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STRATEGY BUILDING FOR FOREIGN EXCHANGE EXPOSURE

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ABSTRACT. *In the presence of deviations from parity conditions, the influence of foreign exchange rate variability extends beyond purely financial companies and now represents an important source of risk for non-financial corporations. Because it is a significant, developed country with a large influence on international trading, this study focuses on Japan and examines how foreign currency movements affect Japanese manufacturing companies. We find that 16% of 65 sample companies and 3 out of 6 sub-sectors of manufacturing industries experienced an economically significant effect due to exposure to the U.S. Dollar, the Chinese Yuan, or the European Euro from January 2002 to December 2007. Based on these findings, we propose a hedging method that uses real options analysis and a binomial decision tree model as a strategy for mitigating the impact of this exchange rate exposure. The results of a numerical example illustrate that options theory can provide useful financial hedges for the management of economic exposure by removing the adjustment costs or providing faster adjustment procedures, which can be used to manage economic exposure and thus to reduce risk.*

Keywords: Exposure; Foreign Currency; Real Options Analysis Corporation

1. Introduction. Among many of the factors that affect the uncertainty of investments, the exchange rate variability has become an important source of risk in a business for companies. Due to the parity conditions nowadays such as purchasing power parity and the international fisher effect, not only financial companies, but also non-financial corporations are confronted with risks from the impact of unexpected exchange rate variability on the value of the firm, particularly for companies with foreign currency-based activities, such as imports and exports. As a result, the risk management of currency exposure has been taken into consideration of a non-financial company to address both short-term and long-term exposures and encompass financial as well as operational hedges. Especially for multinational corporations, operational hedges that can be viewed as real options are used to manage the risk of foreign exchange rate variability.

Exchange rate exposure is an essential issue in financial management. Changes in exchange rates will influence the cash flow and ultimately the value of the firm. Chamberlain et al. (1997), He and Ng (1998) found that exchange rate exposure has a significant influence on the stock performance of banks and multinational corporations (MNCs). However, non-financial firms also face risk with economic exposure. Jorion

(1990) found that the percentage of foreign sales effect exchange rate risk on the stock price of nonfinancial firms, while Dukas et al. (1996) declared that firm size and Williamson (2001) showed market share played the major role in affecting nonfinancial corporations. Even though they do not face transaction exposure risk, they encounter economic exposure indirectly. This occurs because exchange rate fluctuations can cause price shifts in foreign currency.

In the absence of adjustment costs and lags, a risk-neutral firm prefers exchange rate uncertainty to fixed exchange rates, because they can benefit from the exchange rate variability by adjusting input and output decisions. However, in the real world, switching takes time and involves costs, but firms can still benefit as long as the adjustment lags and costs are not prohibitively high. It is important in risk measurement to distinguish between general and downside risk aversion (the desire to reduce a firm's default risk or costs of financial distress or to protect investors against exchange rate-related losses).

Two main research questions are examined in this paper. First, this paper examines whether there is any relationship between the stock returns of Japanese manufacturing firms and fluctuations in the currency values of Japan's major trading partners, and whether or not these exchange risk exposure patterns are both firm-level and industry-specific. This paper uses firm-level monthly data to investigate the foreign exchange exposure of Japanese non-financial manufacturing corporations listed on the Tokyo Stock Exchange for the continuous period from January 2002 through December 2007. It is of interest to consider the exchange rate exposure of Japanese corporations, since Japan is an open and highly developed country and Japanese firms have a high foreign debt ratio.

Second, the significant finding of exchange rate exposure in three subsectors of the manufacturing sector gives management a picture of how to reduce the risk of exchange rate fluctuations. Madura (2000) mentions that inflation rate, interest rate, earnings level, government control, and market expectation are five primary factors that influence the level of an exchange rate. In foreign exchange risk management, it is in fact difficult to forecast results accurately, due to many unquantifiable influencing factors. Depending on the analysis of risks that firms face from foreign currency exposure, a corresponding hedging policy is proposed by introducing a real options method and a binomial decision tree model, as most firms can change between their home currency and foreign currency after a certain adjustment period or by incurring adjustment costs. The result indicates that options theory can provide useful financial hedges for managing economic exposure by removing the adjustment costs, which can be used by manufacturing industries to manage their economic exposure and thus reduce risk.

The remainder of this paper contains the following: Section 2 provides a background of currency exposure; Section 3 analyzes the influence of exposure in Japanese industries, with some industries being naturally heavily affected, while others experience little influence; Section 4 discusses strategic decision-making in light of real options analysis for managing currency risk exposure. Finally, conclusions are drawn in Section 5.

2. Literature Review.

2.1. Empirical Evidence. Economic exposure is defined as the influence of exchange rate fluctuations on the present value of expected business cash flow. Economic exposure is much more important for shareholder value in the long term compared with transaction exposure and/or translation exposure. Shapiro (1975) concluded on his research that the main determinants of exchange rate risk are the proportion of foreign sales, the substitutability of production factors, and the level of intensity of competition. Corporations with a high proportion of foreign sales, or with direct foreign investment, will experience significant exposure to exchange rate fluctuations. Adler and Dumas (1984) illustrate that exposure to exchange rate risk is similar to that of market risk measured in the traditional sense. Therefore, the average exposure to exchange risk can be obtained by regressing the stock returns on the changes of exchange rates.

Until now, many researchers have done a large number of empirical studies analyze the foreign exchange rate exposure of nonfinancial corporations. Bartram and Karolyi (2006) found that the foreign exchange rate exposure of nonfinancial firms is systematically related to firm characteristics, regional factors and industry characteristics. Jorion (1991) found a significant impact of foreign exchange rate risk on stock prices for only 5.2% of the analyzed 287 U.S. multinationals at the 5% level. While Choi and Prasad (1995) showed that 14.9% of the individual firms in the United States and 10% of the industry portfolios show a significant foreign exchange rate exposure at the 10% level. He and Ng (1998) found that from 1979 to 1983, 25% of 171 Japanese MNCs' stock returns were impacted by significant foreign exposure. Bodnar and Gentry (1993) examined industry-level exposures for Canada, Japan, and the U.S. They found that 20% to 35% of industries in Canada, Japan, and the U.S. displayed significant exchange rate exposure. Booth and Rotenberg (1990), Chan (2002) also found significant exposure to exchange rates in both companies and industries.

2.2. Foreign Exchange Exposure Measurement. In determining the extent of exposure, much of the research on exchange rate exposure employs variations of a model in which an individual stock return is regressed on a foreign exchange rate variable, see for example, the work of Dumas (1978), Hodder (1982) and Adler and Dumas (1984). In each case, the coefficient of the foreign exchange variable is interpreted as the firm's exchange rate exposure. Kent and Shapiro (1984) used a cash study method to assess the impact of foreign exchange risk, and their study uses the present value of cash flow as the primary determinant of the firm's value, in order to gauge exposure. The formula is written as follows:

$$\mathrm{CF_t} = \alpha + \beta \mathrm{FX_t} + \varepsilon_\mathrm{t} \tag{1}$$

where $\mathrm{CF_t}$ is the cash flow of the company at time t, $\mathrm{FX_t}$ the percentage of exchange rate movement within period t, and ε_t the error.

Adler and Dumas (1984) defined exchange rate exposure as the effect of exchange rate fluctuations on the value of an asset. The exposure is calculated by regressing stock returns with respect to exchange rate changes. The regression formula is expressed as follows:

$$\mathrm{R}_{\mathrm{it}} = \beta_{\mathrm{i0}} + \beta_{\mathrm{ix}} \mathrm{FX}_{\mathrm{t}} + \varepsilon_{\mathrm{it}} \tag{2}$$

where R_{it} is the stock return of firm i at time t, FX_{t} the percentage change in an exchange rate variable at time t, and β_{ix} the measure of exposure of firm i.

Bodnar and Wong (2003) reformulated the model by including a stock market portfolio in the regression model, and estimate R_{it} as:

$$\mathrm{R}_{\mathrm{it}} = \alpha_{\mathrm{i0}} + \beta_{\mathrm{im}} \mathrm{R}_{\mathrm{mt}} + \beta_{\mathrm{ix}} \mathrm{FX}_{\mathrm{t}} + \varepsilon_{\mathrm{it}}, \tag{3}$$

where R_{it} is the stock return of firm i at time t, FX_{t} the percentage change in an exchange rate variable at time t, and R_{mt} the return on domestic market portfolio at time t.

3. Exposure Measurement in Japanese Manufacturing Industries. Methodology: With regard to the first research question as mentioned in Section 1, the following model is developed to identify whether manufacturing industries in Japan have significant exposure. The Japanese Yen (JPY) exchange rates against the U.S. Dollar (USD), Chinese Yuan (CNY) and European Euro (EUR) are identified as the independent variables, and the stock return of the firm is identified as the dependent variable**.** Mathematically, the above issue can be expressed in the following model:

$$\mathrm{R}_{\mathrm{it}} = \beta_{\mathrm{i0}} + \beta_{\mathrm{USD}} \Delta\mathrm{FX}_{\mathrm{USD}} + \beta_{\mathrm{EURO}} \Delta\mathrm{FX}_{\mathrm{EURO}} + \beta_{\mathrm{CNY}} \Delta\mathrm{FX}_{\mathrm{CNY}} + \varepsilon_{\mathrm{it}} \tag{4}$$

where Rit is the stock return for firm i at time t, FXUSD, FXEURand FXCNY are the percentage changes in the USD, CNY and EUR exchange rate at time $t-1$, respectively. $\beta_{\mathrm{USD}}, \beta_{\mathrm{EURO}}$, β_{CNY} are the estimates of USD, EUR and CNY exposure, respectively, and $\varepsilon_{\mathrm{it}}$ is the standard error. The regression model will produce some value for β_{i0}, β_{USD}, β_{EURO} and β_{CNY}. The regression coefficient β_{i0} will illustrate the extent to which the exchange rate movements affect a firm’s value.

However, because of an omitted variable problem, the estimates of the exposure coefficients could be biased. For example, there may be factors that simultaneously affect stock returns and exchange rates but have nothing to do with exposure. Suppose there is a reduction in interest rates, which simultaneously stimulates the economy and lowers the exchange rate. Since stock returns rose due to the stimulation from lower interest rates, and simultaneously exchange rates fell, it may appear that there is a direct relationship between stock returns and exchange rates--when in fact there is not.

In order to solve the problem, following the work of Adler and Dumas (1984), the above issue can be expressed mathematically by the following model:

$$\mathrm{R}_{\mathrm{it}} = \beta_{\mathrm{i0}} + \beta_{\mathrm{USD}} \Delta\mathrm{FX}_{\mathrm{USD}} + \beta_{\mathrm{EURO}} \Delta\mathrm{FX}_{\mathrm{EURO}} + \beta_{\mathrm{CNY}} \Delta\mathrm{FX}_{\mathrm{CNY}} + \beta_{\mathrm{mt}} \mathrm{R}_{\mathrm{mt}} + \varepsilon_{\mathrm{it}} \tag{5}$$

where R_{mt} is the market return, and all the other terms are as before.

However, the market portfolio is simply an aggregation of the individual stocks, and if the individual stocks are exposed, then the market is exposed. Therefore, R_{mt} is the exposure of stock *i* over and above that of the market portfolio. However, if the stock has the same exposure as the market portfolio, then the equation above would result in the conclusion that the exposure of stock *i* is zero, but since the market return contains a currency exposure component, this would be incorrect.

To solve the problem, we used the Nikkei 225 composite index in this research, for market returns from monthly stock price changes. A composite index consists of many constituents averaged to form a product representative of an overall market or sector, and thus provides a useful statistical measure of the overall market or sector performance over time. For example, the Nikkei 225 index is a market capitalization-weighted grouping of 250 stocks listed on the Tokyo Stock Exchange and represents 36 industry groupings. Indices are useful tools for measuring and tracking changes in price levels for an entire stock market or sector. Therefore, they provide a useful benchmark against which to measure an investor's portfolio. The goal of a well-diversified portfolio is usually to outperform a selected major composite index that is used as a benchmark.

Research Variables**:** This research employs five variables, namely, a dependent variable and four independent variables. The dependent variable is the average returns of company stocks, and the independent variables are (1) change in the JPY–USD exchange rate, (2) change in the JPY-CNY exchange rate, (3) change in the JPY-EUR exchange rate and (4) market returns.

The stock returns used in this research are obtained from the difference between today's stock price (closing price) and yesterday's. The stock returns are obtained in the following formula:

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \qquad (6)$$

where:

Rit = stock returns of company i for period t,

Pit = stock closing prices of company i for period t, and

Pit-1 = stock closing prices of company i for period t – 1.

The average stock returns of the manufacturing industry are obtained from averaging individual stock returns, which can be obtained by formula (6) above; otherwise, it can also be obtained directly from the following formula:

$$\overline{R_{it}} = \frac{\sum_{1}^{N} R_{it}}{N} \qquad (7)$$

where:

$\overline{R_{it}}$ = average stock returns of the manufacturing industry for period t,

Rit= individual stock return of manufacturing firm for period t,

N = the number of manufacturing sample firms.

The JPY – USD, JPY—CNY, JPY – EUR exchange rates were obtained from Bank of Indonesia’s data monthly. The changes in these exchange rates are calculated using the formula below:

$$\Delta FX_{st} = \frac{FX_{st} - FX_{st-1}}{FX_{st-1}} \qquad (8)$$

where:

ΔFXst = change in JPY-USD, JPY-CNY, JPY-EUR exchange rates, respectively for period t,

FXst = JPY-USD, JPY-CNY, JPY-EUR exchange rates, respectively, for period t,
FXst-1= JPY-USD, JPY-CNY, JPY-EUR exchange rates, respectively, for period t-1,

Market returns are obtained from the changes in the monthly stock price composite index. They are computed by the formula below:

$$R_{Mt} = \frac{Nikkei225_t - Nikkei225_{t-1}}{Nikkei225_{t-1}} \tag{9}$$

where:

R_{Mt} = market returns for period t

Nikkei225t= stock price composite index for period t

Nikkei225t-1 = stock price composite index for period t – 1

TABLE 1. Influence of exchange rate exposure in Japanese industries

Industry	Constant	Exchange rate exposure coefficient			R-Sqr
		USD	EUR	CNY	
Pharmaceutical	-0.002	-0.428**	0.595**	-0.305	0.425
Metal & Non-metal	0.008	-0.175	-0.172	0.092	0.766
Electronic	0.001	0.802**	-0.519	0.264	0.770
Food & beverage	0.003	-0.041	0.147	0.431**	0.382
Machinery	0.015	0.023	-0.320	-0.021	0.731
Textile	0.006	-0.065	-0.318	0.079	0.611

Note: Exchange rate exposure coefficients that are significant at 5% level.

(1) Data Description: In this paper, the nominal exchange rate is measured by the Japanese yen/U.S. dollar, Japanese yen/Chinese Yuan, Japanese yen/European dollar exchange rates (see Figure 1). The data comes from Statistics Bureau of Japan. It is of interest to consider the exchange rate exposure of Japanese manufacturing corporations, since Japan has an open economy, and Japanese firms have a high foreign debt ratio ((exports+imports)/GDP ratio).

The sample firms are limited to manufacturing companies listed on The Nikkei Stock Average (Nikkei 225). The sample consists of 64 companies, with complete information on the stock prices and financial statements providing data on the variables we use, for the entire period from 2002:01 to 2007:12.

A monthly return horizon is used in this paper, following the prevalent argument in the literature that the use of weekly or daily data may understate the true extent of exposure. As Bartov and Bodnar (1994) argue, because of the complexity of modeling the effect of exchange rate on firm’s future cash flow, stock prices do not respond immediately to changes in exchange rates. Chow et al. (1997) argue that a longer return horizon, such as a month or more, can make the exposure of firms becomes more detectable.

Following the models developed to answer the research hypothesis, the data used in this study are gathered from a range of sources.

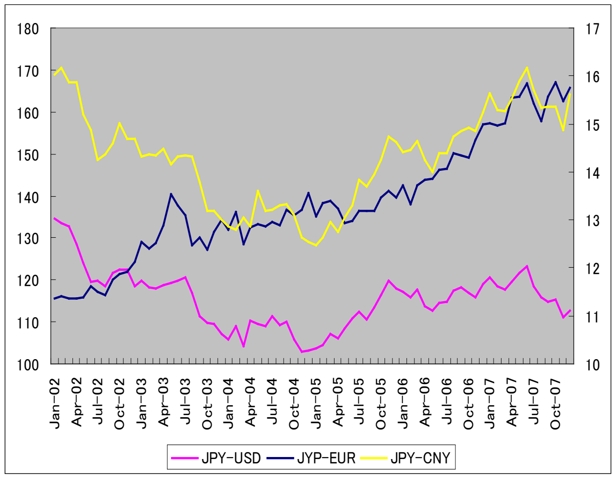

FIGURE 1. Real exchange rate of JPY against USD, EUR and CNY

(2) Empirical Testing and Analysis: As explained in the methodology section, the extent to which JPY fluctuations impact manufacturing industries is investigated by measuring the impact of the three currencies of Japan's major trading partners, namely the USD, EUR, and CNY. The real exchange rate of JPY against USD, EUR and CNY is shown in Figure 1. And the results produced by this model are reported in Table 1.

From Table 1, because the p-value of the exchange rate is lower than the level of significance (α = 0.05), it can be concluded that there is significant exchange rate exposure in the food & beverage, pharmaceutical and electronic industries within the period. The coefficients of exchange rate variables are positive for food & beverage and electronic industries. This shows that, ceteris paribus, the correlation with the dependent variable is reciprocal, indicating that for every 1% increase in the value of CNY, there will be increases of 0.431% and 0.802% in share price appreciation for the food & beverage and electronic industries, respectively. The pharmaceutical industry has USD and EUR exposure, but the coefficient of the JPY/USD exchange rate variable is negative. The correlation with the dependent variable is reciprocal, indicating that, ceteris paribus, for every 1% increase in the value of the USD, a 0.428% decrease in stock return occurs for the pharmaceutical industry. The coefficient of the JPY/EUR exchange rate variable is positive, showing that the correlation with the dependent variable is reciprocal, meaning that, ceteris paribus, for every 1% increase in the value of the USD, a 0.595% increase in share price occurs in the pharmaceutical industry.

Generally, all models have relatively high R^2 values of around 40–80%. This means that the models can explain 40–80% of the variations in the share price performance of Japanese manufacturing companies, with the rest explained by other factors affecting share prices, but not captured by the model. The models also show that there are variations in exposure among the samples. Regarding the high percentage of the companies exposed to the USD, EUR, or CNY, the results show that the samples are jointly exposed as a group (exposure at the industry level) to those three currencies.

Based on the research at the firm level, see Table 2, about 5% of the 65 manufacturing firms experienced economically significant effects from exposure to the USD (all 3 firms had significant positive exposure coefficients), 6% to the CNY (all 4 firms had significant positive exposure coefficient) and 5% to the EUR (all 3 firms had significant positive exposure coefficients). Since the extent of exchange rate exposure is relatively low, this points to the fact that firms, especially multinational firms, are likely to have access to both financial and operational hedging strategies. The positive coefficients suggest that appreciation of the USD, CNY and EUR against the JPY has a positive impact on Japanese

TABLE 2. Summary of the impact of currency exposure in Japanese industries

Industry	of firms	Summary of Statistics					
		USD exposure		CNY exposure		EUR exposure	
		N(+)*	N(-)*	N(+)*	N(-)*	N(+)*	N(-)*
Food & Beverage	12	0	0	2	0	0	0
Textile & apparel	7	0	0	0	0	2	0
Pharmaceutical	7	0	0	1	0	1	0
Electronic	12	2	0	0	0	0	0
Machinery	13	0	0	0	0	0	0
Metal & Non-metal	14	1	0	1	0	0	0
Total	65	3	0	4	0	3	0

Note: N(+)* reports the number of firms with positive coefficients that are significant at the 5% level. N(-)* indicates the number of firms with negative coefficients that are significant at the 5% level.

Stock returns, in other words, the share price valuations of Japanese manufacturing are positively affected by the appreciation of these currencies.

The outputs show that some samples are exposed to a time-lagged exchange rate of certain currencies by using a time-lagged rate, the low utilization of hedging techniques in many firms also contributes to the firms' sensitivity to exchange rate fluctuations.

3. Strategy Building for JPY/CNY Currency Exchange.

3.1. Financial Hedging. Different companies have different approaches to managing foreign exchange risk, though they usually take one-sided hedges, such as options, swaps, forward contracts, etc, to avoid adverse effects, in the face of macroeconomic shocks to their industry, trade volumes, geographical markets and market power. To avoid downside risk and practice good risk management, companies should measure their foreign exposure, identify all the components of their business that are exposed to foreign exchange risk, and then calculate what will happen if the currency to which they have significant exposure appreciates or depreciates by a certain amount against their own currency.

Jorion (1991) defined exchange rate exposure as the sensitivity of the value of the firm to exchange rate randomness. The finding of significant exchange rate exposure in three sub-sectors of the manufacturing sector gives management a picture of how to reduce the risk of exchange rate fluctuations. For example, implementing more efficient use of imported raw material, applying proper hedging techniques, and expanding the market to foreign markets are some strategies that firms can use to reduce and more effectively manage their risk.

In this research, we suppose that firms consider the timing of payables and receivables in order to implement the most suitable foreign exchange rate risk management. As Snijders

(1989) addressed, the greater the firm's ability to react, the shorter is its adjustment lag, translating into lower adjustment costs. We also suppose that a company with adjustable cash flows has the choice of whether to purchase inputs and pay in the home currency (HC) or to pay in foreign currency (FC), or even the ability to switch between HC and FC under certain conditions (1997). In the above situation, with sufficiently low adjustment costs and lags, managers can exploit the variability of the company's real profit and thus apply the corresponding policy to its investment and business activities. However, the elements that can result in the fluctuation of exchange rates are complicated and difficult to forecast.

3.2. General Methodology.

3.2.1. Real Options Analysis. A real option refers to a real investment, in which the owner of the option has the right, but not the obligation, to acquire the present value of expected cash flows by making an investment when the opportunity is available.

Real options analysis is an application of a discrete-time financial option valuation model that attempts to quantify the values of options. In another words, it applies the techniques of option valuation to capital budgeting exercises in which a project is coupled with a put or call option. For example, the firm may have the option to abandon a project during its life. Ignoring the cash flow associated with the project, which is the value of real options (as in standard discounted cash flow techniques) can lead to incorrect investment evaluation decisions. Under the assumption of investment reversibility, the net present value (NPV) rule implicitly assumes that "either the investment is reversible" or "if the investment is irreversible, it is a now or never proposition" ,Dixit and Pindyck (1994).

Nowadays, real options analysis has been widely used by companies considering investment decisions. Traditionally, the Discounted Cash Flow (DCF) method is probably the most widespread and commonly established method to quantify the value of an investment within a corporation. On a high level, option valuation models can be divided into continuous and discrete-time models.

A continuous model assumes an infinite number of steps between now and the future, and that the variations in the underlying asset follow a specified statistical distribution. The Black-Scholes option formula is the classical continuous model, which uses the variables defined in the following way following Bodie and Merton (2000):

$$C=N(d_1)S-N(d_2)Ee^{-rT} \tag{10}$$

$$d_1=\frac{In(S/E)+\frac{(r+\sigma^2)}{2}}{\sigma\sqrt{T}} \tag{11}$$

$$d_2=d_1-\sigma\sqrt{T} \tag{12}$$

where E = expenditure required to acquire the project's assets; r = risk-free rate of return; T = length of time the decision may be deferred. Amram and Kulatilaka (1996) offer the following interpretation for the groups of terms on the right-hand side of equation 1: $N(d_1)S$ represents the expected value of the current underlying asset, if the current value is greater than the investment cost at expiration. $N(d_2)S$ represents the risk-neutral probability that the current value of the underlying asset will be greater than the cost of investment at expiration. Finally, Ee-rT represents the present value of the cost of investment.

3.3.2. Binomial Options Pricing Model. A binomial pricing model uses a "discrete-time framework" to trace the evolution of the option, under the condition that the prices of a stock can either appreciate or depreciate over the period.

Each node in the lattice represents a possible price of the underlying, at a particular point in time. This price evolution forms the basis for the option valuation.

The valuation process is iterative, starting at each final node, and then working backwards through the tree to the first node (valuation date), where the calculated result is the value of the option.

Option valuation using this method is, as described, a three-step process:

(1) price tree generation;

(2) calculation of option value at each final node;

(3) Progressive calculation of option value at each earlier node; the value at the first node is the value of the option.

A pricing tree diagram is formulated by working forward from the valuation date to expiration. At each step, it is assumed that the underlying instrument will move up or down by a specific factor (u or d) per step of the tree (where, by definition, $u \geq 1$ and $0 < d \leq 1$). Therefore, if S is the current price, then in the next period the price will either be

$$S_{\mathrm{up}} = S \cdot u \quad \text{or} \tag{13}$$

$$S_{down} = S \cdot d\ . \tag{14}$$

The up and down factors are calculated using the underlying volatility σ and the time duration t in years of a step (using the day count convention of the underlying instrument). From the condition that the variance of the log of the price is $\sigma^2 \mathrm{t}$, we have

$$u = \exp(\sigma\sqrt{t})$$

$$d = \exp(-\sigma\sqrt{t}) = 1/u\ ,$$

where σ is the underlying volatility, and t is the time duration in years of a step.

The above can be obtained from the original Cox, Ross, & Rubinstein (CRR) method (1979). The binomial tree model has underlying relations with the classic Black-Scholes (B-S) models, which is the core of real option analysis.

3.4. Effect of JPY/CNY Exchange Rate Variability. According to a recent report from the Japanese finance ministry, in 2006, China replaced the U.S. as Japan's largest trading partner. Japan's trade with China was valued at 25.4276 trillion Yen, while its trade with the U.S. was valued at 25.1608 trillion Yen. China is also the largest importer of goods from Japan. In 2002, China was responsible for 38% of Japan's economic growth, but in 2006, this rate reached 68%. China's fast economic growth is the main reason for Japan's export surplus with China. The value of the China-Japan trade is shown in Figure 2.

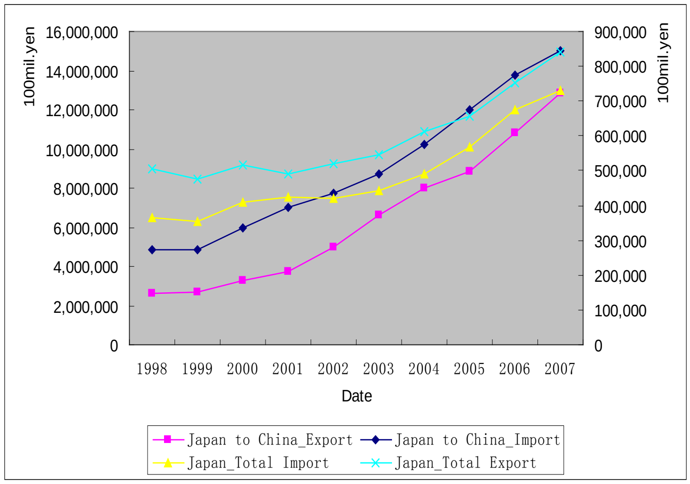

FIGURE 2. Trade between Japan and China

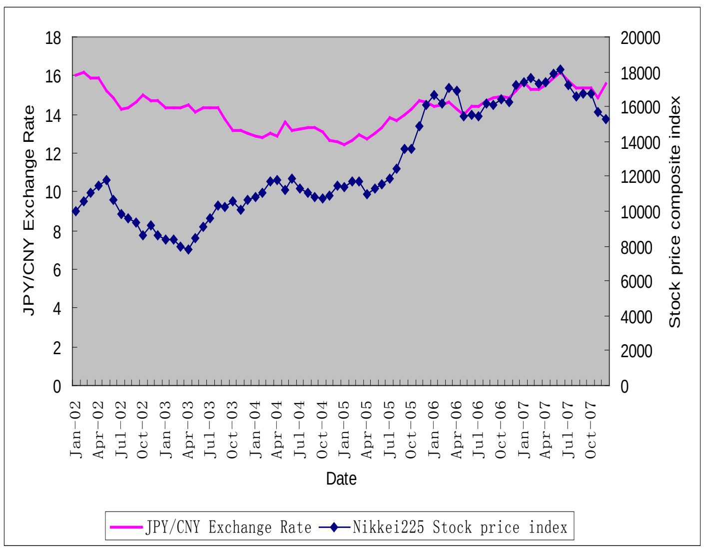

FIGURE 3. Exchange rate variability of JPY / CNY and Nikkei225 stock price composite index

Since July 21, 2005, Chinese Yuan policy reform has ushered in a new exchange rate system in China. Subsequently, the appreciation of the CNY has also promoted an increase in Japanese exports to China. The international situation has changed fundamentally, impacting imports and exports as well, as China is one of the biggest production countries in the world. Based on the analysis of the currency exposure of Japanese manufacturing industries, it is meaningful to use the CNY as an example to analyze the hedging practices of Japanese companies; the exchange rate variability of JPY/CNY and the Nikkei225 stock price composite index is shown in Figure 3.

Changes in the Nikkei 225 composite index are used in this research to get market returns, which are obtained from changes in the monthly stock price composite index. The market value of a firm is the present value of its expected future cash flows. The impact of exchange rate variability on a firm's operation is as follows:

(1) Exchange rate fluctuations are relevant to a company: for example, price fluctuations between JPY and CNY may have a real impact on the trade between Japanese and Chinese firms. In another words, the payment terms, as determined by the contract, will actually see an increase or decrease in real payment as exchange rates fluctuate.

(2) A company should reduce its exposure based on the extent to which exchange rate changes will affect the firm’s performance. For example, a firm’s total cash flow in terms of the Home Currency in a given period is affected by depreciation (appreciation) of a Foreign Currency; suppose this effect is negative.

As described above, people often forecast the direction of currency changes in order to reduce risk and derive more benefit. However, accuracy in forecasting is based on the timeliness of the data and the conditions under which the forecast is made. For example, a forecast made on January 1, 2007 for a real exchange rate on January 1, 2010 is less precise and more uncertain than on January 1, 2009. The reason is that updated information will become available in the interim, such as additional real exchange rate observations.

In the absence of adjustment costs and lags, a risk-neutral firm prefers exchange rate uncertainty to fixed exchange rates, because it can benefit from exchange rate variability by adjusting input and output decisions. However, in the real world, switching takes time and involves costs, but firms can still benefit as long as adjustment lags and costs are not prohibitively high. It is important in risk management to distinguish between general and downside risk aversion (risk aversion in order to reduce the firm’s default risk or costs of financial distress, or to protect investors against exchange rate related losses).

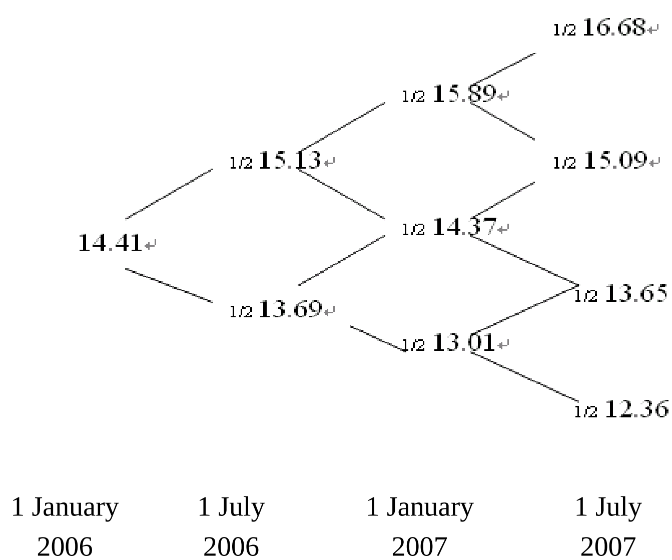

FIGURE 4. Exchange rate path--PY to CNY

3.5. Numerical Calculation. Exposure to exchange rate risk is a complex problem that requires further discussion. However, a simple numerical example is illustrated here - a project between Chinese and Japanese companies, with a payment scheme as follows:

(1) The project is divided into half-year phases, and after each phase, the Japanese

company will pay for the following phase. The currency used for payment can be either JPY or CNY.

(2) The firm should reduce its exposure as it determines the extent to which exchange rate changes affect the firm's performance.

The associated data is as follows:

(1) Payments made on January 1, 2006, July 1, 2006, January 1, 2007, and July 1, 2007 are set to be one million Yen if JPY is the chosen currency, or 69,400 Yuan if CNY is the chosen currency, based on the exchange rate of 14.41 on January 1, 2006.

(2) For simplicity, the real exchange rate is assumed to be 14.41 on 1 January and follow a basic 5% change. The probabilities of appreciation and depreciation are set to be equal, both with a 50% probability.

TABLE 3. Cost minimizing decision at each real exchange rate

Real exchange rate	Currency used	The money will be paid (Unit: thousand JPY)	Paid by switching to alternative strategy (Unit: thousand JPY)
Decisions with greater benefit - Next 1 July			
16.68	CNY	1157.6	1100
15.09	CNY	1047.2	1100
13.65	CNY	947.3	1100
12.36	CNY	857.8	1100
16.68	JPY	1000	1257.6
15.09	JPY	1000	1147.2
13.65	JPY	1000	1047.3
12.36	JPY	1000	957.8
Decisions with greater expected benefit - Next 1 January			
15.89	CNY	2176.4	2100
14.37	CNY	1994.6	2100
13.01	CNY	1805.5	2078.9
15.89	JPY	2000	2276.4
14.37	JPY	2000	2094.6
13.01	JPY	1978.9	1905.5
Decisions with greater expected benefit on 1 July			
15.13	CNY	3597.8	3100
13.69	CNY	2850.2	3052.8
15.13	JPY	3000	3697.8
13.69	JPY	2952.8	2950.2
Decisions with greater expected benefit on 1 January			
14.41	CNY	3975.1	4075.1
14.41	JPY	3975.1	4075.1

Note: The decisions which should be chosen to maximize benefits are in bold text

(3) The cost of adjustment from one currency to the other is 100,000 Yen. The binominal process of the real exchange rate variability is shown in Figure 4.

The probability distribution of the input costs, and hence the risk implications of cost minimization, can be obtained by eight possible future exchange rate paths, as shown in Figure 2, and thus determine a cost-minimizing decision in each case, as shown in Table 3.

In the simple binominal tree, there are eight different possible paths of exchange rate fluctuation with the possibility of both appreciation and depreciation. If payment is in JPY, when the JPY depreciates against the CNY, a Japanese company's actual payment is less if the CNY is used, and vice versa. Therefore, in order to decrease the risk the company will face due to fluctuations in exchange rates, and to be more competitive, the method of binominal options analysis and real options analysis should be taken into consideration.

TABLE 4. Decision of Japanese company in the change paths

The change path of exchange rate	For Japanese Company	
	Use JPY currency (thousand Yen)	If greater benefit, change to CNY (thousand Yen)
14.41—15.13—15.89—16.68	4000	Change is not more beneficial
14.41—15.13—15.89—15.09	4000	
14.41—15.13—14.37—15.09	4000	
14.41—15.13—14.37—13.65	4000	
14.41—13.69—14.37—15.09	4000	4094.6
14.41—13.69—14.37—13.65	4000	3994.7 (change in 1 July)
14.41—13.69—13.01—13.65	4000	3900.3 (change in 1 July)
14.41—13.69—13.01—12.36	4000	3810.8 (change in 1 July)

From Table 4, we can learn the following:

Firms with relatively low adjustment costs benefit from real exchange rate uncertainty. Table 4 shows that the expected input costs for a firm that switches optimally are 3.9947 million Yen regardless of its initial strategy, and follows the path of 14.41—13.69—14.37—13.65, whereas a firm that starts with Japanese Yen inputs and sticks to that currency regardless, pays a pre-determined 4.0 million Yen. Adjustment costs should be assessed relative to the degree of uncertainty. With different periodical changes in the real exchange rate, the optimal method (to switch or not) will vary. Risk-reduction can be given explicit priority. Exchange rate-induced losses may be lowered by investing mainly in a smooth transition from the FC to the HC strategy.

However, this is only a simple model, as the actual exchange rate variability will be different, and when the ratio of appreciation and depreciation is different, the results will be different. However, the variability of exchange rates is essential to the development of the international market environment, and the binominal method is a useful tool.

4. Conclusions. When the Bretton Woods system of fixed exchange rate unraveled during the 1970s, foreign exchange rate exposure expand to be an important source of risk not only for financial corporations, but also for non-financial corporations. For example, in year

2001, Toyota reported a 2.5 billion Yen operating loss in Europe because of the change of current Euro against Yen. These spectacular losses of non-financial corporations showed us the importance of managing economic exposure, which is to exploit the variability of exchange rates in order to increase a firm's market value, while ensuring that the downside risk of exchange rates remains sufficiently small. In this research, we took Japan manufacturing industries for example and two main research questions are examined in this paper.

First, this paper examines whether there is a relationship between Japanese manufacturing firm's stock returns and fluctuations in the currency values of the Japan's three major trading partners. We find that about 16% of these firms experienced an economically significant positive effect with exposure to the U.S. Dollar, Chinese Yuan and European Euro (among them, 5% of these firms have significant exposure to the U.S Dollar, 5% to the Chinese Yuan and 6% to the Euro). At the industry level, three sub sectors within Japan's manufacturing industry (pharmaceuticals, electronic, foods and beverage industries) had significant currency exposure from January 2002 to December 2007. The pharmaceutical industry was exposed to the USD and EUR, and the impact of the fluctuations was negative. As the JPY depreciated against the USD or EUR, the manufacturing firms' value would decline. The electronics industry, and food and beverage industry were significantly influenced by USD and CNY, respectively. However, the impact of these fluctuations was positive. The coefficients of exposure also vary for each currency and manufacturing industry. These coefficients of exposure for the USD range from -0.428 to 0.802, for the EUR from -0.519 to 0.595, and for the CNY from -0.305 to 0.431. The results also show that the samples are jointly exposed as a group (exposure on the industry level) to those three currencies.

Even though at the firm level, firms face risk with significant positive exposure, at the industry level, the pharmaceutical industry is negatively exposed to the USD and EUR. As Choi and Prasad (1995) and Dominguez and Tsar (2001) pointed out, firms within an industry group are not necessarily homogeneous in their operational characteristics or in their financial strategies, and movement in exchange rates may lead to offsetting effects within an industry. The result may be partly because firms within the same industry group may possess both positive and negative exchange risk exposure, so aggregating across such firms may result in finding an insignificant exposure coefficient for the industry group.

Second, a hedging policy is proposed by investing in lower adjustment costs or faster adjustment procedures. In practice, real exchange rates take a long time to revert to their Law of One Price levels. Therefore, a firm involved in an import/export business can employ a strategy of switching between a home currency and a foreign currency, and be more effective at hedging than a firm that has only access to one strategy. It was shown that by investing in lower adjustment costs or faster adjustment procedures, the firm can attain its dual objective of raising expected cash flows and limiting the downside risk of exchange rate changes. In particular, if the exchange rate uncertainty is high, the firm should consider measures that facilitate future adjustments in its cost and revenue structures.

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