Ejercicios propuestos C. Alexander – II.2 Principal components

1. A portfolio of UK government bonds has been mapped to interest rates at maturities 1 year, 2 years, ..., 20 years. The cash flow (in £m) and PV01 sensitivity vectors of the portfolio are shown in the spreadsheet. Use monthly data on these interest rates from 31 December 1994 to 31 December 2007 to build a principal component factor model for this portfolio.
2. A UK company has forward payments of $1 million on the 5th of every month over the next 5 years. Using the Bank of England daily interest rate data from 1 month to 60 months between 4 January 2005 and 31 December 2007 and the daily exchange rate data over the same period given in the spreadsheet for this example, apply a principal component factor model to the UK spot rates to describe the interest rate, foreign exchange and correlation risks on 31 December. On this day the sterling-dollar exchange rate was 1.9909 and the US discount curve is given in the spreadsheet.
3. The spreadsheet contains daily prices of twelve constant maturity futures, between 1 and 12 months, on West Texas Intermediate crude oil over the period from February 1992 to February 1999. Performa a permanent component analysis on the correlation matrix of daily log returns.
4. Consider again the factor model estimated in exercise 2, that describes P&L as a function of three permanent components. How much should we ad of the 10-year bond so that the new portfolio's P&L is invariant to changes in the first principal component, i.e., to an almost parallel shift in interest rates? Having done this, how much should we then add of the 5- and 15-year bonds so that the new portfolio's P&L is also invariant to changes in the second principal component, i.e., a change in the slope of the yield curve?
5. A UK company has a fixed stream of liabilities of £1 million per month over the next 5 years. It seeks to finance these by issuing zero coupon bonds at 1, 3 and 5 years to maturity. How many bonds should it issue (or indeed, purchase) on 31 December 2007 so that its portfolio of assets and liabilities has zero sensitivity to parallel shifts and changes in slope of the UK government spot yield curve?
6. Use the factor model representation for the bond portfolio in exercise 1to estimate the following: a) the portfolio's P&L volatility based on a one-, two- and three component representation. Compare your result with the portfolio's P&L volatility that is calculated without using the factor model, b) the 'worst case' loss when the yield curve shifts, tilts and changes convexity and these movements are based on the principal components. How would you evaluate the 'worst case' loss without references to the factor model?
7. The spreadsheet for this exercise contains data on spot euro interest rate indices based no a) all euro AAA issuer companies and governments and b) all euro A- to AA issuer companies and governments (http://sdw.ecb.europa.eu). On both curves the spot rates have ten different maturities between 1 and 10 years. Find the eigenvalues and eigenvectors of the 20x20 combined covariance matrix and interpret the first few principal components.
8. Perform a combined principal component analysis on the covariance matrix of monthly changes on the USD, EURO and GBP yield curves (Figure II.2.12) and interpret the principal components.
9. Consider the following portfolios of DJIA stocks: a) an arbitrary fund portfolio with long and short positions in any of the 30 stocks, b) a portfolio with equal weights in each of the 30 DJIA stocks, c) the DJIA portfolio.