Chapter 3

The impact of exchange rate movements on Taiwan's Outward FDI into China: Market-seeking versus Reverse-importing

1. Introduction

In this chapter, the industry panel data on Taiwan's outward FDI into China over the period 1991-2002 are employed to test the validity of the theoretical results derived in Chapter 2. Particularly, due to data limitation, we will focus on the differences in the impact of exchange rate movements on market-seeking FDI versus reverse-importing FDI.

Previous empirical studies regarding the FDI of Taiwanese firm ignore the possible heterogeneity of the investing motives in a certain host country. For instance, Chen (1992) and Chen and Yang (1999) reveal that the outward FDI activity of some Taiwanese firms has been motivated for seeking a new market, whereas that of some other firms has been motivated for reducing production costs by relocating production abroad. However, it is worth noting that, in their study, Chen and Yang (1999) assume that to invest into a country with a lower wage rate than that in the home country (e.g., Taiwanese investment into China) is probably with a view to reducing production costs. This chapter by contrast argues that the motives for FDI flows into a certain host country can be heterogeneous. In particular, a Taiwanese firm might invest into China for seeking a new market or other purposes.

In addition, despite the popular claim that the appreciation of Taiwan's currency has been one of the most important reasons for the drastic rise of Taiwan's outward

FDI, the role of the exchange rate has not been considered in most recent studies (e.g. Chen (1992), Chen (1996), Chen and Yang (1999), Lin et al. (2001), Henly et al. (1999), and Zhang (2001)). To fill the gap in the literature, this chapter will investigate if exchange rates have even played an important role in determining the short-run movements in Taiwan's FDI flow. And if so, what is relationship between exchange rate and FDI? Do the effects of exchange rate movements on FDI vary with different types of FDI?

The remainder of this chapter proceeds as follows. In the following section, the expected signs of the determinants of market-seeking FDI and reverse-importing FDI derived from Chapter 2 are presented. Section 3 discusses the empirical model and estimation method, followed in the subsequent section by a presentation of the data and empirical results. Brief concluding remarks are given in the final section.

2. Expected signs of determinants of FDI

According to Propositions 2-6~2-12 in Chapter 2, the expected signs of the determinants of market-seeking FDI and reverse-importing FDI are summarized in Table 3-1. These results reveal that the effects of these determinants on FDI for these two types of firms have similarities as well as differences.

Table 3-1. Expected signs of the determinants of FDI

Types \ Variables	Exchange Rate (R)	Exchange Rate Trend (μ)	Exchange Rate Volatility (σ)	Sunk Costs (k)	Host Country Wage Rate (W_f)
Market-seeking Firms	+	?	-	-	?
Reverse-importing Firms	-	-	-	-	-

First, we find that the expected sign of the volatility of the real exchange rate is negative, which is the same for the two types of firms. The economic intuition is that the investment is like a call option whose value increases if the underlying uncertainty increases. Hence, the potential entrant has more incentive to wait until it gets extra information from the market as the uncertainty rises. In addition, both types of FDI increase the exposure of profits to exchange rate risk, thus it reduces the incentive to invest when uncertainty rises. Therefore, the expected sign of exchange rate volatility is negative for both types of the firms.

Second, the expected sign of the sunk costs *k* is negative, which is also the same for the two types of firms. This is because, given the irreversibility of investment, the higher the entry costs are, the higher the revenues or the lower the variable costs will be that are requested to compensate the opportunity loss. Thus, the entry trigger rate will be higher for the market-seeking firms and the entry trigger rate will be lower for the reverse-importing firms. As a result, the amount of FDI should decrease with the increase in *k*.

Third, the expected sign of the wage rate is negative for reverse-importing firms. It is because the higher the foreign wage rate is, the higher the variable costs will be that are involved in foreign production, thus it is less willing to set up a foreign subsidiary for production activity. In addition, the expected sign of the wage rate for market- seeking firm is ambiguous as Proposition 2-13 shown.

Finally, the effects of the exchange rate level and its trend differ between two different types of firms. As for market-seeking firms, they benefits from an appreciation of foreign currency because the profits in terms of the home currency are higher (if $P_f > W_f$). However, for reverse-importing firms, an appreciation of the foreign currency implies higher variable costs in terms of the home currency without

affecting revenue. As a result, the profits of a foreign subsidiary will be lower. Therefore, the expected sign of the exchange rate for market-seeking firms is positive, whereas the expected sign of the exchange rate for reverse-importing firms is negative. As for the effects of the exchange rate trend, according to Propositions 2-8 and 2-10 in Chapter 2, the expected signs of μ for market-seeking firms are ambiguous while the expected signs for reverse-importing firms are negative.

3. Empirical model

Based on our theoretical framework, the following empirical model is established:

$$\begin{aligned} FDI^{*}_{i,t} = {} & \alpha_i + \beta_1 R_{t-1} + \beta_2 \mu_t + \beta_3 \sigma_t + \beta_4 Wage_{i,t-1} + \beta_5 Sunk_i * \sigma_t \\ & + \beta_6 Mar_i * R_{t-1} + \beta_7 Rev_i * R_{t-1} \\ & + \beta_8 Mar_i * \mu_t + \beta_9 Rev_i * \mu_t \\ & + \beta_{10} Trend_t + \beta_{11} D_t + \varepsilon^{*}_{it} \end{aligned} \tag{3-1}$$

Here, subscript *i* refers to industries, subscript *t* refers to time periods, α_i and β_j $(j = 1,...11)$ are parameters, and ε^{*}_{it}'s are disturbance terms. The definitions of the variables in Equation (3-1) are explained as follows:

$FDI^{*}_{i,t}$: the desired number of new FDI cases of industry *i* at time *t*, which is divided by China's real GDP to control for changes in the size of the host country.

$R_{t\text{-}1}$: the one-period lagged real exchange rate of Taiwan's currency (New Taiwan Dollar, NTD) versus China's currency (Renminbi, RMB) , in which nominal exchange rates are deflated with the prices of the respective countries to control for the possible movements in prices following the change in nominal exchange rates. In addition, since it is time-consuming to make an

FDI decision, the final decision might be more related to the previous exchange level, and thus the one-period lagged values are used. The expected sign of this variable is positive for market-seeking firms and negative for reverse-importing firms.

μ_t: the trend of the real exchange rates. The expected sign of this variable is ambiguous for market-seeking firms and negative for reverse-importing firms.

σ_t: the volatility of the real exchange rate. The expected sign of this variable is negative for both types of the firms.

$Wage_{i,t-1}$: the ratio of China's one-period lagged real wage rate over Taiwan's one-period lagged real wage rate. One alternative for investing firms to produce abroad is to produce in the home country instead. To control for this option, the relative wage rates instead of the absolute wage rates are used in our empirical model. The expected sign of this variable is negative for reverse-importing firms and ambiguous for market-seeking firms.

$Sunk_i$: a dummy variable, whose value is 1 for industries with substantial sunk investment costs and 0 for other industries.

Mar_i: a dummy variable, whose value is 1 for market-seeking industries and 0 for other industries.

Rev_i: a dummy variable, whose value is 1 for reverse-importing industries and 0 for other industries.

$Trend_t$: a time trend, used to control for other time-related variables.

D_t: during our sample period, Taiwan's government required firms to register their investment in China if they did not do so prior to their investment in previous years. As a result, the official number of new FDI cases in several years is biased upward. A dummy variable is used to control for this bias,

whose value is 1 for the years of 1993, 1997, 1998, and 2002, and 0 for the other years.

Since only the observations regarding the numbers of new FDI cases in different industries are observed, the dependent variable is limited to be non-negative; that is:

$$FDI_{i,t} = \begin{cases} FDI^*_{i,t}, & \text{if } FDI^*_{i,t} > 0 \\ 0, & \text{if } FDI^*_{i,t} \le 0 \end{cases} \quad (3\text{-}2)$$

where $FDI_{i,t}$ shows the observed new FDI cases. As the dependent variable's range is constrained, a Quasi Maximum Likelihood Tobit Model is adopted to fit the data.[39]

4. The data and empirical results

4.1 The Data

Industry panel data on Taiwan's outward FDI in China are employed to test the theory in the Chapter 2. This dataset consists of 27 sectors over the period from 1991 to 2002 with a total sample size of 324 observations. The numbers of new FDI cases used in this study are the approved cases of Taiwan's outward FDI in China, which vary across industries and over time. The sources of the data are described in Appendix 3-1.

As shown in Table 3-2 and Figure 3-1, the electronics and electric industries have accounted for a significant and increasing share of FDI cases in Taiwanese investment into China, particularly after 1997. Their share has been around 30% in recent years. Outward investment from service sector has also exhibited an increasing trend. In contrast, the investment cases from the chemicals and plastic products, and the food and beverage industries have declined from the peak of the early 1990s. Investment

[39] See Hsiao (2003), Chapter 8.

cases from precision instruments and metal products also each account for a considerable and stable share of Taiwan's outward FDI.

Table 3-2. Taiwan's outward FDI cases in China: 1991-2002

	1991-1993	1994-1996	1997-1999	2000-2002	1991-2002
Selected Industries					
Food & Beverage	837	135	1,227	129	2,328
Chemicals and Plastic Products	1,723	276	1,469	589	4,057
Metal Products	810	166	900	474	2,350
Precision Instruments	1,223	121	823	339	2,506
Electronics & Electric Appliances	1,263	301	1,704	1,515	4,783
Services	305	86	397	538	1,326
All Industry	9,830	1,801	1,0497	5,142	27,270

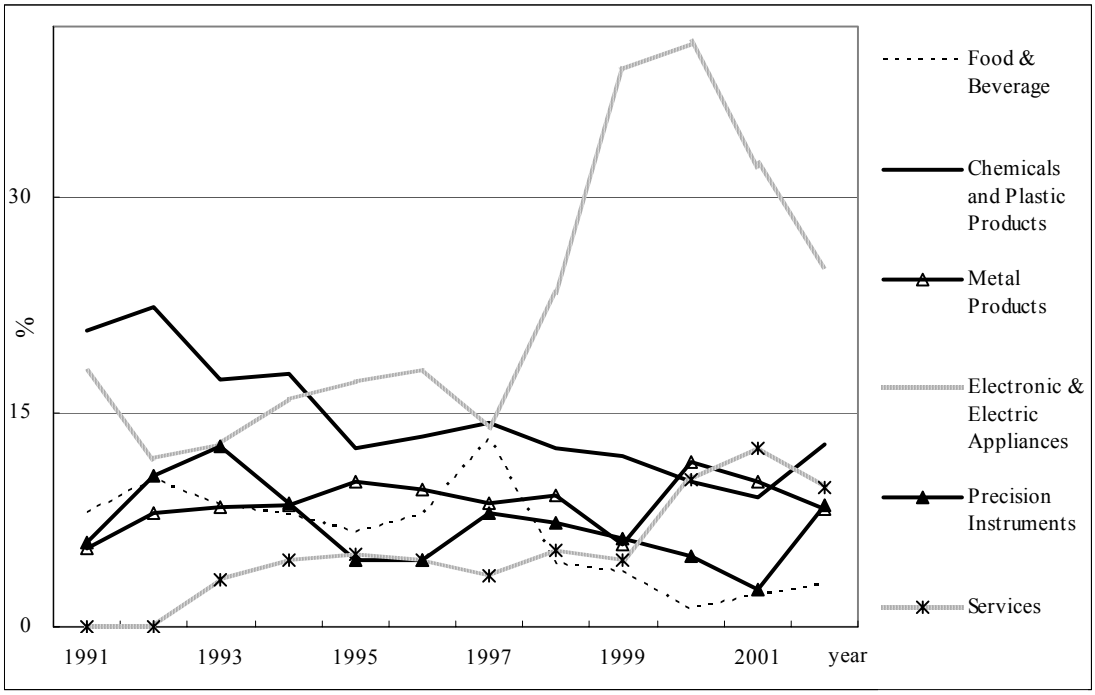

Figure 3-1. Percentages of outward FDI cases in China for some selected industries

The exchange rates between NTD and RMB are calculated from the ratio of exchange rates of NTD and US Dollar (USD), and the exchange rates of RMB and USD. Several measures of trend and volatility of the real exchange rate have been proposed in the literature. Following Tsay (2002, p.229), this thesis first uses a modified average and a modified standard deviation of the monthly change in the logarithm of the real exchange rate to stand for the trend and volatility of the real exchange rates, which are designed to approximate a continuous-time geometric Brownian motion process. Then a GARCH process is used to estimate the conditional mean and variance of the real exchange rate as the other measures of its trend and volatility, since some studies such as Pozo (1992) note that exchange rates often exhibit persistent behavior.[40]

In regards to the sunk investment costs dummy, $Sunk_i$, its value is 1 for an industry which is among the top ten industries by the percentage of Taiwanese subsidiaries with R&D departments as well as among the top ten industries by the percentage of Taiwanese subsidiaries with marketing departments in China during 1999-2002; 0 otherwise. According to these criteria, the industries with high sunk investment costs in our sample include food & beverage processing, chemicals, non-metallic minerals, machinery equipment, and precision instruments.[41] Taiwanese official surveys reveal that Taiwanese investors in China tend to invest in local distribution channels in order to penetrate into the very competitive markets in these industries. As shown in Table 3-3, many investing firms in these industries have set up marketing and R&D departments in the host country.[42]

[40] See Appendix for the derivation of the measures of the trend and volatility of real exchange rates.
[41] Our empirical results are basically the same when we use the top five industries instead of the top ten industries.
[42] See Investment Commission, Ministry of Economic Affairs, ROC. 1999-2003. *Survey on Taiwanese Firms in Mainland China*.

Table 3-3. Summary statistics

	Mean	Min	Max	Standard deviation
Real exchange rate	3.5313	2.6263	4.2271	0.4637
Real relative wage rate	0.0544	0.0150	0.1438	0.0273
Percentage of sales in China in total sales in a market-seeking industry	90.9%	46.2%	100.0%	15.5%
Percentage of reverse-imports in total sales in a reverse-importing industry	49.9%	25.0%	97.0%	26.0%
Percentage of subsidiaries with R&D and marketing departments in a high sunk cost industry	66.7%	40.0%	87.5%	17.5%

The market-seeking industry dummy, Mar_i, is defined as follows: If the percentage of an industry's sales in China in its total revenue is significantly greater than the weighted-average percentage of all industries at the 5% significant level, then the industry is referred to as market-seeking and the value of Mar_i is 1; 0 otherwise. Market-seeking industries in our sample include mining, construction, restaurant, transportation, and storage. Most of these industries belong to the service sector, in which most of their products are non-tradable, and the products of the mining industry are also known for their considerable transportation costs. Consequently, these industries tend to have high percentages of sales in China in their total revenue (see Table 3-3).

The reverse-importing industry dummy, Rev_i, is defined similarly as follows: If the percentage of reverse-imports of an industry from China in its total sales is significantly greater than the weighted-average percentage of all industries at the 5% significant level, then it is referred to as reverse-importing and the value of Rev_i is 1; 0 otherwise. It turns out that the reverse-importing industries in our sample are electronics & electric appliances and plastic products. Taiwanese official surveys reveal that there are high percentages of foreign subsidiaries and parent firms in these

two industries that have either a vertical or a horizontal relationship.[43] This implies that the cost consideration in these firms' decision to relocate their production activities is very important. The percentages of reverse-imports of these two industries from China are illustrated in Table 3-3.

4.2 Empirical results

Table 3-4 summarizes the results of the Tobit estimation of our empirical model. Six regression equations are estimated. In the first three equations shown in Columns 1, 2 and 3, Tsay's (2002) measures of the trend and volatility of real exchange rates are used while the measures estimated from a GARCH model are adopted in the other equations reported in Columns 4, 5 and 6.

Column 1 is our benchmark case in which the sunk costs dummy and industry dummies that control for investing motives are not considered. The results in Column 1 indicate that the coefficients of all the explanatory variables have a negative sign and are significant at the 5% level. These results reveal that overall the uncertainty in the exchange rate of RMB has had a negative impact while a depreciation of RMB and low relative wage rates in China have had a positive impact on Taiwanese firms' investment into China.

Column 2 attempts to test the relationship between sunk cost and the effect of exchange rate uncertainty. It indicates that both the coefficient of σ_t and that of $Sunk_i*\sigma_t$ are negative, but only the latter is statistically significant at the 5% level. These results suggest that exchange rate volatility would exert a significantly negative impact on the FDI activity of the Taiwanese industries only if those industries face

[43] See Bureau of Statistics, Ministry of Economic Affairs, ROC. 1999-2001. *Survey on Outward Foreign Direct Investment*.

considerable sunk investment costs.[44]

Table 3-4. Tobit estimation of the determinants of FDI

Equations / Explanatory variables	Tsay (2002)			GARCH (1,1)		
	(1)	(2)	(3)	(4)	(5)	(6)
R_{t-1} (β_1)	-0.0059[a] (-8.66)	-0.0059[a] (-8.72)	-0.0061[a] (-8.91)	-0.0057[a] (-8.59)	-0.0056[a] (-8.61)	-0.0058[a] (-8.73)
μ_t(β_2)	-0.0085[a] (-6.73)	-0.0085[a] (-6.75)	-0.0091[a] (-7.12)	-0.1972[a] (-6.51)	-0.1962[a] (-6.51)	-0.2117[a] (-6.89)
σ_t(β_3)	-0.0072[b*] (-2.30)	-0.0044[c*] (-1.31)	-0.0043[c*] (-1.32)	-1.0120[a*] (-3.56)	-0.8409[b*] (-1.83)	-0.8295[a*] (-2.85)
$Wage_{i,t-1}$(β_4)	-0.0079[b] (-2.31)	-0.0076[b] (-2.26)	-0.0096[a] (-2.94)	-0.0064[c] (-1.89)	-0.0061[c] (-1.83)	-0.0080[b] (-2.46)
$Sunk_i*\sigma_t$ (β_5)		-0.0146[b*] (-2.15)	-0.0147[b*] (-2.25)		-0.8874[c*] (-1.59)	-0.8870[c*] (-1.64)
$Mar_i* R_{t-1}$ (β_6)			0.0013[c*] (1.36)			0.0012 (1.27)
$Rev_i* R_{t-1}$ (β_7)			-0.0027[b*] (-1.94)			-0.0026[b*] (-1.85)
$Mar_i*\mu_t$(β_8)			0.0052[b] (2.57)			0.1252[b] (2.55)
$Rev_i*\mu_t$(β_9)			-0.0098[a*] (-3.61)			-0.2165[a*] (-3.29)
$Trend_t$	0.0009[a] (4.72)	0.0009[a] (4.70)	0.0010[a] (5.44)	0.0008[a] (3.89)	0.0008[a] (3.84)	0.0009[a] (4.52)
D_t	0.0045[a] (10.65)	0.0045[a] (10.74)	0.0045[a] (11.22)	0.0043[a] (10.14)	0.0044[a] (10.15)	0.0044[a] (10.62)
Wald test ($\beta_6 = \beta_7$)			6.50[a]			5.85[b]
Wald test ($\beta_8 = \beta_9$)			22.33[a]			19.68[a]
Likelihood ratio test	398.28[a]	399.62[a]	469.16[a]	398.71[a]	405.58[a]	469.36[a]

Notes: 1. Twenty-seven industry dummies are included in the regression equations, but their coefficients are not reported here. 2. Tsay (2002) and GARCH (1,1) represent two different measures of trend and volatility of real exchange rates. 3. The t-statistics are in parentheses; subscripts a, b and c denote that the test statistics are significant at the 1%, 5% and 10% confidence levels, respectively. 4. * represents the expected signs of some explanatory variables are known from the theoretical model in Chapter 2, a one-tail test is used.

[44] It is worth noting that, if sunk investment costs are zero, then the volatility would have no effect on the entry decision for risk-neutral firms. This is because the firm could decide whether or not to abandon the project at each moment of time without any opportunity costs. Consequently, the uncertainty is independent of the amount of FDI.

The estimation in Column 3 is used to test the differences in the impact of real exchange rates on market-seeking FDI versus reverse-importing FDI. All explanatory variables have the expected signs. The coefficients of Mar_i*R_{t-1} and $Mar_i*\mu_t$ are significantly positive, whereas those of $Rev_i* R_{t-1}$ and $Rev_i*\mu_t$ are significantly negative. Furthermore, Wald test statistics in the same column indicate that the null hypothesis - the coefficients of Mar_i*R_{t-1} and Rev_i*R_{t-1} are equal, or the null hypothesis - the coefficients of $Mar_i*\mu_t$ and $Rev_i*\mu_t$ are equal, is rejected at the 5% level. These results imply that, relative to market-seeking firms, the depreciation of a home country's currency is more likely to deter FDI activity of reverse-importing firms. It demonstrates that the effects of the real exchange rate on FDI indeed vary with its motives, as proposed in this thesis. In addition, the results in Columns 4, 5, and 6 show that the empirical results in Columns 1, 2, and 3 are not qualitatively sensitive to different measures of the trend and volatility of real exchange rates.

It is worth noting that, as shown in column 3 of Table 3-4, since the estimated coefficients for R_{t-1} and $Mar*R_{t-1}$ are -0.0061 and 0.0013, respectively, the total effect from R_{t-1} on market-seeking FDI seems to be negative. Similarly, the estimated coefficients for μ and $Mar*\mu$ are respectively -0.0091 and 0.0052, which also imply a negative total effect on market-seeking FDI. One possible reason for the estimated coefficient of R_{t-1} or μ to be negative is that exchange rate movements might exert negative impact on FDI activity through some other channels, such as the imperfect capital market hypothesis advanced by Froot and Stein (1991). Another reason is that it still has some degree of aggregation bias in industry-level data. Whereas this chapter uses the industry characteristics to demonstrate the importance of diversity of investing motives in investigating the effect of exchange rate movements on the FDI,

further research to examine the determinants of their total effects seems warranted.[45]

To sum up, the empirical findings of this chapter indicate that relative wage rates, the exchange rate level and its volatility have a significant impact on Taiwanese firms' outward FDI into China. In particular, the results reveal that China's low relative wage rates have been one of the important driving forces behind Taiwanese investment into China. Moreover, exchange rate uncertainty has had a negative impact on Taiwanese firms' FDI, particularly for those firms facing considerable sunk investment costs. Finally, the relationship between exchange rates and FDI vary with the motives of investing firms, which suggests that it is important to consider this fact in investigating the determinants of foreign direct investment.

5. Conclusion

This chapter empirically examines how exchange rate changes influence FDI activity. Industry panel data on Taiwan's outward FDI in China over the period 1991-2002 are employed to test the validity of the theoretical results. The empirical findings indicate that the exchange rate level and its volatility have had a significant impact on Taiwanese firms' outward FDI into China. In general, the empirical results are consistent with the prediction of the theory. These results imply that, relative to market-seeking industries, the depreciation of NTD is more likely to deter FDI activity of reverse-importing industries. In addition, the volatility of RMB to NTD has a negative impact on Taiwan's outward FDI into China regardless of whether the firm is market-seeking or reverse-importing. These results reveal that the relationship between exchange rates and FDI is crucially dependent on the motives of the

[45] One possible extension is to use firm-level data to incorporate the effect of firm heterogeneity into the empirical model.

investing firms. Without considering this fact in an empirical model, the testing results might suffer from aggregations bias.

Appendix 3-1. Data Description

The annual approved cases of Taiwan's outward FDI in China, $FDI_{i,t}$, classified into 27 industries according to their CCC code and SIC code for the period of 1991 to 2002, are compiled from "*Statistics on Overseas Chinese & Foreign Investment, Technical Cooperation, Outward Investment, Outward Technical Cooperation*," Investment Commission, Ministry of Economic Affairs (MOEAIC), ROC, 2004. China's real GDP of China is measured in 1995 prices in billions of RMB, which is compiled from the database of Taiwan Economic Journal (TEJ).

The level of the real exchange rate, R_t, is the average bilateral real exchange rate, expressed in units of NTD per RMB. It is calculated with a nominal exchange rate of NTD to USD, and that of RMB to USD, and it is deflated with Taiwan's CPI and China's CPI, respectively. The data are compiled from the AREMOS database, Ministry of Education, ROC (AREMOS).

The real relative wage index, $Wage_{i,t}$, defined as the ratio of the real annual average wage index of China over the real annual average wage index of Taiwan, is compiled from AREMOS. The base year is 2001, in which the value is 1.

Two measures of trend and volatility of the real exchange rate are used. First, μ_{Tasy} and σ_{Tasy} are defined respectively as a modified average and a modified standard deviation of the monthly changes in the log of the real exchange rate over the past 24 months; that is

$$\sigma_{Tasy,t} = \frac{1}{\sqrt{\Delta}}\left[\frac{1}{T-1}\sum_{j=1}^{T}\left(r_{t-j+1} - \frac{1}{T}\sum_{j=1}^{T} r_{t-j+1}\right)^2\right]^{1/2}, \quad \mu_{Tasy,t} = \frac{1}{T\cdot\Delta}\sum_{j=1}^{T} r_{t-j+1} + \frac{\sigma^2_{Tasy,t}}{2},$$

where $r_j = \log R_j - \log R_{j-1}$; $T = 24$; Δ is the space time interval, equal to $1/T$.

Second, a GARCH process is adopted to estimate the volatility. With data

covering the period from 1989:01 to 2002:12, we conduct the Augmented Dickey Fuller (ADF) test. The test result rejects the null hypothesis of unit root for $\Delta \ln R_t$. The estimated GARCH model is as follows:

$$\Delta \ln R_t = \ln R_t - \ln R_{t-1} = \underset{(-1.35)}{-0.0036} + u_t ,$$

$$h_t = \underset{(5.12)}{0.0008} + \underset{(3.84)}{0.7156} u_{t-1}^2 - \underset{(-3.96)}{0.0560} h_{t-1} ,$$

where $\Delta \ln R_t$ is the first difference of the real exchange rate; and h_t is the conditional variance of the error term u_t. The numbers in parentheses are t-statistics. Thus, μ_{GARCH} and σ_{GARCH} are defined respectively as

$$\sigma_{GARCH,t} = \left[\frac{1}{T} \sum_{j=1}^{T} h_{t-j+1} \right]^{1/2}, \mu_{GARCH,t} = \frac{1}{T} \sum_{j=1}^{T} u_{t-j+1} .$$

The monthly nominal exchange rates and CPI are compiled from the database of TEJ.

The data used to define sunk costs, market-seeking industries and reverse-importing industries are obtained from "*Survey on Taiwanese Firms in Mainland China*", 1999~2002, MOEAIC.