sample of 172 stocks. According to the first two digits of the TSE codes, the selected stocks are divided into nine industry portfolios: cement, food, plastics, textiles and fibers, electrics and machinery,

5. Taiwan established its foreign exchange market in February 1979. However, its exchange rate did not “float” until December 1979.

6. Daily price floor and ceiling are imposed by the SEC to discourage speculation and protect investors against abnormal price movements. The daily limits were set to be plus or minus 10 percent of the closing prices on the previous business day.

TABLE 1. **Summary Statistics of the Taiwan Stock Market**

Year	Number of Companies	Listed Shares	Market Capitalization	Trading Volume	Trading Value
1979	96	10,282	178,809	13,037	205,488
1980	102	10,659	219,053	11,495	162,113
1981	107	12,805	201,331	13,198	209,217
1982	113	15,144	203,111	10,244	133,875
1983	119	16,716	305,956	23,869	363,845
1984	123	19,039	390,260	18,164	324,475
1985	127	21,345	415,706	14,534	195,228
1986	130	24,082	548,436	39,041	675,656
1987	141	28,735	1,386,065	76,857	2,668,633
1988	163	34,358	3,383,280	101,350	7,868,024
1989	181	42,130	6,174,164	220,559	25,407,963
1990	199	50,643	2,681,911	232,307	19,031,288
1991	221	61,671	3,184,028	175,941	9,682,738
1992	256	73,564	2,545,508	107,592	5,917,079
1993	285	89,102	5,145,410	204,678	9,056,717
1994	306	102,179	5,685,295	285,341	15,921,582

Note: The units of measurement are millions of NT dollars for market capitalization and trading value, and millions of shares for total listed shares and trading volume. Source: various issues of *Taiwan Stock Exchange Statistical Data.*

chemistry, pulp and paper, construction, and banking and insurance.[7] These portfolios are further classified into three different types of industries based on the degree of their international involvement. Plastics, textiles and fibers, electrics and machinery, and chemistry are export-oriented industries. Food together with pulp and paper are two import-oriented industries. The remaining three sectors–cement, construction, and banking and insurance–are purely domestic industries. The monthly returns of each stock are computed by taking the log-difference of prices with adjustments for cash and stock dividends. With this information, the monthly value-weighted returns of all nine industries are then calculated. Descriptive statistics for the entire market and each portfolio are summarized in table 2.

The monthly trade-weighted exchange-rate indices from December 1979 to January 1995 are readily available from the Central Bank. An increase (decrease) in the index means that the New Taiwan dollar

7. Other industries listed in the TSE such as glass, steel, rubber, motor, transportation, and hotels are excluded because too few companies are included within each industry.

TABLE 2. Descriptive Statistics of Industry Portfolios

Portfolio	TSE Code	Number of Companies	Mean	St. Dev.
Market		238	2.01	1.04
Cement	11	8	1.88	.93
Food	12	21	1.79	1.02
Plastics	13	14	1.91	.97
Textiles and Fibers	14	39	1.85	1.03
Electrics and Machinery	15,16,23	43	1.82	.96
Chemistry	17	14	1.96	1.04
Pulp and Paper	19	7	1.82	1.03
Construction	25	10	1.73	.94
Banking and Insurance	28	16	2.75	1.34

Note: Columns 3 and 4 present the mean and standard deviation of monthly rate of returns for the market and nine industry portfolios from December 1979 to January 1995.

appreciates (depreciates) relative to a trade-weighted basket of foreign currencies. Since the Taiwanese government didn't issue Treasury bills during the sample period, the Treasury-bill rate cannot be used as the risk-free rate. As in Cheung, Wong, and Ho (1993), the monthly interbank call loan rates are adopted as the replacement. These rates are collected from the Central Bank's annual reports. However, the monthly interbank call loans were not available before April 1980. Therefore, the one-month time deposit rate is employed as the risk-free rate between December 1979 and April 1980.

III. Econometric Methodology

A. Linearity Test

To test the linearity of the market model, the method recently proposed by Li and Wang (1998) is used. These authors presented a simple, consistent test for examining a parametric regression model under very general conditions. The null model to be tested can be any linear or nonlinear regression in which the random error terms are only assumed to have finite variance without any distributional specifications. Moreover, their test does not require estimating the alternative models, hence making it very straightforward to implement. Here, the construction of their test statistic and its asymptotic properties are briefly summarized.

Consider a random sample $(X_1, Y_1), \ldots, (X_n, Y_n)$, where $X \in R^q$, $q \geq 1$, $Y \in R$, and n is the number of observations. The null hypothesis to be tested is

$$E(Y|X) = \phi(X, \beta), \tag{1}$$

where β is a set of parameters and $\phi(X, \beta)$ is a known function. Under the alternative hypothesis, there exists another function $\theta(X)$ such that

$$E(Y|X) = \theta(X) \neq \phi(X, \beta). \tag{2}$$

The above null and alternative hypotheses can be rewritten in the following regression formulation with additive error terms

$$Y_i = \phi(X_i, \beta) + U_i, \tag{3}$$

$$Y_i = \theta(X_i) + V_i, \tag{4}$$

where U and V are random variables with zero means, and i = 1, 2,..., n. Notice that $\phi(X_i, \beta) = X_i\beta$ for our purpose of testing for linearity.

From (1) and (3), it is straightforward to verify that $E(U|X) = 0$ almost everywhere if and only if the null hypothesis is true. It is well known that this conditional expectation $E(U|X)$ can be consistently estimated by nonparametric techniques, such as the kernel estimator.[8] As a result, a consistent test statistic based on $E\{U\,E(U|X)\}$ $+E\{E(U|X)\} \geq 0$, and the equality holds if and only if the null hypothesis is true. To avoid the random denominator problem of the kernel estimation, Li and Wang construct a test statistic based on the

8. The basic idea behind the kernel estimation is that the exact functional form of the conditional expectation $E(Y|X)$ might not be known in advance. Specifically, a kernel estimator takes a weighted average of those Y_i's that correspond to X_i in a neighborhood of some arbitrary point x. The kernel function $K(\cdot)$ assigns weights to all those X_i's– high for X_i's close to x and low for X_i's far away from x. Moreover, the bandwidth h determines how many of the X_i's around x are used in forming the average. In fact, a parametric OLS estimator is a special case of the kernel estimator with $h \rightarrow \infty$. See Nadaraya (1964) and Watson (1964) for early developments of this estimation method.

weighted density, $E\{U\,E(U\,|\,X)\,f\,(X)\}$, where $f\,(X)$ is the density function of *X*. Their test statistic is given by

$$J_n = \frac{1}{n\sqrt{h^q}} \sum_{i=1}^{n} \sum_{j=1, j\neq i}^{n} \frac{\tilde{U}_i \tilde{U}_j K_{i,j}}{\sqrt{\tilde{\Omega}}}, \tag{5}$$

where $\tilde{\Omega} = \frac{2}{n^2 h^q} \sum_i \sum_{j\neq i} \tilde{U}_i^2 \tilde{U}_j^2 K_{i,j}^2$. In (5), h is the smoothing parameter (bandwidth), $\tilde{U}_i$ represents the least-squares residuals from equation 3, and $K_{i,j}$ is the kernel function. Under the null hypothesis and some regularity conditions, Li and Wang show that the statistic J_n is asymptotically normal with zero mean and variance Ω that can be consistently estimated by $\tilde{\Omega}$.

B. Nonparametric Local Linear Regression Method

The nonparametric local linear regression method was first developed by Stone (1977) and Cleveland (1979) and later expanded in Fan (1992, 1993), Fan and Gijbels (1992), and Ruppert and Ward (1994). Like every other nonparametric technique, this method does not specify any functional form in the estimation. However, it has several advantages over other alternatives. In particular, the local linear estimator has the highest asymptotic efficiency among all possible linear smoothers, including those produced by kernel, orthogonal series, or spline methods. Furthermore, most nonparametric regression smoothers exhibit "boundary effects" in that the rate of convergence is slower at boundary points compared to those in the interior of the support. By contrast, the local linear estimator does not suffer from this problem since its convergence rate is not influenced by the position of the point under consideration.[9] The workings of the local linear regression method are summarized below.

In general, the multivariate nonparametric regression problem is to estimate the following model:

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9. Fan and Gijbels (1992) have shown that the bias and variance of the local linear estimator are of the same order of magnitude in both the interior and near the boundary of the support. Moreover, it can be shown that the local linear estimator has a smaller MSE than the kernel estimator, particularly around the boundary points. As a result, the local linear estimator displays a faster rate of convergence, regardless of the position of the support. See chapter 4 of Pagan and Ullah (1999) for more details.

$$Y_i = m(X_i) + \varepsilon_i \text{ and } E(Y_i|X_i) = m(X_i), \tag{6}$$

where $i = 1, 2,..., n$. Under the assumption that the second derivatives of $m(X_i)$ exist, the logic of the local linear estimator can be understood by considering the first-order Taylor's series expansion of $m(X_i)$ around a point x

$$m(X_i) \approx m(x) + m'(x)(X_i - x) \equiv a + b(X_i - x). \tag{7}$$

In contrast to the kernel regression that estimates only the conditional mean, $m(x)$, the local linear method also includes the first derivative term, $m'(x)$. Intuitively, the local linear regression fits a line at each point of estimation whereas the kernel method simply estimates a point, the conditional mean. Hence, the local linear regression is equivalent to finding a and b to minimize the following weighted objective function:

$$\sum_{i=1}^{n} \{Y_i - a - b(X_i - x)\}^2 K_i, \tag{8}$$

where $K_i = K((X_i - x)/h)$ is the standard normal kernel. The bandwidth of the regression smoothers h is chosen to be σ_x / n^{4+q}, where σ_x denotes the sample standard deviation of X_i and q is the number of regressors. Notice that this regression uses only observations close to the point x to minimize the sum of squared residuals. Therefore, the estimates of a and b are no longer constants but functions of x.

In practice, a local linear regression is implemented by combining (6) and (7) and then multiplying both sides by

$$\sqrt{K_i}\, Y_i = \sqrt{K_i}\, a(x) + \sqrt{K_i}\, (X_i - x) b(x) + e_i$$

$$= \sqrt{K_i} \begin{bmatrix} 1 & X_i - x \end{bmatrix} \begin{bmatrix} a(x) \\ b(x) \end{bmatrix} + e_i \tag{9}$$

where $e_i \equiv \sqrt{K_i}\, \varepsilon_i$. Alternatively, equation 9 can be rewritten as

$$Y_i^* = Z_i^*(x)\, \delta(x) + e_i, \tag{10}$$

where $Y_i^* \equiv \sqrt{K_i}\, Y_i$, $Z_i^*(x) \equiv \sqrt{K_i}\,[1 \quad X_i - x]$, and $\delta(x) \equiv [a(x) \quad b(x)]'$. The estimate of $\delta(x)$ could be obtained by running OLS on (10):

$$\hat{\delta}(x) = \left(\sum_{i=1}^{n} Z_i^{*\prime} Z_i^*\right)^{-1} \sum_{i=1}^{n} Z_i^{*\prime} Y_i^* \qquad (11)$$

and the variance of $\hat{\delta}(x)$ is given by:

$$\operatorname{var}\hat{\delta}(x) = A(x)\Omega(x)A'(x) \qquad (12)$$

where $A(x) = \left(\sum_{i=1}^{n} Z_i^{*\prime} Z_i^*\right)^{-1} \sum_{i=1}^{n} \sqrt{K_i}\, Z_i^{*\prime}$, $\Omega(x) = \operatorname{diag}\{\sigma^2(x_1), \ldots, \sigma^2(x_n)\}$, and $\sigma^2(x_i) = \operatorname{var}(e_i | x_i)$.

IV. Estimation Procedure and Results

Following Jorion (1990, 1991) and Bartov and Bodnar (1994), this article develops a similar two-stage estimation procedure. First, the market model for the Taiwan stock market is shown to be nonlinear, thus the local linear regression technique is used to obtain time series of abnormal stock returns for the nine industry portfolios. Second, the foreign exchange exposure effect is estimated by regressing abnormal stock returns on exchange-rate movements. Moreover, in the second stage, the CUSUM of squares test is conducted to verify that a structural break of firms' foreign exchange exposure has occurred in July 1987.

A. Test for Non-linearity and Obtaining Abnormal Stock Returns

The analysis begins by using the Li-Wang test summarized in section IIIA to examine whether the market model for the Taiwan stock market is linear. Table 3 presents the J_n statistics as in (5) for the nine portfolios that have been constructed. Notice that the linearity hypothesis of the market model is rejected at the 5% significance level for all industries. As is pointed out by Giovannini and Jorion (1989), this implies that adopting the linear market model is no longer valid for

TABLE 3. Linearity Tests of the Market Model

Industry	J_n– Statistic	Result
Cement	2.1173	Reject H_0
Food	2.5781	Reject H_0
Plastics	2.4456	Reject H_0
Textiles and Fibers	3.4940	Reject H_0
Electrics and Machinery	2.4495	Reject H_0
Chemistry	2.3877	Reject H_0
Pulp and Paper	2.4078	Reject H_0
Construction	2.9473	Reject H_0
Banking and Insurance	3.1839	Reject H_0

Note: This table presents the J_n statistics for the nine industry portfolios based on the Li and Wang (1998) linearity test. This test statistic is asymptotically standard normal. The null hypothesis is that the market model is linear.

our study. Instead of working on a particular nonlinear specification, the following nonparametric market model for each portfolio is estimated by

$$R_{i,t} = m\left(R_{r,t}\right) + \varepsilon_{i,t,} \tag{13}$$

where $R_{i,t}$ is the excess return of industry i, $R_{r,t}$ denotes the valued-weighted market excess return and $i = 1,2,...,9$. Excess return is defined as the portfolio or market return minus the risk-free rate, which is approximated by the monthly interbank call loan rate. Furthermore, $m(R_{r,t})$ represents the conditional mean of $R_{r,t}$, and $\varepsilon_{i,t}$ are mean-zero, i.i.d. random errors. The local linear regression method discussed in section IIIB is employed to estimate (13). It follows that the abnormal returns for each industry are calculated by

$$AR_{i,t} = R_{i,t} - m\left(R_{r,t}\right), \tag{14}$$

where $AR_{i,t}$ represents the abnormal return of portfolio i in period t, $\hat{m}\left(R_{r,t}\right)$ denotes the estimated conditional mean of $R_{i,t}$ from (13) and i = 1, 2,...,9.

B. Estimating the Foreign Exchange Exposure Effect

In the second stage, the following nonparametric regression model is used to estimate firms’ foreign exchange exposure:

$$AR_{i,t} = g(\Delta EI_t, \Delta EI_{t-1}) + V_{i,t}, \qquad (15)$$

where ΔEI_t represents the percentage change of the trade-weighted exchange-rate index between t – 1 and t, $V_{i,t}$ is an error term with zero mean and i = 1, 2,..., 9. The inclusion of a lagged term ΔEI_{t-1} is based on the suggestion of Bartov and Bodnar (1994).[10] They argued that since information concerning the impact of exchange-rate fluctuations on the value of firms might not be contemporaneously present, delayed responses of investors can arise. As a result, investors rely on news about firms’ past performance, such as earnings of the last period, in order to better evaluate the magnitude of foreign exposure. This implies that it will take time for stock prices to fully adjust to movements in the exchange rate.

As mentioned in the introduction, a structural break in firms' exchange-rate exposure is expected to occur around July 1987 as Taiwan relaxed its control on foreign exchange. To verify this proposition, the CUSUM of squares test developed by Brown, Durbin, and Evans (1975) is run on equation 15 for each portfolio to identify possible structural changes during the sample period. This test is based on the cumulative sum of squared recursive residuals. In comparison with the Chow test, the CUSUM of squares test is more general since it does not require prior knowledge of the potential dates for structural breaks. Figure 1 plots the cumulative sum of squared residuals together with a pair of 5 percent confidence bounds. When the cumulative sum moves outside the critical lines, it indicates parameter instability of the regression model and hence a structural change. This figure clearly shows that a structural break of foreign exchange exposure took place in *all* industries around July 1987, particularly those with active participation in international trade such as food, plastics, textiles and fibers, electrics and machinery, chemistry, and pulp and paper. Based on this result, the sample period is divided into two sub-periods, December 1979 to June 1987 and July 1987 to January 1995.

Next, firms’ foreign exchange exposure is estimated by the local linear regression (15) for each sub-period. The two exposure coefficients, β_1 and β_2, represent partial derivatives of abnormal stock

10. Both the Akaike and Schwartz information criteria indicate that the appropriate lag length in (15) is one.

returns with respect to contemporaneous and lagged exchange-rate movements, respectively. Figures 2 and 3 plot pointwise derivative estimates $\hat{\beta}_1$ and $\hat{\beta}_2$ respectively, together with their 95% confidence intervals for each industry. The variances of these coefficients $\hat{\Omega}$ are computed according to (12). These figures give a local indication of the shape for the regression function. Their maximum and minimum values are reported in table 4. To provide a global curvature description of (15), table 4 also presents the expected derivative estimates, $\bar{\hat{\beta}}_1$ and $\bar{\hat{\beta}}_2$, and their associated t-ratios.[11] It turns out that in the pre-liberalization period, *none* of the nine industries exhibit significant foreign exchange exposure. This is not surprising since the government's strict control of the foreign exchange market before mid-1987 has provided a stable environment for promoting international trade. Once this policy was abolished, dealing with exchange-rate risk became a new and important issue for firms with foreign operations. As a result, the six trade-oriented industries display significant contemporaneous foreign exposure after July 1987. In particular, the signs of the estimated $\bar{\hat{\beta}}_1$'s are consistent with standard international finance theories. For the export-oriented industries such as plastics, textiles and fibers, electrics and machinery, and chemistry, a higher exchange-rate index (or appreciation of the NT dollar) reduces their profitability and hence yields a negative impact on firms' stock returns. This mechanism works in the opposite direction for the import-oriented industries like food, and pulp and paper. For the three purely domestic industries (cement, construction, and banking and insurance), exchange-rate movements have no significant effect on the value of firms.

Moreover, table 4 shows that in the post-liberation period, the six trade-oriented industries also display significant lagged foreign exchange exposure effect. This result suggests that investors are unable to characterize the relationship between exchange-rate fluctuations and firms' value without bias, especially in a country like Taiwan with a very short history of the floating-rate system. As information regarding performance is disclosed, systematic adjustments to the value of firms takes place. These adjustments in turn induce a delayed foreign

11. An expected derivative estimate is simply the sample mean of pointwise estimates. Rilstone (1991) has shown that this estimator is consistent and asymptotically normally distributed. As a result, it is straightforward to conduct hypothesis testing since its standard errors are comparable to parametric estimates.

TABLE 4. The Foreign Exchange Exposure Effect

		December. 1979 to June 1987				July 1987 to January 1995			
Industry		Mean	*t*-ratio	Min	Max	Mean	*t*-ratio	Min	Max
Cement	β_1	.48	1.39	–3.1	4.1	–.07	–.55	–1.6	5.3
	β_2	.24	.96	–2.5	4.4	.17	1.11	–2.1	1.9
Food	β_1	–.02	–.09	–3.1	5.7	.64*	1.98	–3.6	6.1
	β_2	.41	1.53	–3.8	4.4	1.24*	3.41	–4.9	6.7
Plastics	β_1	–.47	–1.37	–5.4	1.9	.63*	–2.01	–3.1	1.4
	β_2	–.76	–1.35	–3.8	6.4	.51*	–2.19	–2.1	2.2
Textiles	β_1	.51	1.33	–4.1	4.7	.78*	–2.56	–6.1	4.8
and Fibers	β_2	–.65	–1.21	–5.2	3.5	.86*	–2.73	–6.5	3.1
Electrics	β_1	–.03	–.21	–5.7	2.2	.89*	–1.97	–3.7	2.8
and Machinery	β_2	.44	1.29	–5.9	5.4	1.67*	–2.41	–5.7	0.3
Chemistry	β_1	–.09	–.81	–2.5	1.1	1.43*	–2.24	–4.1	1.5
	β_2	.19	1.31	–2.1	4.5	.84*	–2.01	–1.9	2.1
Pulp and	β_1	–.16	–.56	–5.1	3.3	1.21*	1.99	–2.1	5.1
Paper	β_2	.26	.54	–5.8	4.7	1.02*	2.36	–2.1	6.7
Construction	β_1	.51	.87	–5.1	4.3	–.09	–.53	–2.9	3.6
	β_2	–.82	–.49	–5.6	5.1	–.02	–.17	–2.6	.7
Banking	β_1	.61	1.39	–5.8	5.1	.31	.66	–4.6	4.3
and Insurance	β_2	–.41	–1.01	–5.1	4.9	.53	1.11	–4.6	5.2

Note: This table presents estimation results from the nonparametric regression 15. β_1 and β_2 represent partial derivatives of abnormal stock returns with respect to contemporaneous and lagged exchange-rate movements, respectively. T-ratios are calculated according to Rilstone (1991). The asterisks denote significance at the 5% level.

Figure 1a to be placed here

FIGURE 1.—CUSUM of Square Test – the cumulative sum of squared residuals from (15) and a pair of 5 percent confidence bounds for each industry portfolio.

Figure 1b to be placed here

FIGURE 1.—(Continued)

Figure 1c to be placed here

FIGURE 1.—(Continued)

Figure 2a to be placed here

FIGURE 2.—Beta One – pointwise estimates of partial derivatives of abnormal stock returns with respect to contemporaneous exchange–rate movements and their 95% confidence intervals for each industry portfolio.

Figure 2b to be placed here

FIGURE 2.—(Continued)

Figure 2c to be placed here

FIGURE 2.—(Continued)

Figure 3a to be placed here

FIGURE 3.—Beta Two – pointwise estimates of partial derivatives of abnormal stock returns with respect to one–period lagged exchange –rate movements and their 95% confidence intervals for each industry portfolio.

Figure 3b to be placed here

FIGURE 3.—(Continued)

Figure 3c to be placed here

FIGURE 3.—(Continued)

exchange exposure effect.

V. Conclusion

The main findings of this article are summarized as follows. In the pre-liberalization period, no industry in Taiwan exhibits significant exposure to exchange-rate fluctuations. However, in the post-liberalization period, the six trade-oriented industries–food, plastics, textiles and fibers, electrics and machinery, chemistry, and pulp and paper–all show significant contemporaneous and lagged foreign exchange exposure effect. In addition, exchange-rate movements have no impact on the value of firms in three purely domestic industries–cement, construction, and banking and insurance. These findings indicate that financial liberalization that took place around July 1987 introduced an important structural break to Taiwanese firms' foreign exchange exposure.

The analysis in this article also suggests that the linearity hypothesis of the market model should not be taken as given prior to estimating the foreign exchange exposure effect. Once the Taiwan stock market is found to be nonlinear, a nonparametric approach is adopted to show that the six trade-oriented industries exhibit significant contemporaneous and lagged exchange-rate exposure after the financial liberalization of July 1987. This implies that firms could influence their cost of capital by currency hedging. Jorion (1991) and Loudon (1993) have shown that exchange-rate risk appears to be diversifiable in U.S. and Australia, that is, investors seem unwilling to reward companies for hedging this kind of risk. An interesting extension of this article is to investigate whether any premium for exchange-rate risk exists in Taiwanese equity returns. This is a research project that will be pursued in the near future.

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