

Table 1. Coefficients of principal components (4). The data for the economic variables were from monthly reports, financial statistics, business statistics, and surveys of current businesses.

#	Index	PC1	PC2	PC3
X ₁	Business conditions in Japan	0.045	0.416	0.653
X ₂	Money supply in Japan	-0.346	-0.128	0.033
X ₃	Trade balance in Japan	-0.192	0.137	0.030
X ₄	Index of wholesale price in Japan	0.286	-0.256	-0.287
X ₅	Foreign reserves in Japan	-0.316	0.226	-0.112
X ₆	Industrial production in Japan	-0.274	-0.262	-0.235
X ₇	Business conditions in the USA	0.317	-0.011	-0.244
X ₈	Money supply in the USA	-0.346	0.035	-0.054
X ₉	Trade balance in the USA	-0.171	0.398	-0.485
X ₁₀	Index of wholesale price in the USA	-0.345	-0.155	0.085
X ₁₁	Foreign reserves in the USA	-0.275	-0.332	0.281
X ₁₂	Industrial production in the USA	-0.347	-0.065	-0.087
X ₁₃	Difference in interest rates	0.131	-0.552	0.167

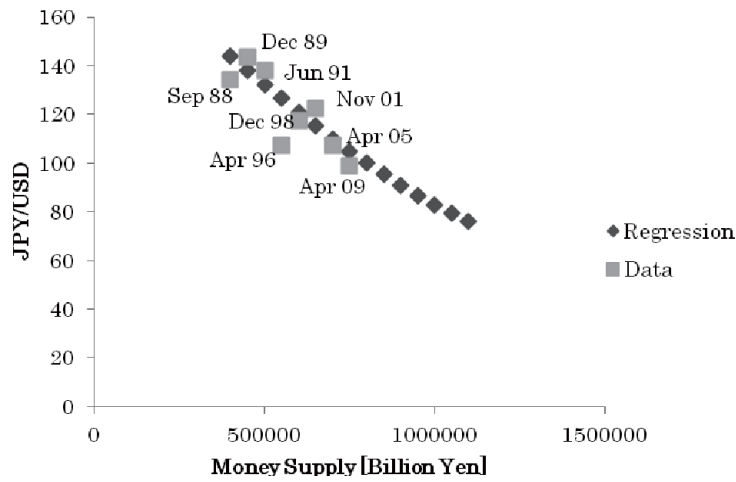


Fig. 1. A partial regression plot with standardized partial regression coefficients of money supply in Japan. The exchange rates can be estimated by the inverse standardization of regression values.

later identify two variables based on principal component analysis.

3. Problem and Solution in Mathematical Analysis of JPY/USD Exchange Rate

In this section, we discuss what the essential variables are, mentioned above, based on economic fundamentals.

We seek to look for correlations between interest rate and exchange rate. Many economists have studied the interdependence between interest rate and exchange rate. In our previous research (Matsugi *et al.*, 2001; Yoshimori *et al.*, 2001), it was concluded that the interest rate, especially the difference between Japanese and American long-term interest rates, was not as significant as certain other economic variables describing the exchange rate. In some quarterly models (Fukao, 2000), interest rates are estimated to be significant as a determinant of exchange rate. We now examine whether the interest rates of both countries are effective for the analysis of the exchange rate. In our monthly model, we analyze relations between the exchange rate and economic variable with backward and forward time lags. The

term “lag” is defined to show a correlation between interest rate at a time, and exchange rate prior. We found that the Japanese short-term interest rate has the highest correlation coefficient with the exchange rate. The next significant correlation is with the US long-term interest rate.

We investigated for economic variables that seemed to depend on exchange rate, exploring several papers and books (Amano, 1978; EPA, 1995; Rosenberg, 1996; Cross, 1998; Ronald and Oono, 1998; Moriyama, 1999) for variables such as money supply, trade balance, index of wholesale prices, foreign reserves, industrial production, interest rates, current account, direct investment, portfolio investment, and unemployment rates. We also considered the variables such as business conditions, the macro index, and share prices (Yoshimori *et al.*, 2003).

We calculated correlation functions between the exchange rate and each economic variable listed in Table 1;

1) We employed the moving averages method so that the time series smoothened out, and then calculated correlation functions between the exchange rate and each economic variable with seven-month moving averages. The time in-