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In this review session, we will be working with the 6 FF portfolio returns (returns.txt). We will also need two program files: `opt_port.prg`, which calculates the optimal portfolio weights and returns, and `dcc.prg`, which estimates the dcc model.

We begin by loading the data set and converting the raw returns on the portfolios into excess returns. Notice that the column `mkt_rf` contains the excess market return and the column `rf` the annualized risk-free rate.

```eviews
series mse=ms-rf/52
series mbe=mb-rf/52
```

We will construct portfolio returns for a strategy that trades in the Mid-Value, Small Stock portfolio (MS) and Mid-Value, Large Stock portfolio (MB).

## 1 Factor Model

Consider estimating a factor model for MS and MB. Recall that this is given by:

$$r_e^i = \beta_{0i} + \beta_{1i} r_e^M + \epsilon_i, \quad i = \{MS, MB\},$$

where the superscript $e$ denotes excess returns. In EViews, we use:

```eviews
vector(2) beta0
def beta0=1
vector(2) beta1
def beta1=2
def nu(1)=@var(residms)
equation lsms.ls mse c mkt_rf
beta0(1)=c(1)
beta1(1)=c(2)
series residms=resid
nu(1)=@var(residms)
equation lsmb.ls mbe c mkt_rf
beta0(2)=c(1)
beta1(2)=c(2)
series residmb=resid
nu(2)=@var(residmb)
```

Consider now estimating a GARCH model for the excess market return. Recall that, for GARCH estimation, we use the `arch` function:

```eviews
equation garch11.arch(1,1) mkt_rf
garch11.makegarch garch11var 'save the conditional GARCH variance
series garch11vol=@sqrt(garch11var) 'compute the corresponding vol
series garch11err=mkt_rf/garch11vol 'compute the standardized residuals
```
Then, to construct the conditional correlation between MS and MB, we would use:

```plaintext
series corr=beta1(1)*beta1(2)*garch11var/@sqrt((beta1(1)^2*garch11var+nu(1)) *(beta1(2)^2*garch11var+nu(2)))
series corr_fact=corr
```

The conditional correlation is plotted in Fig. 1. Notice that, to compute the variance of a portfolio which has \(\alpha\) invested in the MS portfolio and \((1 - \alpha)\), we use:

\[
\text{var}(\alpha r_{MS} + (1-\alpha)r_{MB}) = \alpha^2(\beta_{1,MS}^2h_t+\nu_{MS}) + (1-\alpha)^2(\beta_{1,MB}^2h_t+\nu_{MB}) + 2\sqrt{\alpha(1-\alpha)}h_t\rho_t
\]

### 2 Conditional Portfolio Weights

Consider now calculating optimal portfolio weights for the strategy that trades in MS and MB. The program `opt_port.prg` calculates the returns for the unconditional weights and weights given by the correlation time series. In particular, the program file contains a subroutine called `portfolio`, which takes the desired level of return \((\mu_0)\) and the start point of the calculation as an argument. To call this in EViews, we would use:
series hx=beta1(1)^2*garch11var+nu(1)
series hy=beta1(2)^2*garch11var+nu(2)
series x=mse
series y=mbe

include opt_port
call portfolio(0.05,1)
series ret_fact=ret

Notice that we need to provide the conditional variance time series for the routine.

3 DCC model

Now, consider estimating a DCC model for the excess returns. For this, we will use the \texttt{dcc} program. In particular, we use:

\begin{verbatim}
include dcc
series corr_dcc=corr
\end{verbatim}

Then, to calculate the optimal weights and the corresponding returns, we call once again the portfolio subroutine:

\begin{verbatim}
call portfolio(0.05, 2)
series ret_dcc=ret
\end{verbatim}

The returns to the three trading strategies are plotted in Fig. 2.
Figure 2: Portfolio returns