Chapter 5

Conclusions and Limitations

In this chapter, we give some conclusions reached from our study, indicate some of its limitations, and suggest avenues for further study.

Conclusions

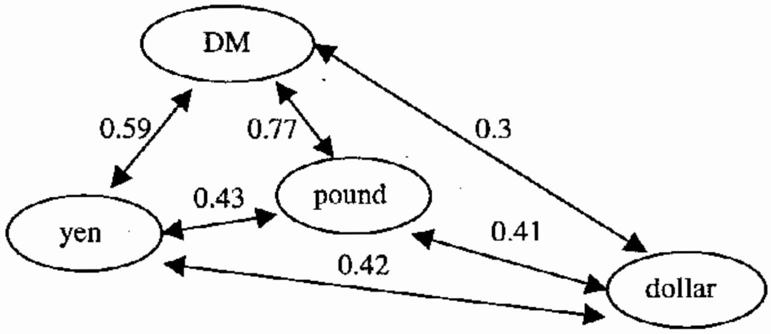
A. The variation in currency exchange rates.

The financial time series studied comprise the trivariate daily exchange rates of the pound sterling, the Japanese yen and the German deutsche mark, measured against the US dollar, running from 3 January 1986 to 12 April 1994, yielding 2158 observations on each series.

The exchange rate returns between the pound, the yen and the deutsche mark relative to the US dollar are highly positive correlated with each other. The highest correlation is between the pound sterling and the deutsche mark. Furthermore the pound sterling and the deutsche mark have the highest correlation of the standard deviations (volalitity), the skewnesses and the kurtoses for exchange rate returns.

The correlation of four currency exchange rate returns is calculated, taking each currency in turn as the referent currency. The high correlation between the pound and the deutsche mark is remarkable. However, the correlation between the yen and the pound is not consistent when using the dollar and deutsche mark (0.617 or 0.252), respectively, as the referent exchange rate. These correlations are shown in Figure 5.1.

Figure 5.1: Correlation between exchange rates (taking each currency in turn as the referent currency)



B. Statistical modeling of stochastic volatility

The following conclusions were obtained from the study.

1. The exchange rates need to be transformed by taking logarithms, to remove the relation between the standard deviation and the mean

2. The log-transformed exchange rates need to be differenced, to remove the autocorrelation. These differences are called the compounded returns from one trading day to the next.

3. The compounded returns have similar distributions, which have longer tails than the normal distribution. The kurtosis is greater than 5 in each case.

4. The means of the exchange rate returns are stationary and close to 0, so the mean is not a useful predictor of the exchange rate.

5. The standard deviations (volatilities) of the exchange rate returns are not constant, and appear to follow a random walk in which the 25-day averages are well fitted by a first-order autoregressive process with parameters approximately equal to 0.3.

6. In the time series analysis, we select period of 25 days to estimate the volatility of each series from 20 to 40 days. This is because periods of 25 trading days show the highest first –order autocorrelation coefficient in the time series analysis based on the averages.

7. The time series analysis of the volatility over periods of 25 days for the pound, the yen and the deutsche mark related to US dollar, show that the volatility of three currency returns is not constant (p-values 0.0003, 0.02 and 0.005, respectively).

8. The estimated standard deviations and kurtosis coefficients of these simulated exchange rate returns are close to those for the data and look just like the volatility series based on the data, but the estimated skewness coefficients are less than those of the data.

9. The time series analyses for the volatility series based on 25-day averages of the simulated data are computed for $\alpha = 0.9$ and $\alpha = 0.95$. This series is fitted well by a first-order autoregression, showing that the volatility is not constant.

The model we have used to describe to compounded early exchange rate returns may be written as

$$y_t = \mu + (\sigma + \delta u_t) z_t,$$

where u_t is a stationary first-order autoregressive process, that is

$$u_t = \alpha u_{t-1} + w_t$$

In the model the autocorrelation coefficients are zero at all positive lags. However, the autocorrelations of the squares are positive, provided $\alpha > 0$.

Thus, we have developed a methodology for modelling exchange rates that can be applied to other currencies.

Limitations

General statistical tests are needed to test for constant volatility, skewness, and kurtosis. The test for constant volatility we used assumed that $\alpha > 0$.

The simple model we used (the limit as $\delta \to 0$ and $\alpha \to 1$ with $\delta\alpha \to \kappa$) does not fit the data, as shown by Figure 4.4.

The skewness in the data does not appear to be constant. The skewness in the model is constant, so a better model is needed.

Suggestions for further study

First, some better method for estimating the volatility series is needed. Some form of robust smoothing could be used.

Second, if an effective estimate of the volatility is available for each trading day, it is possible to obtain the white noise series z_t directly, and to obtain its distribution. If this distribution is not normal, a more general model is needed.

Finally, more extensive data need to be collected, especially data from countries in the South East Asian region.