May 18. 2011. Liberec

Financial Market (Theory and Practice)

:Arnott's paper (Clair voyant). MV approach.(quality of stock investment)

:Derivatives in Japan : Journalism

:Gosou-Sendan Houshiki contains "implicit contracts" with several main stochastic process of well-controlled very small volatility(compare with US firms or current free economy.

: VaR did not work during the crisis period

: BDS statistics & Stock indices

: Interest rates with 3 or 4 factors in term structures

: derivatives to reduce risk (particular risk components) with necessary cost. This is available for cost ;not for free.

“Basic View of Financial Securities”

in my lectures

4^{th}.Floors. Variety of Derivatives.

3^{rd}.Floors : Options (Call, Put)

2nd. Floor : Forwards, Futures, Swaps

1st. Floor : Stock, Bond, Commodity.

Currency Exchange. Loans.

Ground: Economic Activities (Firms,Individuals,Government)

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Financing : its Function and Instruments.

Needs for Risk Management

New kinds of Securities/Derivatives

: large volume and not a simple price behavior

: need systematic measurement?

: Regulation side and Banks

1988. Basel committee and BIS. And Regulators.

Since 1988--- development of statistical analysis/system

1. Value at Risk (VaR)

Measure the Market Risk
(statistical methodology)

Today's price is known, but what about tomorrow's.

Change of the Market Price of Portfolio.

Daily change. 10 days change.

Uncertainty. Stochastics (randomness?).

Technical matter

Rate of change = change/(today' price)

How do we measure this ? Statistical methodology comes in.

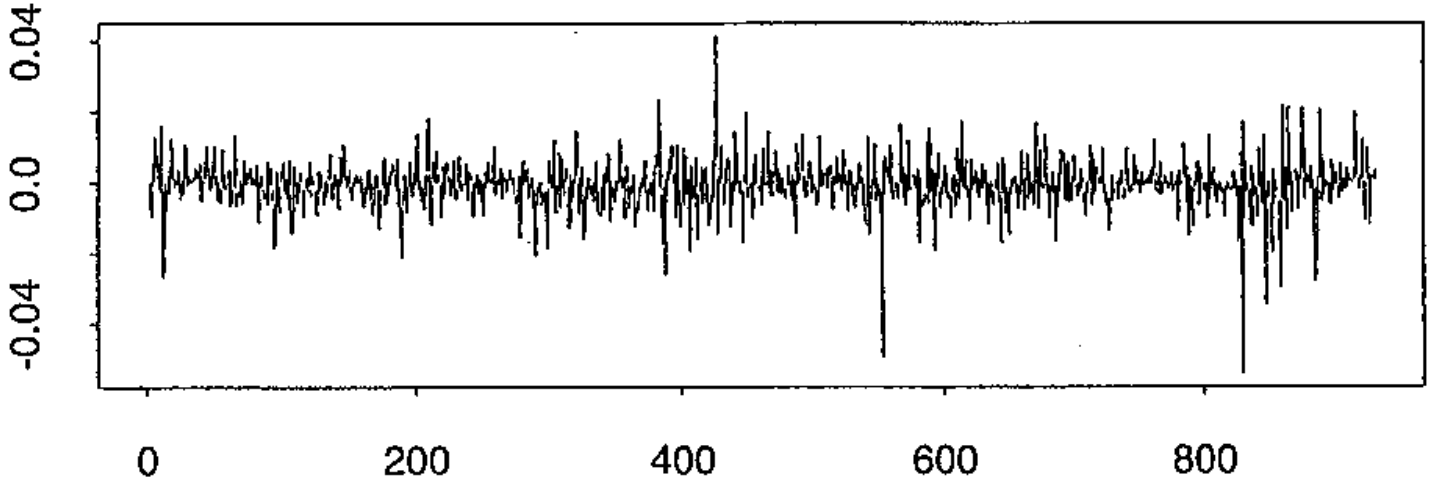

Figure 1. YEN/USD daily data: time series plot of log-ratios.

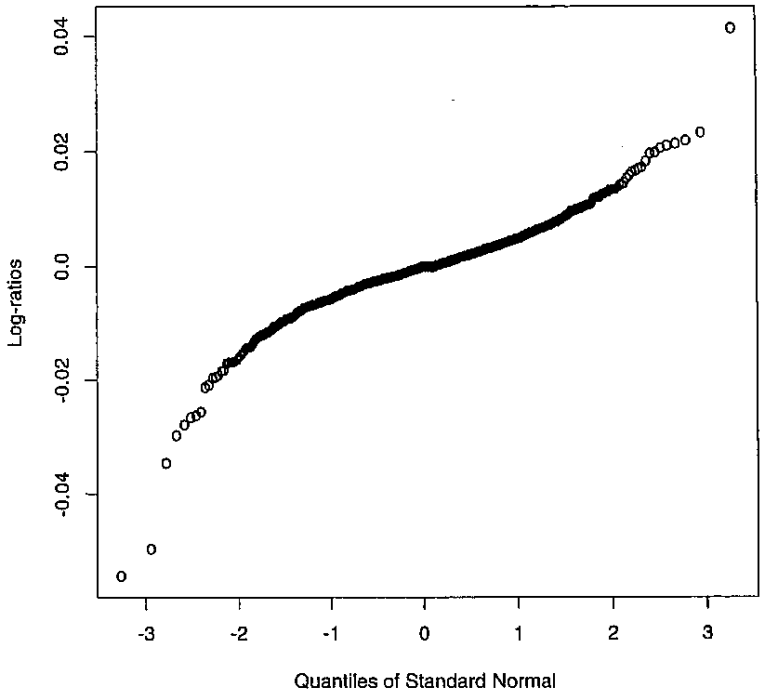

Figure 2. YEN/USD daily data: normal probability plot of log-ratios.

2. The I.I.D. Normal Model

Let $S_{i,t}; i = 1, \ldots, n$ be the values of n assets in portfolio at time t. For each factor asset, the rate of return $X_{i,t} = (S_{i,t+1} - S_{i,t})/S_{i,t}$ is the building block of the estimation as follows. The rate of return is approximately the log-ratio $Y_{i,t} = \log S_{i,t+1} - \log S_{i,t}$. Given the investment ratios $a_i; i = 1, \ldots, n$ with $\sum_{i=1}^{n} a_i = 1$, the rate of return of the portfolio is written as $X_t = \sum_{i=1}^{n} a_i X_{i,t}$ and

$$V_{t+1} - V_t = V_t X_t = V_t \sum_{i=1}^{n} a_i X_{i,t} .$$

The starting point is then making a graph of the past returns as in Figure 1 where the log-ratios of YEN/USD daily data are plotted against time. Once we assume that daily returns are independent and identically distributed (i.i.d.), the normal probability plot such as Figure 2 is useful to identify the shape of the probability distribution.

Under the i.i.d. normal assumption, $X_{i,t}, X_{i,t-1}, \ldots$ are assumed to be i.i.d. normal random variables for each i. The mean $\mu_i = E(X_{i,t})$ and the covariance $\sigma_{ij} = \mathrm{Cov}(X_{i,t}, X_{j,t})$ are therefore time-independent. Then,

$$V_{t+1} - V_t = V_t \sum_{i=1}^{n} a_i X_{i,t} \sim N(V_t \mu_p, (V_t \sigma_p)^2), \tag{1}$$

where $\mu_p = \sum_{i=1}^{n} a_i \mu_i$ and $\sigma_p^2 = \sum_i \sum_j a_i a_j \sigma_{ij}$. Given the value of V_t, the increment is also a normal random variable. The $\alpha\%$ point of the portfolio increment is easily computed as $V_t(\mu_p - z_\alpha \sigma_p)$ using the $\alpha\%$ quantile z_α of the standard normal distribution.

Given a sample $X_{i,t-1}, \ldots, X_{i,t-T}$ over T time periods, the usual estimates of the mean vector $\boldsymbol{\mu} = (\mu_1, \ldots, \mu_n)^\top$ and the variance-covariance matrix $\Sigma = [\sigma_{ij}]$ are the sample mean $\hat{\boldsymbol{\mu}}$ and the sample variance-covariance matrix $\hat{\Sigma}$; i.e.,

$$\hat{\mu}_i = \frac{1}{T} \sum_{s=1}^{T} X_{i,t-s}, \quad \hat{\sigma}_{ij} = \frac{1}{T} \sum_{s=1}^{T} (X_{i,t-s} - \hat{\mu}_i)(X_{j,t-s} - \hat{\mu}_j).$$

Once we have these estimates, the VaR of a portfolio with arbitrary value of investment ratios can be economically estimated from the Equation (1).

Statistical Models

for daily change (rates of change)

Normal distribution ?

Non-Normal ?

Fat tails and Stochastic Volatilities

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Database. Statistical Analysis.

Communication Network. Computing.

Statistical analysis +Computing + mathematics + economics + database management

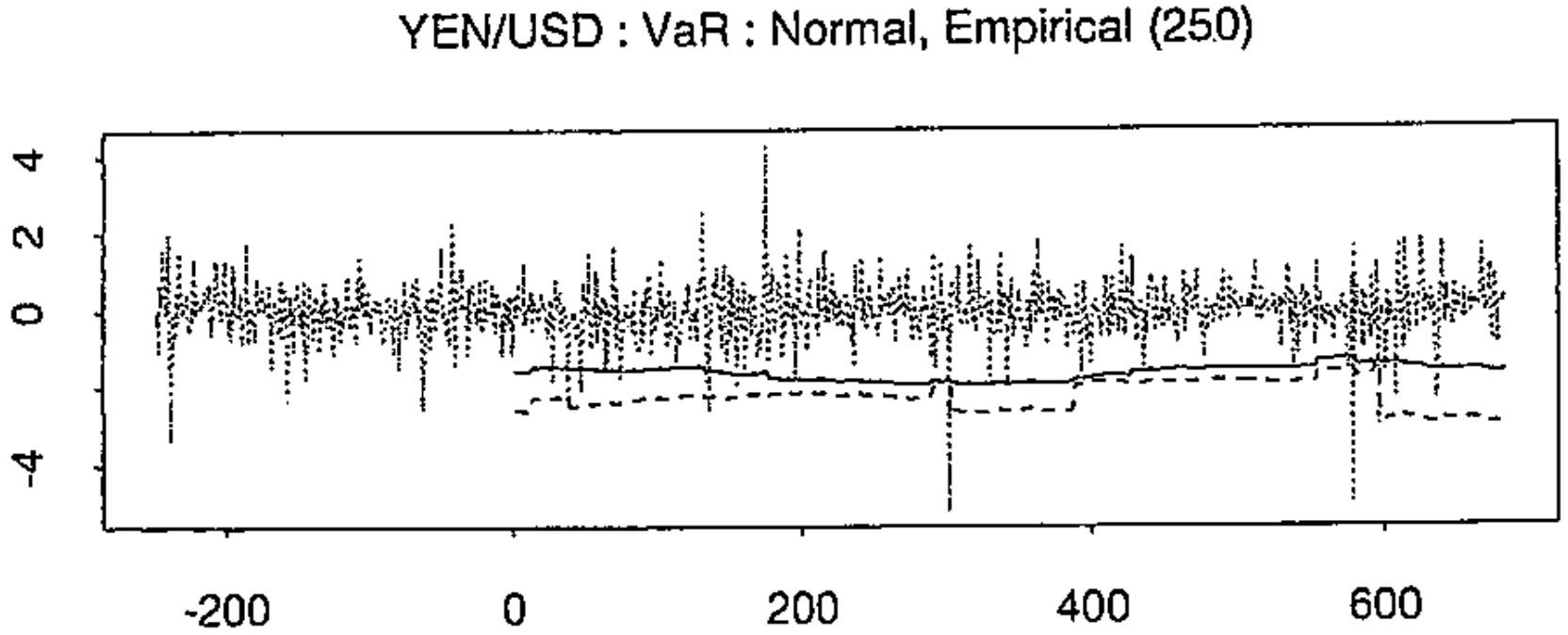

Figure 4. YEN/USD daily data: 1% VaR estimates by i.i.d. normal model (solid line) and empirical CDF model (broken line) along with log-ratios.

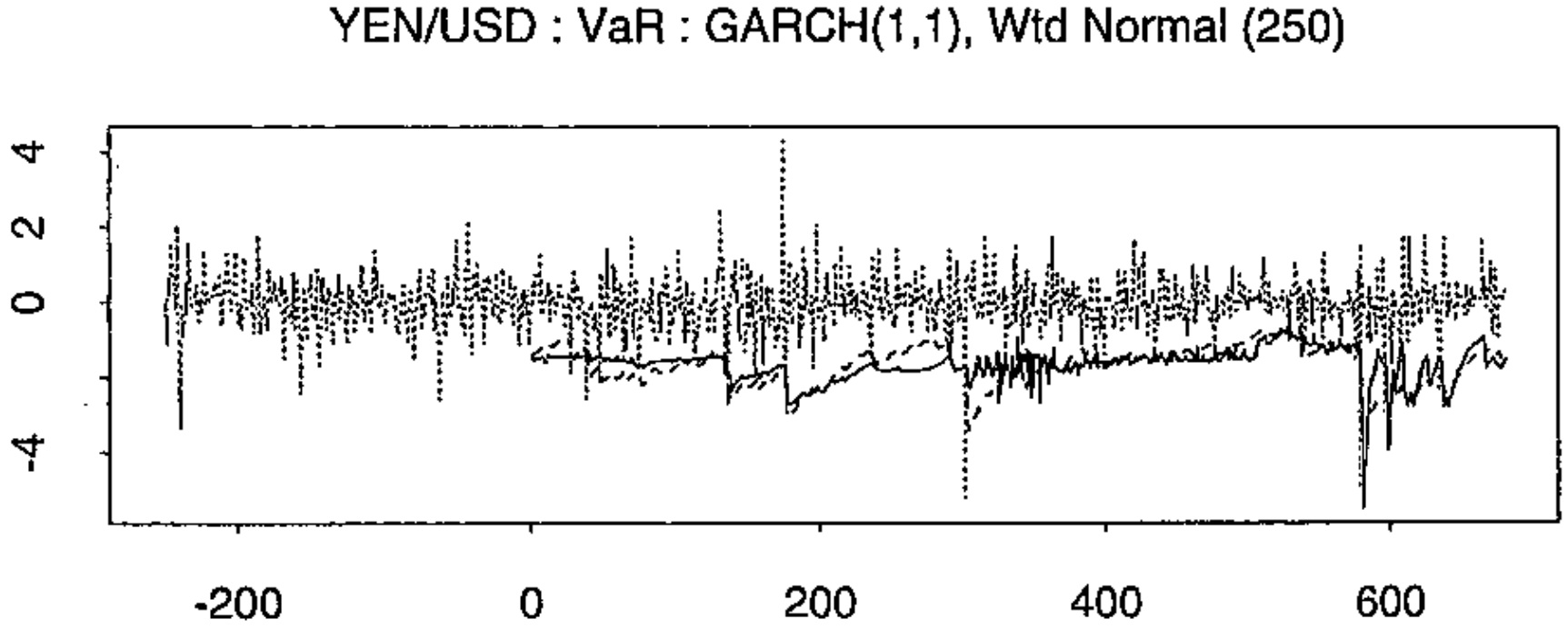

Figure 9. YEN/USD daily data: 1% VaR estimates by GARCH(1,1) model (solid line) and weighted normal model (broken line) along with log-ratios.

Figure 9 draws an example of the VaR estimates by univariate GARCH(1,1) model. The VaR estimates move rather radically as if they copied the rates of return themselves. We may ask whether the move is too sharp from a practitioner's point of view.

2008/2009 Financial Crisis and VaR

Did VaR work well during the crisis period?

: Need to see

the statistical property of the price movements and

assumptions the methodology is based on.

2. Stock price
: Theory and Reality

Arnott (2003,2010).J.of Portfolio management.

Reality: Price of stock in the year of 1956.

Observe the price and dividend 1956—2002.

: Clairvoyant (if we look back ?).

Theory : Stock price is the present value of future capital gain and dividends

3. Options : Call and Put.

: 2005 in Japan.

Call – 3▪Put.

K=100. S= Yen/USDollar exchange rates

5 years contracts

: In 2005, Never thought of the rate going down to 80 yen per dollar in a few years ?

4. Mean Variance Approach

: Means, Variances, covariances

of rates of returns (rate of price changes) of Stocks and bonds.

: Mathematical Theory assumes these parameter values are known. But they are not known in Reality, so estimation is required. Estimation has errors.

: Markets have Informational efficiency (?)

5. Swap Interest rates in Japan 1987--1993

: Decomposition of time series data.

: Locally weighted regression

: Use this twice.

: 1 year span.

: 1 month span.

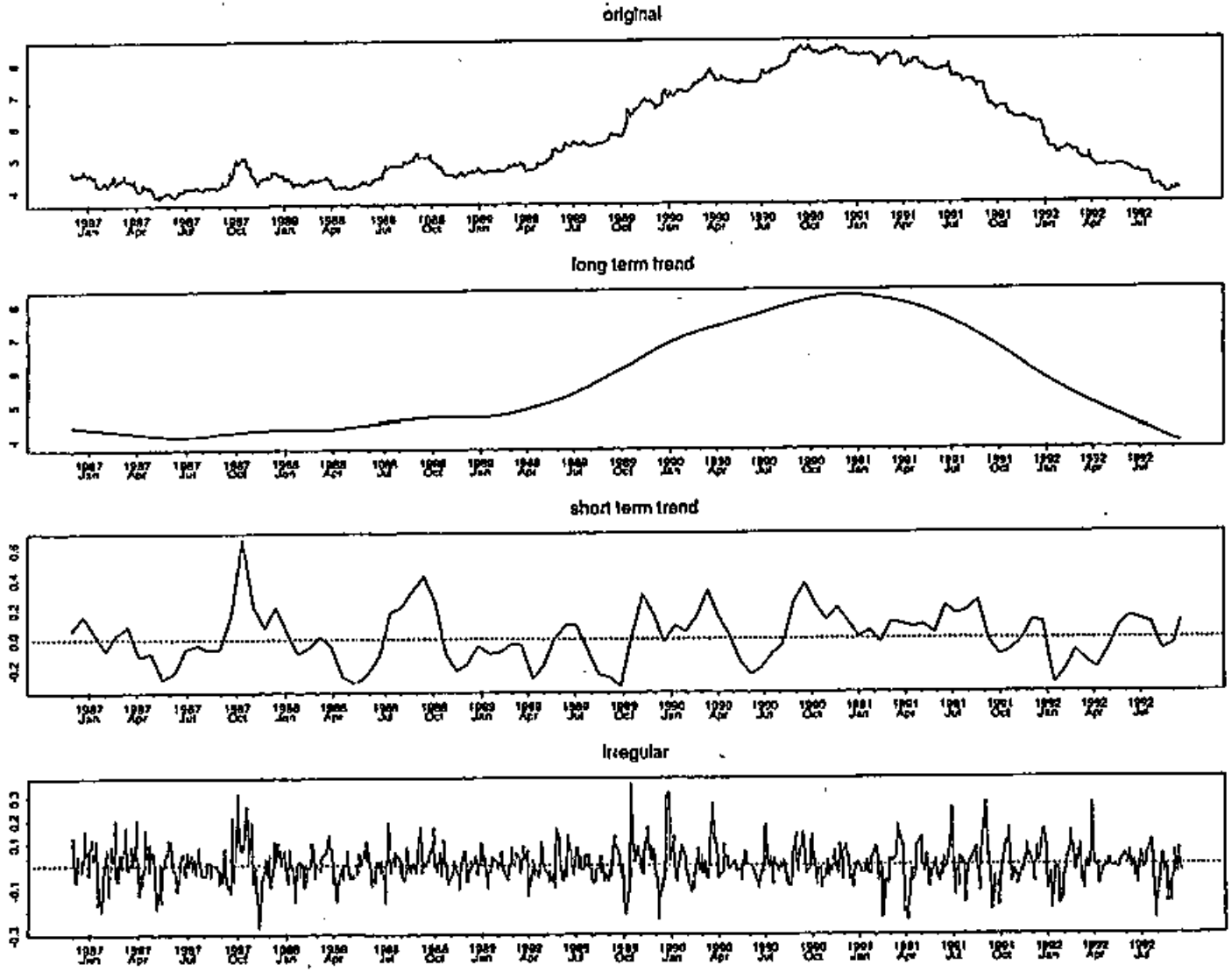

Figure 3. Decompositi on of the 3 month Euro Yen interest rate series, shown on the top panel, into the following three components, the long term trend, the short term trend and the irregular series.

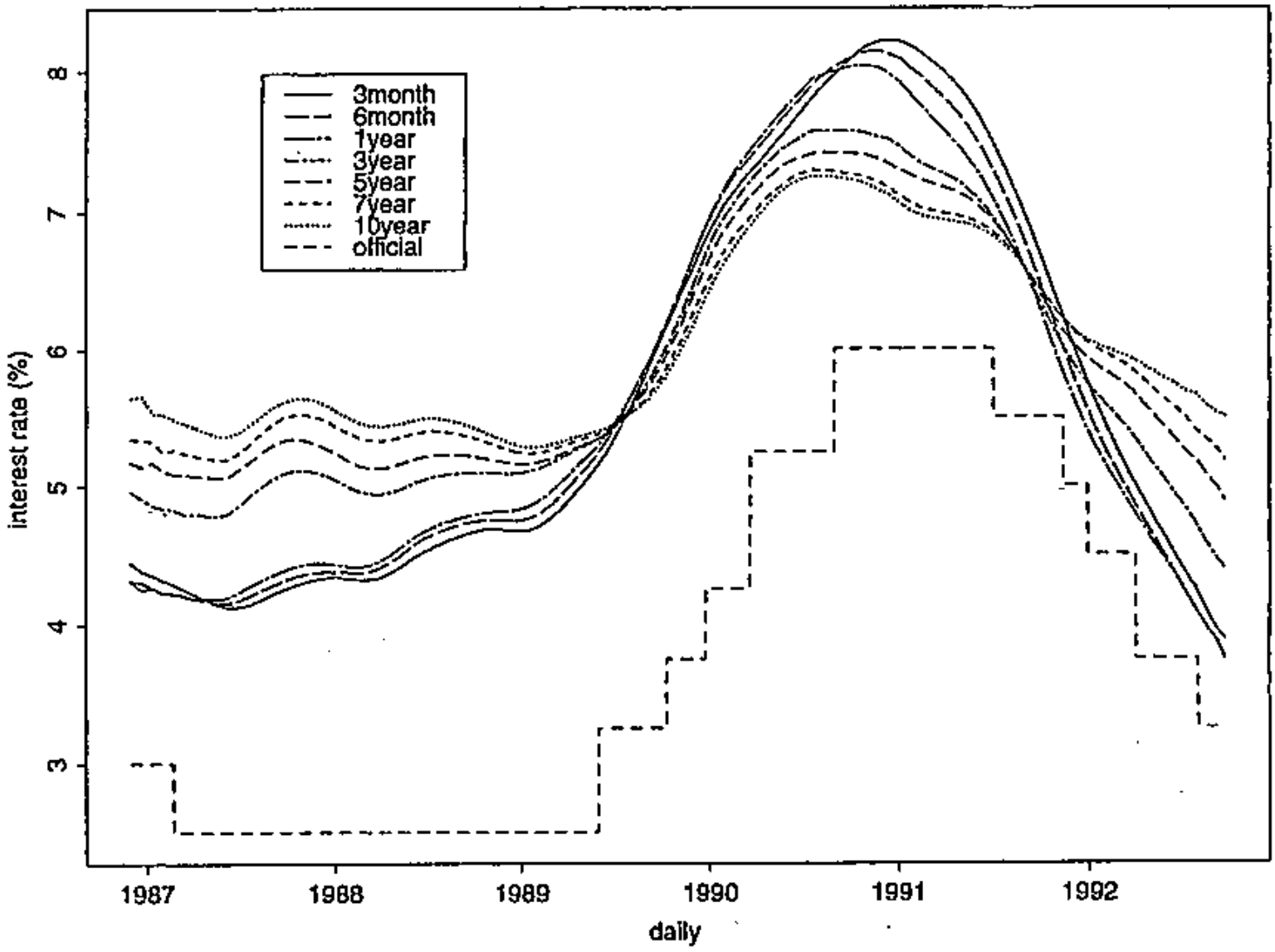

Figure 4. Long term trends and the official discount rate series.

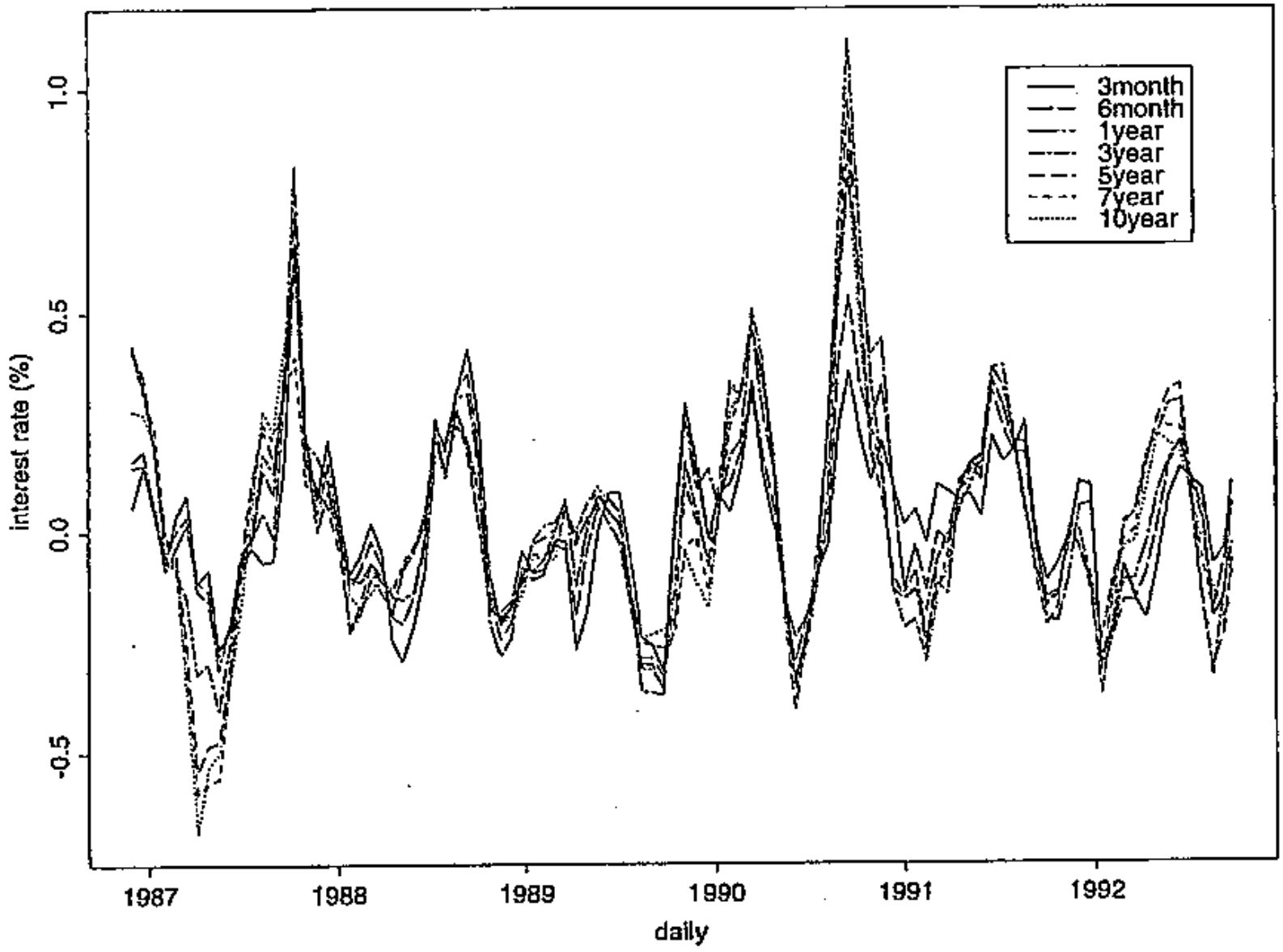

Figure 6. Short term trends

6. Interest rates. Tern structure.

: Daily differences for each term.

: Take many terms: 3 months --- 10 years.

: Use Principal component analysis to find factors.

Thank you.

Tomorrow

Th. 19th. : Rating of Firms.