Pursuing a Different Approach to Exchange Rate Prediction
– *Review of the Nissay Exchange Rate Index*

by Yasuyuki Komaki
Economic & Industrial Research Group

1. Introduction

Exchange rate trends require constant monitoring. Despite longstanding calls for structural change, the economy continues to lie at the mercy of the foreign exchange market. In fact, a ¥10 appreciation in the yen's exchange rate against the dollar can cause billions of yen in corporate profits to evaporate, nullifying years of restructuring efforts.

Despite the exchange rate's crucial importance for the economy, exchange rate prediction is an extremely difficult – if not impossible – task. The exchange rate often fluctuates by two to three percent on a given day, and normally overshoots theoretically estimated levels. The shorter the prediction period, the larger the influence of random factors, and hence the more difficult the prediction. However, one characteristic of the foreign exchange market is that once it changes direction, it tends to keep going in the same direction.

Moreover, when daily noises are eliminated, most of the change in direction can be explained by fundamental factors. Based on this characteristic, we developed the Nissay Exchange Rate Index model, and began announcing monthly predictions for exchange rate trends in May 1999.

This paper reconsiders the exchange rate index approach by reviewing past exchange rate theories and evaluating their usefulness.

The model's results over the first six months are good overall. Presently (September 1999), the model indicates that the yen will remain strong until the end of 1999.

2. The Difficulty of Predicting Exchange Rate Levels

(1) Theoretical and Actual Exchange Rate Trends

Needless to say, even the most academically precise exchange rate theory cannot always fully explain actual exchange rate movements. Exchange rate theory supposedly reveals factors that enable long-term equilibrium in the exchange rate market, and explains short-term movements.

However, in practice the exchange rate diverges widely from the long-term equilibrium level, and volatility in the short term that cannot be explained by theory due to demand and supply and expectations. Let us confirm this point from the relationship between the theoretical model and actual exchange rate trends.

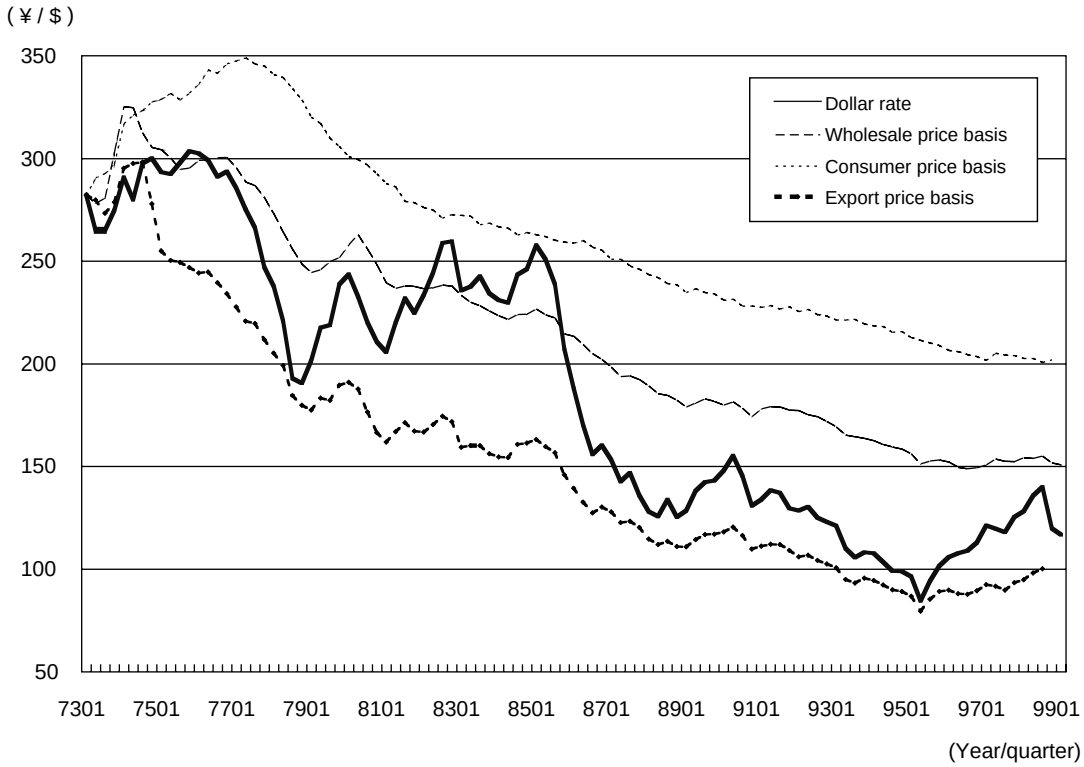
(2) Purchasing Power Parity Diverges Widely from Actual Exchange Rates

In explaining long-term exchange rates, economists primarily resort to the theory of purchasing power parity (PPP). This theory assumes a real economy that has no financial transactions, where all goods are traded. If the trade balance between two countries is in equilibrium, there is an equilibrium rate such that the same goods will sell for the same price in both countries.

As Figure 1 shows, over the past quarter century, very long-term exchange rate trends can be largely explained by the purchasing power parity theory.

However, as the time period is shortened, the actual exchange rate level tends to diverge widely from the equilibrium PPP level. Although the exchange rate tended to converge to the equilibrium level until 1985, it has since remained diverged over the long term. This divergence may be attributed to the existence of financial and capital transactions, and non-traded goods and services such as domestic services. However, even when PPP calculations include non-traded items, the actual exchange rate still fails to converge with the equilibrium level. Thus PPP theory appears to have great difficulty predicting exchange rate levels.

Figure 1 Significant and Long-term Divergence of the Exchange Rate from PPP Equilibrium



(3) Theoretical Basis for the Short-term Prediction of Exchange Rates

Theoretical explanations for short-term exchange rate fluctuations come from the monetary approach, which emphasizes the supply and demand relationship of currencies, and the portfolio balance approach, which focuses on equilibrium in asset markets.

Both approaches construct models with economic variables such as the inflation differential, money supply, and current account balance, and focus on the short-term impact of factors such as current account balances and interest rates.

Below we compare exchange rate movements since fiscal 1995 with each of the factors to examine causal relationships.

1) *Inflation differential* – The Japan-U.S. inflation differential generally explains changes in the direction of exchange rate trends since 1997. However, discrepancies occur in the vicinity of exchange rate turning points. In addition, the exchange rate's decline in Phase 2 of the figure is disproportionate to the increase in the inflation differential. Thus this factor's explanatory power is limited (Figure 2).
2) *Real interest rate differential* – The Japan-U.S. interest rate differential generally explains changes in exchange rate trends with a lag of approximately one year. The interest rate dif-

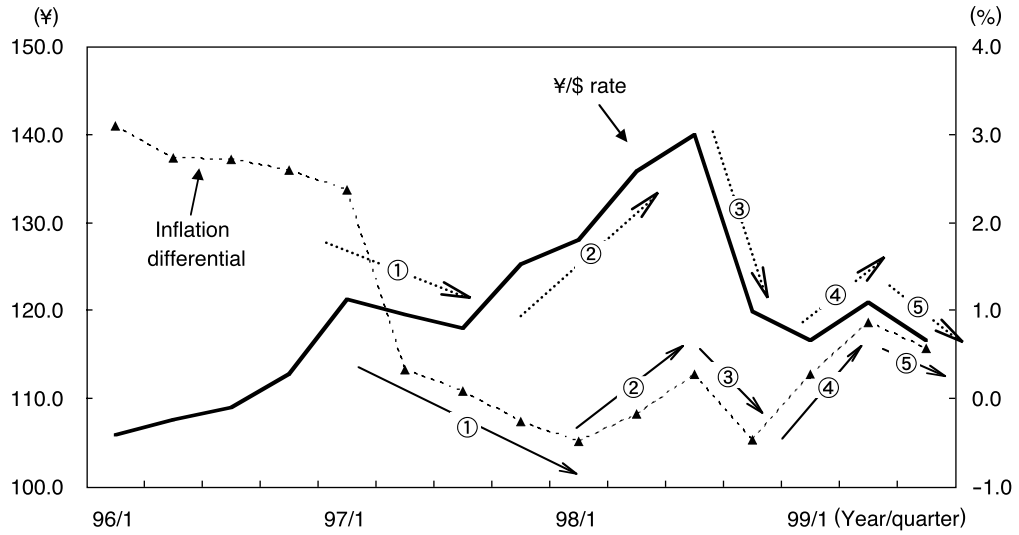
ferential's increase from 1996 to mid 1997 explains the yen's weakness from 1996, while the decrease from mid 1997 suggested the yen's rise from the fall of 1998 (Figure 3).
Moreover, the interest rate differential began expanding again in January 1999, suggesting that the yen will weaken in 2000.

3) *Current account balance* – Japan's current account surplus has been shrinking since 1997, helping to explain the yen's decline from the second half of 1997. The growth of the surplus in 1998 foretold the yen's subsequent rise. The contracting surplus since 1999 suggests that the yen will weaken ahead (Figure 4).
4) *Real glowth rate differential* – The yen's strength since mid 1999 has coincided with a shrinking disparity in growth rates between Japan and the U.S. as Japan's economy recovers. While the growth rate differential appears to have explanatory power since 1999, the correlation has not been very strong over the long term (correlation coefficient 0.36 -0.45). Thus the growth rate differential may affect exchange rates through expectations on interest rates and other factors (Figure 5).

While the above factors help explain changes in exchange rate trends to some extent, they are not absolutely reliable, and their effect appears to vary depending on the particular economic environment.

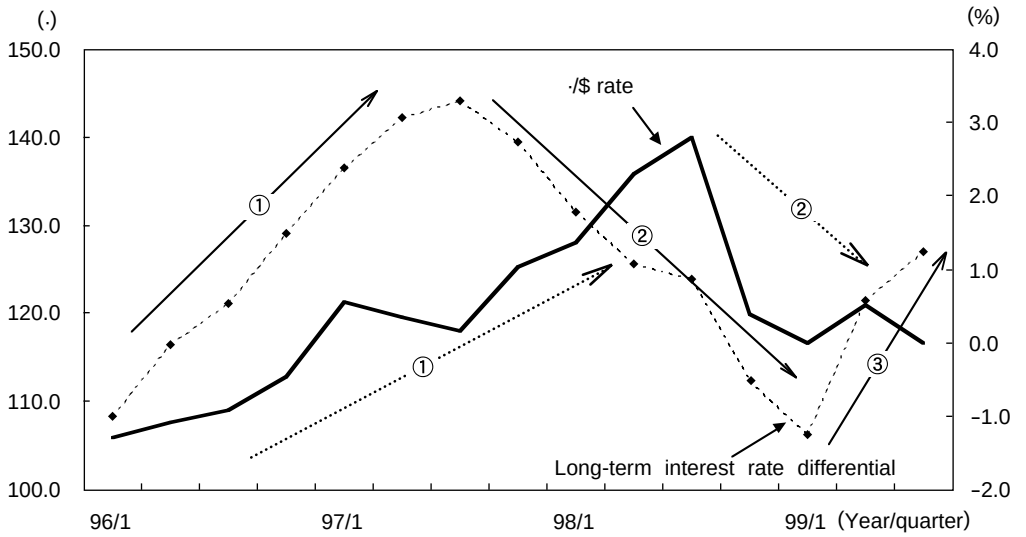
Academic research describes short-term exchange rate movements as a random walk and hence unpredictable. In other words, short-term predictions are extremely difficult because fundamental factors explain only a fraction of exchange rate movements, while the random portion of these movements is significant.

Figure 2 Inflation Differential Helps Explain Exchange Rate Trends



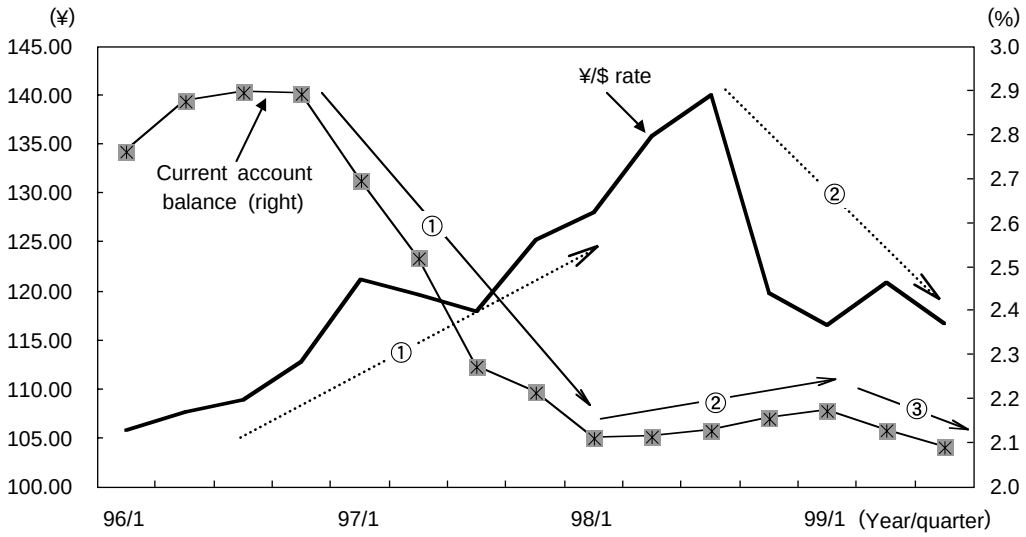
Notes: The inflation differential compares monthly consumer price indexes (yoy change). For Japan,the consumer price index excludes the impact of the change in consumption tax rate.

Figure 3 Real Long-term Interest Rate Differential Explains Exchange Rate Trends with a 1-Year Lag



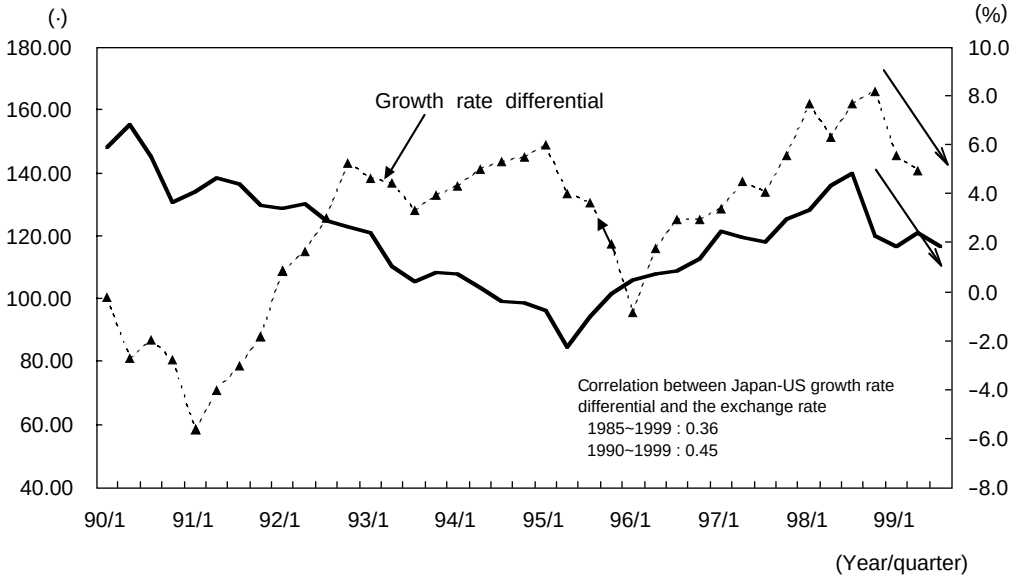
Notes: The real long-term interest rate differential is based on 10-year bond yields. Real interest rates are obtained using each country's wholesale price index. For Japan, the impact of the change in consumption tax rate is excluded.

Figure 4 Declining Current Account Surplus Signals a Weaker Yen



Note: The current account surplus is shown as a ratio to GDP.

Figure 5 Growth Rate Differential Loses Explanatory Power Prior to 1999



3. A Different Perspective for Exchange Rate Prediction

As we have discussed above, no theoretical model currently exists that can decisively explain and predict exchange rate levels. Thus instead of trying to predict exchange rate levels, we developed a short-term exchange rate model based on fundamental factors that predicts the direction and timing of changes in exchange rate trends. The model is based on the following two points.

1. *Prediction of direction of change* – Since the exchange rate tends to overshoot, predicting short-term movements is a hopeless exercise. A model that is preoccupied with predicting the exchange rate level thus compromises its accuracy.
2. *Prediction of exchange rate turning points* – On the other hand, when the focus is shifted from exchange rate levels to turning points of exchange rate trends, we can confirm a loose fit between exchange rate turning points and changes in fundamental factors that affect the exchange rate.

(1) Role of the Exchange Rate Index

Based on feedback received after we developed the exchange rate index, below we clarify the role of the model.

1. Supplemental role

One apparent limitation of the model is that it does not predict exchange rate levels, which is what economic agents would want most from the model. But since this is unattainable, the rational solution is to predict exchange rate conditions (strength and direction of pressures acting on the yen) and turning points. This information can improve predictions of business performance. We can then go an important step further to improve prediction accuracy by supplementing existing exchange rate prediction methods that use quantitative analysis of fundamentals and chart analysis. The model can also be used to gauge exchange rates approximately three months ahead. Thus the model has many uses despite its apparent limitation.

2. Statistical Signs

Exchange rates are not determined by fundamentals alone; politics and policy factors also play a major role.

However, monetary intervention and unexpected political events are reflected in economic statistics either before or after the fact, such as in interest rates and trade patterns. Moreover, theoretically unfounded exchange rate levels cannot be sustained for long periods. Thus for example, monetary intervention can cause the yen to decline, but the effect will be temporary unless the fundamentals are consistent with the new level.

(2) Measurement Method

1. Extraction of trend movements

In the short term, unexpected events can cause the exchange rate to fluctuate greatly. However, once the exchange rate trend changes direction, it characteristically tends to maintain that direction. Thus the exchange rate moves in a smooth trend if daily fluctuations are ignored. We use a time series model as a filter to extract exchange rate trends and determine turning points. [1,2] In addition, we also apply a method for measuring peaks and bottoms of economic cycles to confirm the turning points. [3]

2. Selection of explanatory factors

Based on time series analysis, we identified four variables with the greatest explanatory power, and incorporated them into our exchange rate model. [4]

1. *Japan-U.S. real interest rate differential* – a proxy variable for determinants of foreign capital movements.

2. *Japan-U.S. current account differential* – a proxy variable for the adjustment effect of trade imbalances. Expressed as a ratio to nominal GDP, it also takes into account changes in the growth rate.
3. *Monetary base differential* – a proxy variable for monetary policies in Japan and the U.S., it also expresses the supply and demand of funds in each country. Easing of the monetary base implies a weakening of that country's currency.
4. *Past exchange rates* – this takes advantage of the exchange rate's characteristic of maintaining a particular trend once it changes direction.

(3) Simulation Results

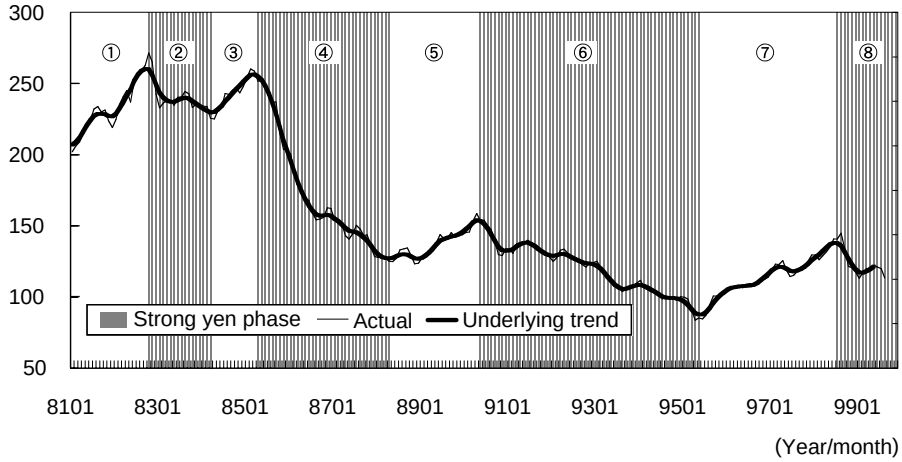
Using the four explanatory variables as well as past exchange rate turning points, we converted qualitative data that indicate exchange rate phases. [5]

Figures 6 and 7 show actual exchange rate trends and results predicted by the exchange rate index. Since 1980, there have been eight actual turning points. Of these, the exchange rate index signaled six turning points. The lack of a turning point signal in the weak yen phase leading up to the Plaza Accord can be attributed to an easing of strong upward pressure from fundamentals. In the next phase, this strong upward pressure on the yen is thought to have contributed to the effectiveness of the exchange rate guidance following the Plaza Accord.

As Figure 8 shows, the exchange rate index can consistently predict turning points with a lead time of approximately three months, and thus indicates exchange rate conditions three months ahead.

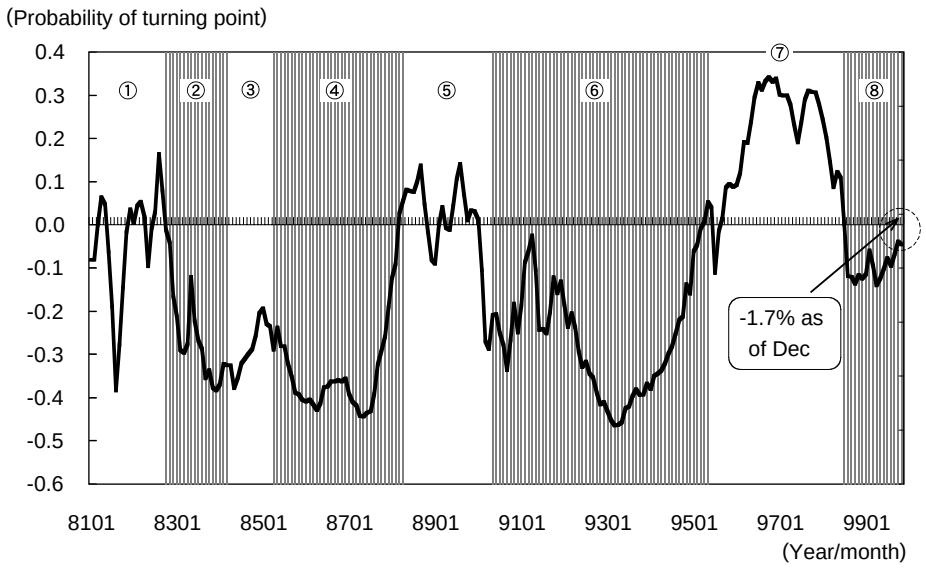
More recently, as of September 1999, the exchange rate conditions suggested by the model for November 1999 point to a continuation of the strong yen phase that began in July 1998.

Figure 6 Trend Movement of the Yen/Dollar Exchange Rate



Note: The trend movement was extracted using Decomp. Numbers within the graph indicate exchange rate phases from Table 8.

Figure 7 Sign Indicates Continued Smooth Yen Appreciation



Note: Estimation was done with economic data for July 1999 (predictions are substituted for unavailable data). Since the estimation equation has a lag structure of three months, the estimated value indicates exchange rate and turning point conditions for October 1999.

Figure 8 Performance of the Exchange Rate Index

Exchange rate phase			Lead time	Actual	Model			Remarks
	Yen's value	Period	(months)		Model's TP	Data date	Data released	
①	Weak	01/81~08/82	-1	01/81	03/81	11/80	12/80	
②	Strong	09/82~02/84	-2	09/82	10/82	06/82	07/82	
③	Weak	03/84~02/85	-1	03/84	05/84	01/84	02/84	No signal
④	Strong	03/85~03/88	-4	03/85	02/85	10/84	11/84	No signal
⑤	Weak	04/88~03/90	-4	04/88	03/88	11/87	12/87	
⑥	Strong	04/90~04/95	-5	04/90	02/90	10/89	11/89	
⑦	Weak	05/95~06/98	-4	05/95	04/95	12/94	01/95	
⑧	Strong	07/98~	-2	07/98	08/98	04/98	05/98	
Average			-2.9					

Note: Exchange rate phases match those in Figures 6 and 7.

4. The Model's Prediction

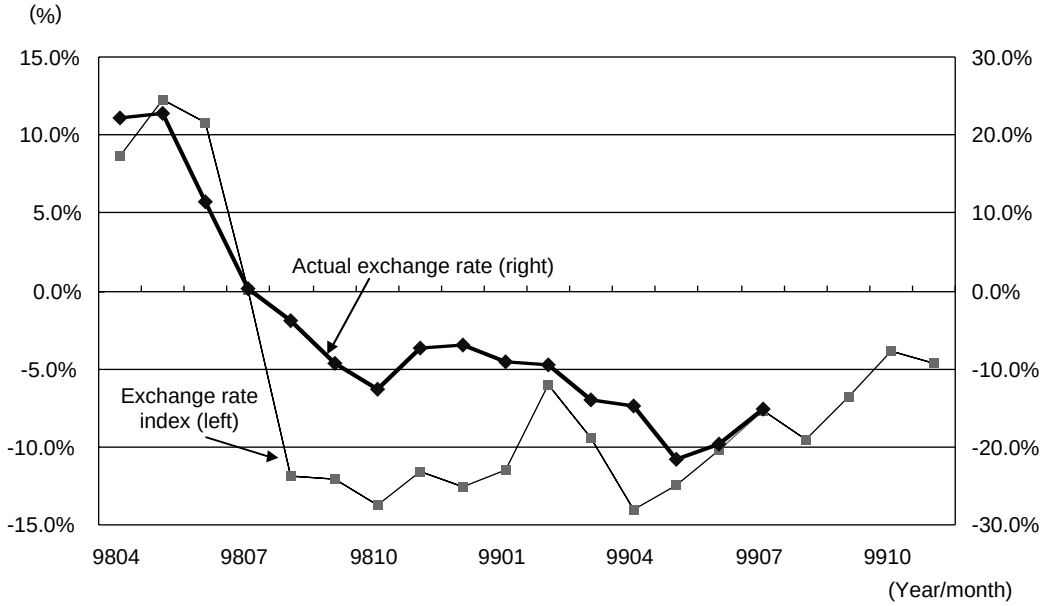
After remaining stable at approximately 120 yen through mid July, the exchange rate then moved past 110 yen amid growing expectations of an economic recovery. Figure 9 shows how the exchange rate index registered this development.

Except for the most recent month, the exchange rate index generally coincides with the direction of the exchange rate movement. The correlation coefficient of 0.902 is also satisfactory.

With regard to the exchange rate's future direction, as of September 1999 the exchange rate index suggested that while the strong yen phase would persist, the yen's appreciation since late August would abate at the end of 1999.

Despite some predictions for a stronger yen based on the market's overly optimistic perceptions of the economy's strength, fundamental factors indicate that the recovery is still nascent and weak. As the market gradually adopts a more realistic view of economic conditions, upward pressure on the yen should ease.

Figure 9 Recent Performance of the Exchange Rate Index



Note: Because the exchange rate index has a lead time of three months, it is compared against the actual exchange rate's change in direction three months later (yoy change).

5. Conclusion

The Nissay exchange rate index has performed satisfactorily over its brief half-year history. However, there remains much room for improvement, such as replacing explanatory variables of fundamentals, and removing random factors from the explanatory variables. By constantly monitoring the model's performance, we aim to make improvements on an ongoing basis, and thereby enhance the model's value as a tool to supplement present exchange rate prediction methods.

Notes

1. The time series extraction for the trend component of fluctuations is done with DECOMP (software developed by the Ministry of Education's Institute of Statistical Mathematics).

2. The turning point for trend movements in the exchange rate is recognized as such only if the same phase continues for at least six months. This criterion is borrowed from the turning point analysis for economic cycles.

3. Called the Bry-Boschan method, several moving averages are used to extract turning points from time series data in stages.

4. The relationship of these variables to the exchange rate are measured with the Granger causality test.

5. The estimation model is a Logit model with estimated values ranging from 0 to 1 (1 = strong yen phase, 0 = weak yen phase). For the exchange rate index, estimated values are converted to a scale ranging from - 0.5 to + 0.5, with the exchange rate turning point set at zero.