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Note

User's guide

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1. Introduction

In this short note, we describe the specifications for some of the programs that were used to estimate the models used in the paper “Conditional Volatility, Skewness and Kurtosis: Existence, Persistence, and Comovements” by Jondeau and Rockinger (2003). The programs described in this note are public and may be obtained from the [www](http://www.fame.ch/research/papers/OccPapers/Rockinger.htm) (<http://www.fame.ch/research/papers/OccPapers/Rockinger.htm>) or by sending an e-mail (MR@fame.ch) to the authors.

All these programs use the optimization algorithm SNOPT developed by Gill, Murray, and Saunders. SNOPT is developed in Fortran 77. The copyright for SNOPT is held jointly by the University of California and Stanford University. The licensing arrangements are taken care of by the Office of Technology Licensing (OTL) at Stanford. We obtained authorization to distribute the models as stand-alone applications. We are also distributing the Fortran programs that may be used as interface for SNOPT, however, for copyright reasons, we cannot distribute SNOPT. Notice that we use a Windows platform and Compac Visual Fortran V6.5.0.

The reader of this note may also wish to obtain from the www the reports describing the algorithm implemented in SNOPT. The documentation may be found in Gill et al. (1997b). In the document Gill et al. (1997a), the reader may find information how directions can be given to SNOPT on issues such as convergence criterion. Since convergence does not necessarily mean optimum, the reader may find directions on how to interpret the output of SNOPT.

The various stand-alone applications that we provide expect a file with univariate data named SP.txt. If the user wishes to run the programs on his own data, he/she would have to create different univariate datasets. Proceeding in this way is for reasons of simplicity. The applications start by reading in the data provided by the user. They also read in a file with initial values. The user may wish to modify a specification file

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that instructs SNOPT how to behave. For instance, one may wish to limit the maximal number of iterations or the precision before convergence occurs.¹

2. The models

Let r_t , $t = 1, \dots, T$, be a series of returns. The program centers the data in a first step. We assume, therefore, to keep notations simple, that r_t have a zero mean. At a first level, we assume that

$$\begin{aligned} r_t &= \sigma_t \varepsilon_t, \\ \varepsilon_t &\sim \text{GT}(\eta_t, \lambda_t), \\ \sigma_t^2 &= a_0 + b_0^+ r_{t-1}^+ + b_0^- r_{t-1}^- + c_0 \sigma_{t-1}^2, \end{aligned}$$

where $\text{GT}(\eta_t, \lambda_t)$ is the generalized t distribution, first presented by Hansen (1994). The various models vary in their specification of the dynamics for η_t and λ_t . We consider

$$\begin{aligned} \text{Model M1 : } & \begin{cases} \tilde{\eta}_t = a_1 + b_1^+(r_{t-1}^+)^2 + b_1^-(r_{t-1}^-)^2, \\ \tilde{\lambda}_t = a_2 + b_2(r_{t-1})^2. \end{cases} \\ \text{Model M2 : } & \begin{cases} \tilde{\eta}_t = a_1 + b_1^+(r_{t-1}^+)^2 + b_1^-(r_{t-1}^-)^2 + c_1 \tilde{\eta}_{t-1}, \\ \tilde{\lambda}_t = a_2. \end{cases} \\ \text{Model M3 : } & \begin{cases} \tilde{\eta}_t = a_1 + b_1^+(r_{t-1}^+)^2 + b_1^-(r_{t-1}^-)^2 + c_1 \tilde{\eta}_{t-1}, \\ \tilde{\lambda}_t = a_2 + b_2(r_{t-1})^2 + c_2 \tilde{\lambda}_{t-1}. \end{cases} \end{aligned}$$

We use the maps $\eta_t = g_{[L_\eta, U_\eta]}(\tilde{\eta}_t)$, and $\lambda_t = g_{[L_\lambda, U_\lambda]}(\tilde{\lambda}_t)$ to restrict the parameters η_t and λ_t to the domain $[2.1, 30]$, respectively $[-0.95, 0.95]$. To do so, we set $(L_\eta, U_\eta, L_\lambda, U_\lambda) = (2.1, 30, -0.95, 0.95)$. We also recall that the logistic function that maps a real number into $[a, b]$ is given by $g(x) = a + (b - a)/(1 + \exp(-x))$.

3. Installation

The implementations of the various models M1, M2, and M3 are given in the programs TVSK1, 2, and 3, respectively. We assume that these programs are installed in the directory `c:\Rocky`. This choice of directory is crucial since the programs are expecting the input files to be located in that directory and also the output files will be written into that directory.

¹ In our study we never hit the upper bound that we set equal to 1000 iterations. A convergence criterion such as a precision of the relative gradients of 10^{-5} seems adequate.

The following table summarizes the various calls and files that are required:

Program	Model	Data	Initial parameters	Specification file	Result file	Output file
TVSK1.exe	M1	SP.txt	Init1.txt	Spec1.spc	Res1.out	Run1.out
TVSK2.exe	M2	SP.txt	Init2.txt	Spec2.spc	Res2.out	Run2.out
TVSK3.exe	M3	SP.txt	Init3.txt	Spec3.spc	Res3.out	Run3.out

The data file SP.txt should not contain missing values. The user should specify the returns r_t here. The program expects the first column of that file to contain the dates. In case the user does not want to specify the dates, this column could contain any type of number.

The meaning of the variables in the specification files is documented in the user's guide provided with SNOPT, i.e. Gill et al. (1997a).

The Res.out files contain several lines:

- *Retcode* in line 1.
- *Time* in line 2.
- *Lik* in line 3.
- Parameters and associated standard errors.

Retcode contains a number that indicates how the algorithm converged. A 0 in this line indicates a normal convergence. Further explanations concerning this number can be found in the SNOPT user's guide. *Time* indicates how much time was required before the algorithm converged. *Lik* gives the values of the log-likelihood. The parameters list always provides with the parameter estimates with their associated standard error.

After installation of the programs, data and specification files, the programs may be run by double clicking on them from the Explorer. A DOS window will display the various steps of the iterations.

Appendix

The SNOPT interfaces TVSK1.for, TVSK2.for, and TVSK3.for may be found in Perex.zip. The reader can notice in the subroutine TVSKobj the expressions for the likelihood and for the analytical computations of the gradients.

The first and last three observations of the file SP.txt are

```
230871          1.021914
240871          1.06139
250871         -1.65708
...           ...
```

120599	0.35197
130599	-2.246518
140599	0.607456

The user may replace this data by his own series.
The file Init1.txt contains the following initial values

0.005
0.015
0.1
0.8
-1.0
-0.5
0.0
0.01
0.0

Some of the elements of the output file Res1.txt are

Retcode	0
Time	22.91
Nobs	7168
Lik	-8625.094
a_0	0.008366
s.e.	0.002389
b_0^+	0.033084
s.e.	0.005335
...	...
c_2	0.045303
s.e.	0.031329

This corresponds to the results reported in Table 3 of the paper.

The output file Run1.out contains detailed information on how the optimization proceeded. Among other thing, this file reports a verification of the analytical gradients.

References

- Gill, Ph.E., Murray, W., Saunders, M.A., 1997a. User's Guide for SNOPT 5.3: a Fortran Package for Large-Scale Nonlinear Programming. <http://sdna3.ucsd.edu/~peg>, <http://www.stanford.edu/~walter>, <http://www.stanford.edu/~saunders>.
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