A New Framework for Currency Strategy — The Fusion of Fundamental Analysis and Financial Engineering

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1. Introduction

Amid the dismal domestic environment for asset management — including the lowest interest rates on record and a floundering stock market — investment in foreign currency denominated assets with higher expected returns is becoming an increasingly important alternative. However, since these assets entail exchange rate risks, risk management plays a critical role in investment performance. In other words, the first step in successfully managing foreign assets is to be able to predict exchange rate trends and control exchange rate risks in an appropriate manner.

To fulfill this need, NLI Research Institute has developed a new analytical approach to foreign exchange that combines the long-term perspective of fundamentals analysis, and the short-term perspective of financial engineering based on quantitative analysis. This fusion overcomes the shortcomings of either method alone by revealing short-term exchange rate movements as well as long-term trends.

The integrated currency strategy consists of: (1) currency strategies based on fundamentals data with a one to three year perspective, and (2) currency tactics with a one-month to one-year perspective. We begin with an examination of foreign exchange characteristics, on which the integrated currency strategy is based.

2. The Risk-Return Characteristic of Foreign Exchange

(1) Foreign Exchange Risk

The common perception of foreign exchange risk is that it is quite large. But this is not necessarily true from a long-term perspective. In fact, the risk is smaller than for some assets. Figure 1 compares the long-term standard deviation of monthly returns for foreign exchange, stocks, and bonds. It shows that foreign exchange is riskier than bonds, but far less risky than stocks.

Figure 1 Risk Comparison of Foreign Exchange, Stocks, and Bonds

	Japan	U.S.	U.K.	Germany	France
Stocks	19.1%	15.3%	16.8%	17.9%	20.3%
Bonds	7.4%	8.7%	9.2%	6.2%	6.1%
Foreign exchange	$ / ¥	Euro / ¥	£ / ¥	A$ / ¥	C$ / ¥
	12.7%	11.2%	12.4%	14.7%	13.1%

Notes: (1) Shows annualized standard deviations of monthly returns from January 1980 to June 2001 (except for bonds for Japan and France, which start in February 1985). (2) Stock data was obtained from Datastream's total market return index, bond data from Datastream's 10-year government bond return index, and exchange rate data from closing rates in London. (3) For the euro/yen prior to 1999, values were calculated by NLI Research Institute using the Datastream euro composite rate and short-term interest rates of participating countries.
Source: Primark Japan

(2) Foreign Exchange Return

Figure 2 compares returns for foreign exchange, stocks, and bonds over the past two decades. While stocks and bonds have positive returns, foreign exchange returns are close to zero.

This is largely due to the difference in characteristics of foreign exchange compared to stocks and bonds. Funds are needed to invest in stocks and bonds, on which dividend or interest income is earned. On the other hand, since no funds are needed for foreign exchange (however, individual investors must provide a deposit), no interest or dividend income is earned. In this sense, foreign exchange is not an asset, but rather represents risk exposure.

Thus except in special conditions where liquidity is poor, foreign exchange transactions are a zero sum game, and from a very long perspective of 20 to 30 years, the expected return of foreign exchange should theoretically be close to zero. However, this assumes that foreign exchange (forward rate) alone is transacted, in which case the return is calculated using the percentage change in exchange rate and spread between domestic and foreign interest rates.

On the other hand, the foreign exchange return for long-term investors in foreign currency deposits and foreign bonds is calculated using the percentage change in exchange rate, without using the spread between domestic and foreign interest rates. In other words, exchange rate fluctuations are reflected directly in the portfolio's unrealized gain or loss, so that a negative change represents the foreign exchange risk for long-term investors.

In fact, as seen from the significantly negative exchange rate fluctuations in the past, foreign exchange risk cannot be ignored (Figure 2). However, thinking that the expected return of foreign exchange approaches zero, many long-term investors tend have neglected risk management either by foregoing

hedging completely, or hedging 100 percent on the assumption that it will reduce the foreign exchange risk to zero. The question, then, is whether foreign exchange risk management is really unnecessary for long-term investment.

Figure 2 Return Comparison of Stocks, Bonds, and Foreign Exchange

	Japan	U.S.	U.K.	Germany	France
Stocks	6.6%	15.0%	16.3%	11.7%	15.9%
Bonds	6.3%	9.0%	11.9%	7.3%	9.5%
Foreign exchange	$ / ¥	Euro / ¥	£ / ¥	A$ / ¥	C$ / ¥
	0.3%	–1.7%	0.3%	–0.8%	0.0%
Change in exchange rate	–3.0%	–6.6%	–5.2%	–6.7%	–4.3%

Notes: See Figure 1
Source: Primark Japan

(3) Pitfalls of the Contrarian Approach to Foreign Exchange

We first consider the case in which no foreign exchange hedging is done whatsoever. Strategies include dollar averaging, wherein dollars (the foreign currency) are bought in small amounts over a period of time to smooth out the average cost and thus reduce risk, and the method of buying dollars when the exchange rate reaches an apparent long-term low and selling at an apparent long-term high. But both methods depend heavily on luck for success.

As seen by the exchange rate trend in Figure 3, such long-term contrarian methods can be highly risky. There is a risk that when a foreign currency position is established and left untouched, the exchange rate will not return to the original level. Even with a long-term investment objective, severe difficulties arise when unrealized losses accumulate, especially with the introduction of mark-to-market accounting and shorter time horizons for performance evaluation.

Figure 3 The Sterling-Yen Exchange Rate

Note: Shows monthly rate (closing rate in London) from January 1965 to May 2001.
Source: Primark Japan

(4) The Pitfalls of Full Hedging

If the opposite approach is taken and foreign currency positions are fully hedged, exchange rate risks can theoretically be eliminated almost entirely. However, it is extremely difficult in practice to hedge foreign exchange positions for long periods of five to ten years. For example, hedging a purchase of 10-year U.S. Treasuries is inefficient because the forward market for maturities of one year or more is fairly illiquid and the desired price cannot be obtained.

In many cases, hedging can be accomplished by rolling over a short-term forward contract of about three months. This entails the following risk of the relative change in the long-term interest rate to the short-term interest rate (yield curve risk). Suppose that all of the interest and principal can be fully hedged for the next ten years. Theoretically, the return will be equivalent to that of Japan's long-term bonds. However, when short-term hedging is rolled over, it entails the risk associated with interest spread (long-term minus short-term interest rates) differences domestically and abroad. This is because the return on U.S. Treasuries with a short-term exchange rate hedge can be expressed as the return on Japanese long-term bonds plus the difference in interest rate spreads between the U.S. and Japan (U.S. spread minus Japan spread). In other words, changes in the shape of domestic and foreign yield curves will determine returns.

(5) Possibility of Short-term Risk Management

As discussed above, since maintaining a fixed hedge ratio over a long period can entail massive losses, controlling this risk is of paramount importance.

On the other hand, there is a concern that making short-term transactions will increase cost as well as risk. However, short-term risk management for foreign exchange is simpler than for other assets because: (1) the transaction cost is low, (2) the risk of failure of the other party (bank, etc.) is limited to the profit portion (however, if foreign currency deposits are involved in addition to the exchange rate transaction, both principal and interest are at risk), (3) the market is highly liquid, and (4) a wide variety of hedging methods exist. Thus a solid currency strategy combined with proper risk management is likely to adequately reduce risk.

3. Currency Strategies (Long-term)

From a long-term perspective, fundamentals have an extremely large effect on the formation of exchange rates. Two particularly important factors are: (1) capital flows related to investment (interest rate differential, forward rate, etc.), and (2) capital flows related to trade (current account balance, purchasing power parity, etc.).

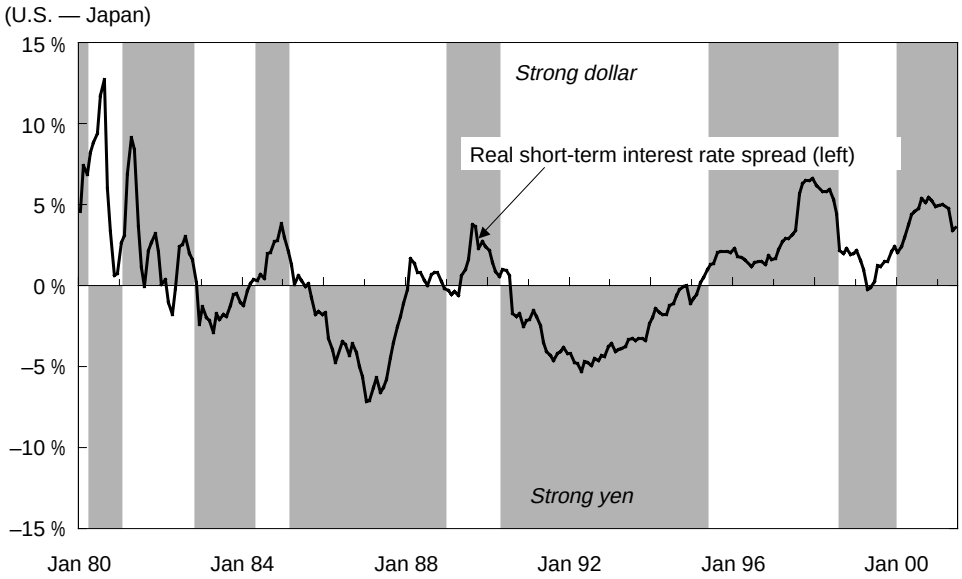
While conventional exchange rate theories attempt to predict exchange rate levels based on such variables, predictions are quite complex and prone to error. Approximately two years ago, NLI Research Institute developed the Nissay exchange rate index, which takes a completely different approach by focusing on the direction and intensity of changes (see “A Conceptual Change in Exchange Rate Prediction,” *NLI Research*, November 1999).

(1) The Nissay Exchange Rate Index

The Nissay exchange rate index determines the probability of strong yen or strong dollar exchange rate phases and turning points; a series of positive values signals a strong dollar phase, while a series of negative values signals a strong yen phase. The index is compiled from three economic variables with strong correlations to the exchange rate (differences in real short-term interest rate, external balance, and real money growth rate between Japan and the U.S.), and a historical effect to express the exchange rate trend (monthly moving average of the percentage change in the dollar-yen rate).

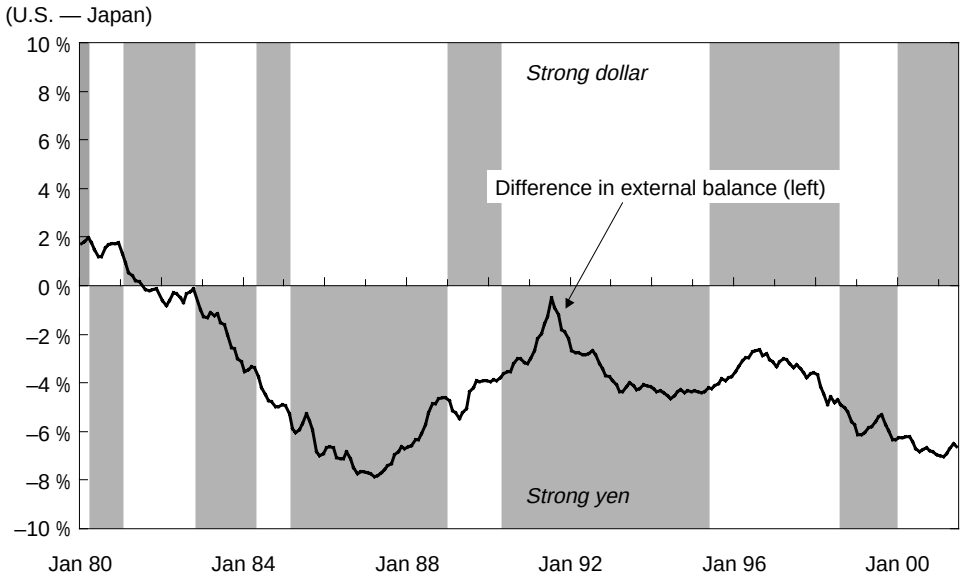
Figures 4 to 8 show how each of the four components, as well as the index, perform compared to the actual exchange rate phases (strong dollar or yen). Although none of the components is particularly accurate alone, the composite exchange rate index performs well.

Figure 4 U.S.-Japan Real Short-term Interest Rate Differential, and Exchange Rate Phases



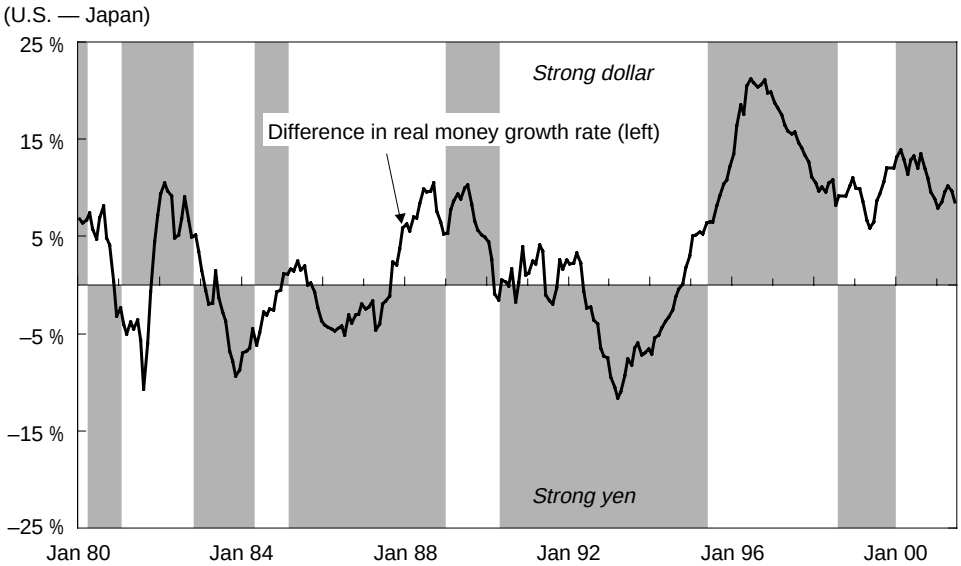
Notes: (1) The short-term interest rates used are the federal funds rate for the U.S. and collateralized overnight call rate for Japan. (2) Real interest rate is calculated using the core producer price index for the U.S., and domestic wholesale price index for Japan.
Sources: FRB, U.S. Department of Labor, BOJ.

Figure 5 U.S.-Japan Difference in External Balances, and Exchange Rate Phases



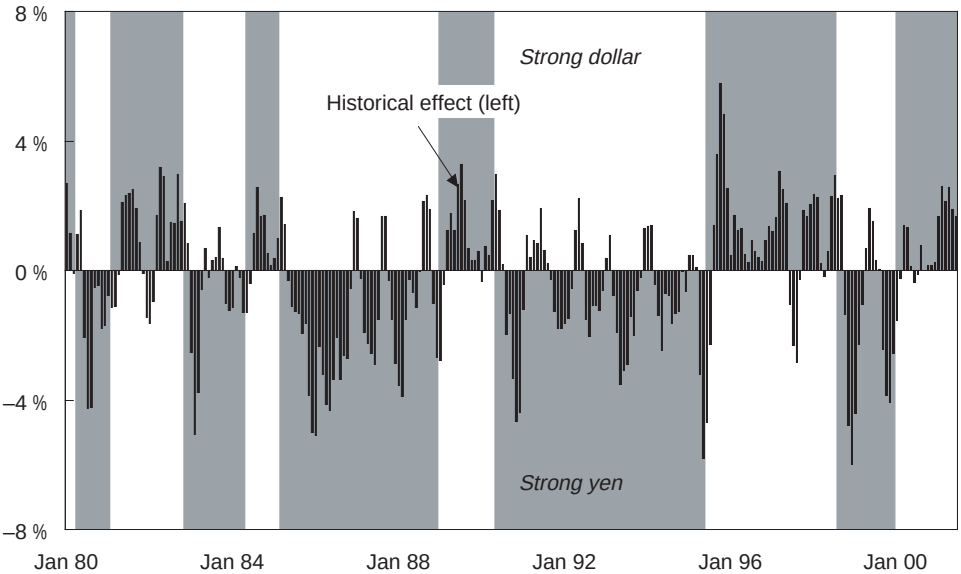
Notes: (1) Shows Japan-U.S. difference in current account balance as a ratio to nominal GDP. (2) Current account balance and nominal GDP are 3-month moving averages obtained by dividing quarterly values by three, and then averaging the next three months.
Source: U.S. Department of Commerce, BOJ, Cabinet Office.

Figure 6 U.S.-Japan Difference in Real Money Growth Rates, and Exchange Rate Phases



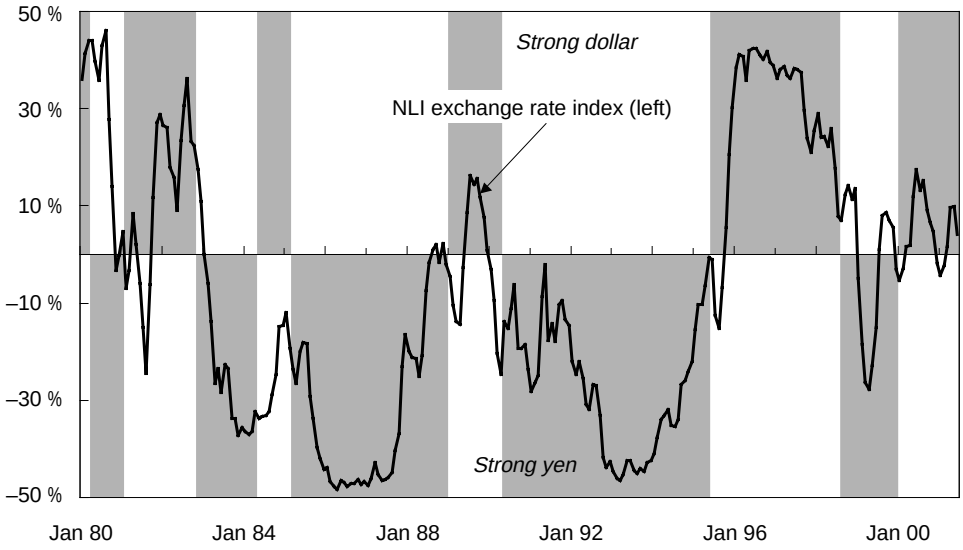
Notes: (1) For money growth rate, year-on-year M1 growth rate is used. (2) Real growth rates for Japan and U.S. are obtained using core consumer price index.
Source: FRB, Department of Labor, BOJ, Ministry of Public Management, Home Affairs, and Posts and Telecommunications.

Figure 7 Historical Effect and Exchange Rate Phases



Note: Shows the dollar-yen rate's monthly percentage change (logarithm) as a trailing 3-month average.
Source: BOJ

Figure 8 The Nissay Exchange Rate Index, and Exchange Rate Phases



(2) Long-term Equilibrium Values and Predicted Long-term Changes

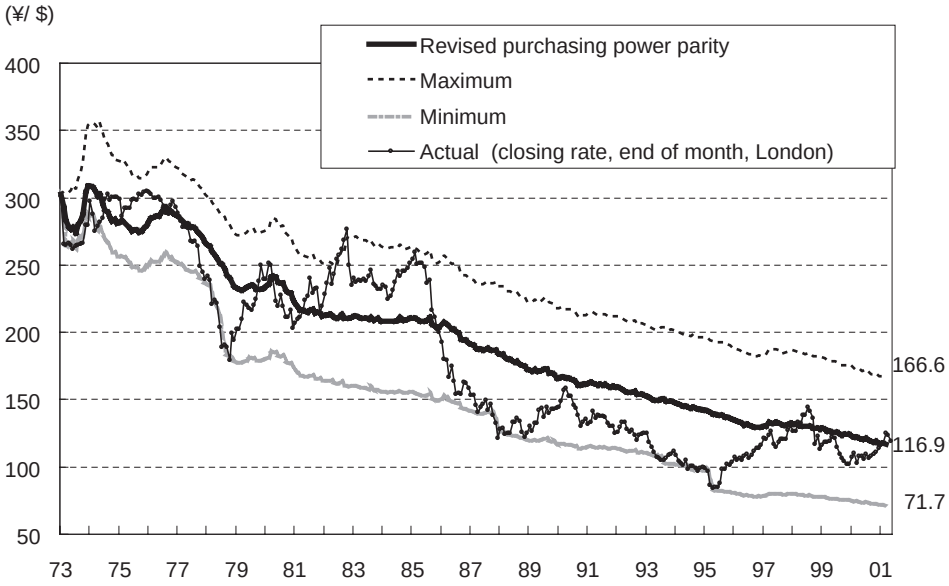
The Nissay exchange rate index estimates long-term exchange rate phases and predicts the direction of change. However, exchange rate risk management on a long-term basis often requires estimating expected future exchange rate levels (long-term equilibrium values).

The most commonly used proxy for equilibrium exchange rate levels is purchasing power parity (PPP). This is the equilibrium exchange rate (absolute purchasing power parity) assumed to enable the purchase of an equal amount of goods (purchasing power) with each country's currency. In practice, the exchange rate at a particular point in time is taken to be the equilibrium rate, and is subsequently adjusted using the difference in inflation rates between the relevant countries (relative purchasing power parity). However, there is no decisive way to determine when the exchange rate is at equilibrium. Thus purchasing power parity can vary significantly depending on the selection of the initial equilibrium rate.

We calculated purchasing power parity using every month as the starting point since January 1973, taking the average value (revised purchasing power parity) to be a proxy for absolute purchasing power parity.

Figure 9 plots the revised purchasing power parity of the dollar-yen rate. Not only is it unaffected by the choice of base year, but the upper and lower limits neatly contain the highs and lows of the actual exchange rate fluctuations.

Figure 9 Revised Purchasing Power Parity and Long-term Predicted Price Range

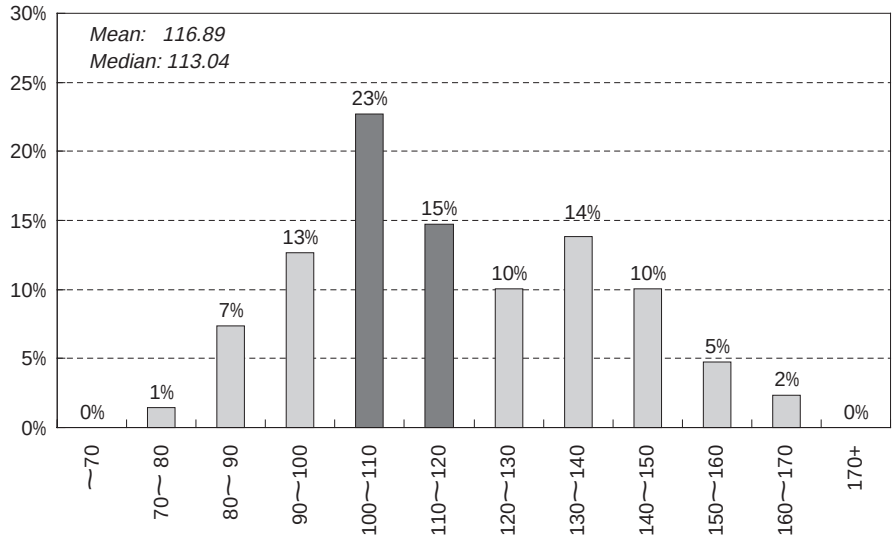


Note: Revised purchasing power parity for May 2001 is the arithmatic average of relative purchasing power parity values (producer price basis) based on the dollar-yen rate for the 339 months from January 1973 to March 2001. Upper and lower levels show its maximum and minimum values.

Sources: BOJ, U.S. Department of Labor, Primark Japan.

Moreover, a frequency distribution of the most recent data (as of May 2001) is shown in Figure 10. When technical analysis is applied, the predicted value for the exchange rate is found to be in the frequency peak of the 100 to 110 yen range.

Figure 10 Distribution of Predicted Values of the Revised Purchasing Power Parity



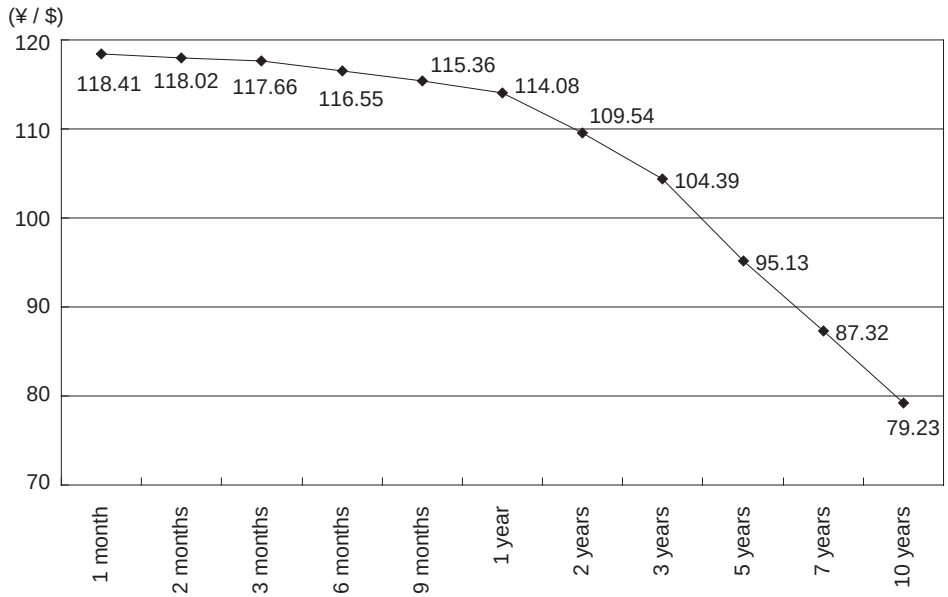
Notes: (1) The relative purchasing power parity is based on producer prices. (2) The frequency distribution of 339 relative purchasing power parity values is based on monthly dollar-yen rates from January 1973 to March 2001.

(3) Fair Rate Prediction of the Future

We were able to estimate the long-term equilibrium rate from the revised purchasing power parity. Moreover, using a different approach, we tried to estimate the arbitrage-free exchange rate (fair rate, such that gains cannot be made without risk) at different times in the future (for example, from one year to ten years ahead). Specifically, the model estimates the arbitrage-free implied forward rate between the interest rate and exchange rate markets using the interest rate term structure between two countries (various interest rates for different time horizons). By entering the present foreign exchange spot rate, the model generates the fair rate for each point in time in the future.

The dollar-yen implied forward rate is plotted in Figure 11. It shows that, for example, if a purchase of 10-year U.S. Treasuries is held to maturity without a foreign exchange hedge, the investment amount in yen terms can be maintained as long as the yen does not appreciate to the fair rate (79.23 yen).

Figure 11 Implied Forward Rate



Note: Based on the dollar-yen rate at the end of May 2001 (closing rate in London), and U.S.-Japan interest rate term structure.
Source: Primark Japan

4. Currency Tactics (Short-term)

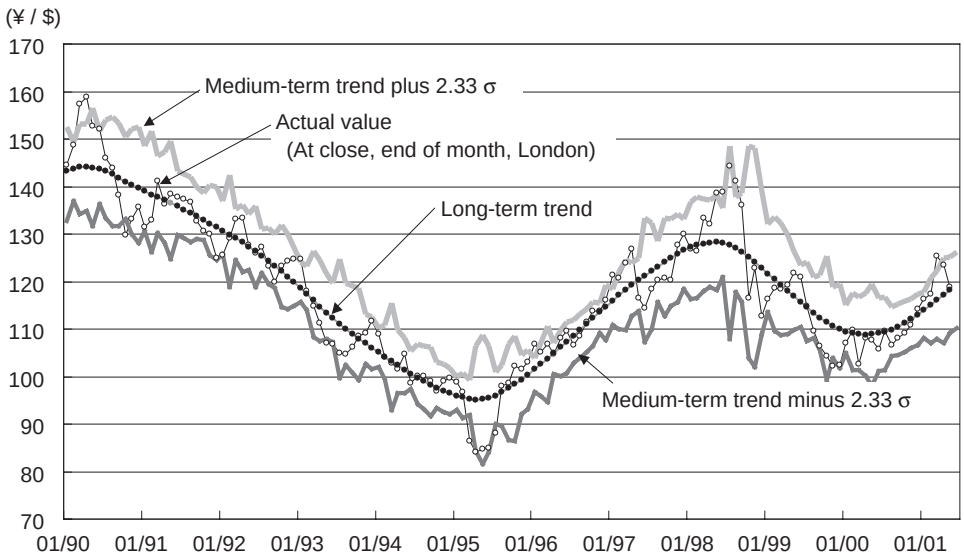
Thus far we have described the basis for long-term foreign exchange management using fundamentals data. However, the foreign exchange market is a 24-hour market with many active speculators and short-term traders. To find profitable opportunities from the market's short-term fluctuations, we need a short-term, active management strategy that uses the following data.

(1) Short-term Predicted Fluctuation Range

We described earlier how the long-term predicted fluctuation range was obtained from the revised purchasing power parity. As a supplement for short-term management, we have also estimated the exchange rate's fluctuation range one month ahead at a 99 percent confidence level (assuming a normal distribution). We estimated this range using a time series model (a type of quantitative model). Results for the dollar-yen rate are plotted in Figure 12, which shows the predicted fluctuation range (maximum risk) for the following month.

Because of the theoretical ease of use, the standard deviation is often used, although it is a historical measure of volatility and has no predictive power. Since the standard deviation is difficult to use as a predicted value, we predict exchange rate volatility using a time series model to obtain the fluctuation range.

Figure 12 Upper and Lower Limits of the Short-term Fluctuation Range



Notes: (1) The medium-term trend is extracted using Decomp, which uses a state-space model to break down time series data into trend, seasonal, AR (auto-regression) and noise components. The method was developed by Mr. Genshiro Kitagawa of the Institute of Statistical Mathematics. (2) Volatility (σ) is derived from the AR(1) • TARCH(1) model. It is an auto-regressive time series quantitative model that makes predictions using only data from the previous period, like the AR(1) • TARCH (1) model. Using daily dollar-yen exchange rate returns (London at close), we obtained monthly volatility data (standard deviations) used in the time series model.
Source: Primark Japan

(2) Optimal Currency Exposure

In addition to the short-term predicted fluctuation range, we used our proprietary quantitative model to calculate the monthly optimal currency exposure. This data is essential for fund managers conducting

short-term, active foreign exchange management.

In Figure 13, the optimal foreign exchange exposure (+100 percent is a strong buy signal for dollars, and -100 percent is a strong sell signal for dollars) is plotted alongside the dollar-yen exchange rate's actual return (the monthly percentage change in the exchange rate). Whenever the signs coincide for the optimal currency exposure and actual return in a given month (both are either rising or falling), the model is working.

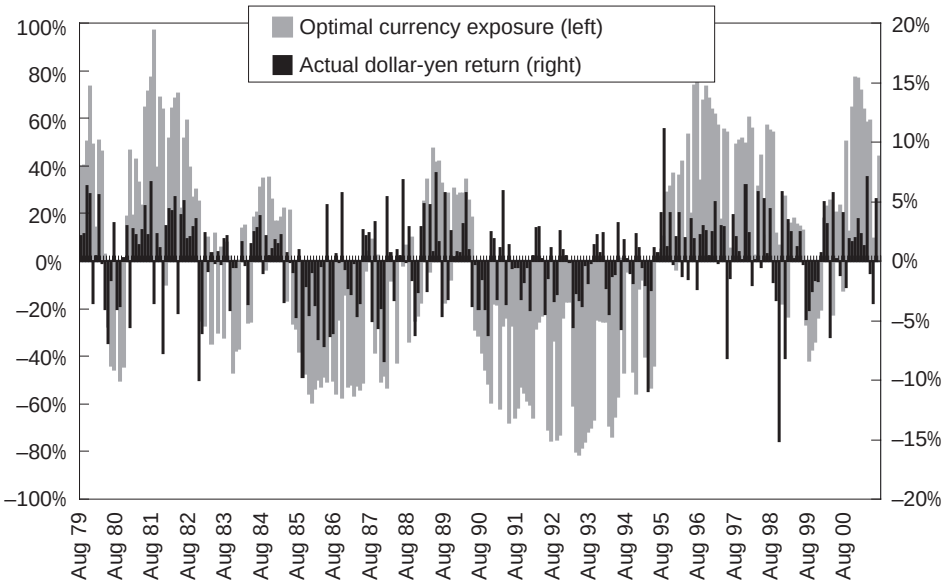
There is a reason we calculated the optimal currency exposure rather than the optimal hedge ratio. The foreign exchange hedge ratio (h) indicates the percentage of foreign currency denominated assets being hedged with foreign exchange. On the other hand, exposure (ex) is the exposure to foreign currency fluctuation risk. For example, if 100 dollars is held in U.S. Treasuries, and 30 dollars of this is hedged by selling dollars, the hedge ratio is 30 percent, and the currency exposure is 70 percent. Thus the hedge ratio can generally be converted in currency exposure with the equation (ex = 100 percent – h).

However, the hedge ratio can only be used when adjusting foreign exchange positions. Since the optimal hedge ratio is expressed in terms of the strength of the sell signals, half of the information is lost. Moreover, if we start from the optimal hedge ratio, the optimal currency exposure becomes limited to a fluctuation range of zero to 100 percent.

Thus we started not with the hedge ratio but with currency exposure. Moreover, by defining the fluctuation range from -100 percent to +100 percent, our model makes use of both buy and sell signals obtained from the model, so that the strength of the signals can be fully reflected in the actual investment management. Thus the currency exposure should be used as is. However, if investment constraints require using the hedge ratio, part of its problem can be solved by incorporating the benchmark hedge ratio (H^B) as follows: [$h = -(ex - 1) \cdot H^B$]. (However, when $H^B = 0\%$, then $h = H^B - ex \cdot 1$.)

The quantative model that estimates optimal currency exposure is a predictive model which mainly utilizes the following three foreign exchange fluctuation characteristics. The model is characterized by built-in factors for actively controlling short-term foreign exchange risk, thereby preventing massive losses.

Figure 13 Optimal Currency Exposure and Actual Dollar-Yen Returns



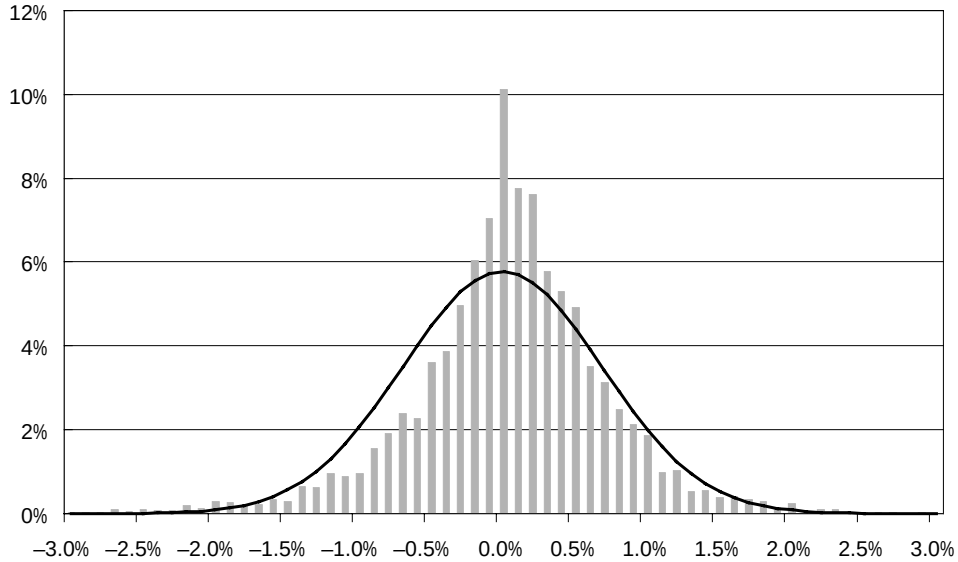
Note: Shows optimal currency exposure from August 1979 to May 2001.

1. Uniqueness of foreign exchange return fluctuations

In statistical analysis, foreign exchange return fluctuations are usually assumed to be random and normally distributed. However, as Figure 14 shows, the actual distribution of returns for the dollar-yen rate is not normal, but instead pointed in the middle and somewhat skewed to the right.

Moreover, during a one-year period, daily fluctuations of 1.5 percent or less occurred 96 percent of the time, while larger fluctuations occurred only 4 percent of the time. The graph does not show the even larger fluctuations, such as the 8.7 percent decline from 130 yen to 119 yen on October 7, 1998, and the 9.7 percent decline from 123 yen to 111 yen on the next day. Moreover, these large fluctuations tend to be concentrated at certain times.

Figure 14 Dollar-Yen Return Distribution



Note: Based on daily dollar-yen rates (London closing rate) from August 1979 to June 2001.
Source: Primark Japan

2. Serial correlation

Short-term foreign exchange fluctuations tend to be serially correlated; if the rate rose or fell last month, it is likely to keep moving in the same direction this month. Thus the ability to discern strong foreign exchange rate trends is key to the success of foreign exchange management.

3. Forward rate bias

In general, the foreign exchange forward rate is supposed to conform with the term structure of interest rate spreads between two countries (under the condition that risk-free arbitrage cannot be made due to the combination of loans/management and foreign exchange transactions in two currencies). However, funds often tend to flow from currencies with a low interest rate to those with a high interest rate (forward rate bias).

For example, since U.S. interest rates are now higher than Japan's, hedging by selling dollars has the same economic effect as borrowing U.S. dollars at a high interest rate and managing the funds in Japan at a low interest rate. Needless to say, this type of investment behavior would be psychologically perverse. In simple regression analysis, which compares past interest rate differentials against foreign exchange rates, this type of investor psychology has not been extracted, and needs further work to be modeled.

5. Conclusion

It is said to be difficult — perhaps impossible — to accurately predict exchange rate levels. However, by taking into account return characteristics while predicting and controlling risk, it may be possible in the medium to long term to obtain stable returns that are commensurate with the risk level.

Toward this end, we have developed an integrated strategy that, based on a defined process, fuses a long-term currency strategy with short-term currency tactics, and can be directly implemented in foreign exchange management.