Comments, Corrections, and Further Explanations for *Statistics and Data Analysis of Financial Engineering, 2nd edition*

Last updated: April 25, 2024

- Page 2, 3rd paragraph: In the description of Chapter 16, "risky assets" is repeated. It should appear only once.
- Page 17, Exercise 9: "small value" should be "smallest value".
- Page 32, first displayed line after (3.21): $r_1 = y_n$ should be $r_1 = y_1$.
- Page 53, last line of footnote: "quantiles" should be "quintiles".
- Page 81, line before Problem 11: Change "QQ plot" to "normal QQ plot."
- Page 82, Problem 7: Change "smallest variance" to "smallest approximate variance," since Result 4.1 provides only an approximate variance. Also, the minimum variance is not actually attained on the set $0 < q < 1$.
- Page 92, line 5: `jarque.bera.test()` is in the `tseries` package.
- Page 119: On this page, L is the log-likelihood, not the likelihood. This notation conflicts with earlier notation where L is the likelihood. This conflict is removed by replacing L by $\log L$ on this page.
- Page 139, line -8: "denominator of (6.1) we used" should be "denominator of (6.2) we used".
- Page 151, second line after Problem 1: "Sect. 6.4" should be "Sect. 6.3".
- Page 169, line 6: "`nu=df`" should be "`nu=df[i]`".
- Page 173, Example 7.5: The algorithm had not yet converged and the reported fit is incorrect. The control parameters should be changed from the default values as below.

  ```
  fit = mst.mple(y=dat,penalty=NULL,
       control=list(iter.max=500, eval.max=750))
  ```

  The revised output shows that the AIC for the skewed-t is lower than that of the symmetric-t model, so the skewed-t model fits better by the AIC criterion.

  ```
  > options(digits = 5)
  > dp2cp(fit$dp,"st")
  $beta
              ge        ibm      mobil       crsp
  [1,] 0.0011541 0.00069199 0.00080083 0.00074143

  $var.cov
                ge        ibm      mobil       crsp
  ge    1.8915e-04 7.2780e-05 5.1480e-05 6.8907e-05
  ```

```
ibm   7.2780e-05 2.7466e-04 3.4455e-05 5.7543e-05
mobil 5.1480e-05 3.4455e-05 1.7425e-04 4.2008e-05
crsp  6.8907e-05 5.7543e-05 4.2008e-05 5.5160e-05

$gamma1
       ge       ibm     mobil      crsp
 0.182401  0.160374  0.097478 -0.042757

$gamma2M
[1] 25.677

> aic_skewt
[1] 5.3331
```

- Page 178, line 12: "`f it$cov`" should be "`fit$cov`".
- Page 211, Problem 6 (a): "`fit_cop`" should be "`ft`".
- Page 278: p should be $p+1$ in two denominators, that is, "For example, suppose that $r(t;\boldsymbol{\theta})$ is a pth-degree polynomial, so that

  $$\int_0^T r(t;\boldsymbol{\theta})\,dt = \theta_0 T + \theta_1 \frac{T^2}{2} + \cdots + \theta_p \frac{T^{p+1}}{p},$$

  and the yield curve is

  $$y_T = T^{-1}\int_0^T r(t;\boldsymbol{\theta})dt = \theta_0 + \theta_1 \frac{T}{2} + \cdots + \theta_p \frac{T^p}{p}.$$

  A popular model ..."

  should be

  "For example, suppose that $r(t;\boldsymbol{\theta})$ is a pth-degree polynomial, so that

  $$\int_0^T r(t;\boldsymbol{\theta})\,dt = \theta_0 T + \theta_1 \frac{T^2}{2} + \cdots + \theta_p \frac{T^{p+1}}{p+1},$$

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  A popular model ..."
- Page 355, line 13 of the `R` code: Delete "`ylim=c(-7,12),`"
- Page 365, line 2: "$(1 - 0.890\,B_4)$" should be "$(1 - 0.890\,B^4)$",
- Page 366, equation (13.5): See equation (4.5) on page 67 for a definition of $Y^{(\alpha)}$.
- Page 368, line 17: "The residuals from the The problem" should be "The problem".

- Page 377, equations (13.13) and (13.14): In (13.13), p is the number of explanatory variable. This notation conflicts with (13.14) where p is the order of the AR process. The p in (13.13) should be changed, say to p' or k.
- Page 385, 2nd line after (13.18): "eigenvectors" should be "eigenvalues".
- Page 390: Replace (13.22) by

$$\binom{d}{k} = \frac{d!}{k!(d-k)!}$$

- Page 411 and elsewhere: Notation for GARCH models varies with textbook and software. In our notation, p (or p_V) is the number of lagged values a_{t-i}^2 in the conditional variance, σ_t^2, and q (or q_V) is the number of lagged values σ_{t-i}^2 in σ_t^2. Also, we list p_V first, i.e., GARCH(p_V, q_V), not GARCH(q_V, p_V). The `rugarch` package avoids using p and q, but agrees with our notation that, for example, GARCH(2,1) would have two lagged values of the squared process and one lagged value of the conditional variance. Use care with other software to make certain you have specified your GARCH model correctly. Fortunately, specification of the commonly used GARCH(1,1) model is not affected by the choice of notation, but you should be careful about which coefficient goes with the lagged squared process and which goes with the lagged conditional variance.
- Page 418, fourth line after the `R` code: Change "The goodnes-of-fit test statistics are much smaller" to "The goodnes-of-fit test statistics are much smaller than when ϵ_t was assumed normally distributed"

  Also, I thank Peter Dalgaard, who has made many helpful suggestions about this book, for noting that in this time series there is an excess of returns that are exactly zero. In fact, approximately 10% of the returns are exactly zero. There is also a deficit of returns near, but not exactly, zero. To investigate this behavior, run the following code:

```
1 library(xts)
2 library(rugarch)
3 data(bmw, package="evir")
4 attr(bmw,"times")[(bmw==0)]
5 sum((bmw==0))
6 hist(bmw,5000,xlim=c(-0.002,0.002))
```

  Line 4 shows the dates of the returns that are exactly zero. Some are due to holidays. Line 5 counts the number of returns that are exactly zero. The histogram created by line 6 shows the distribution of returns near zero. The histogram has a tall spike in the bin containing zero and the other bins near zero have low counts. The histogram has 5,000 bins, but, of course, most of them are outside the range $(-0.002, 0.002)$.

  The cause of the excess number of returns that are exactly zero is unknown, but it might be related to the tick size, the minimum non-zero change in the price. Also, although weekends were not included there are some zero returns reported on holidays such as around December 25. The effect of this excess on the goodness-of-fit tests is also unknown but should depend on the number of bins in these tests.

- Page 419, equation (14.12): $+\beta\eta_{t-1}$ should be $-\beta\eta_{t-1}$.
- Page 419, line before (14.15): "necessary condition for a_t to be stationary" should be "sufficient condition for a_t to be stationary". A necessary condition is that the left hand side of (14.15) must be less than or equal to 1. In the case where the left hand side of (14.15) equals 1, a_t is stationary and is called the "integrated GARCH, or IGARCH, process." An IGARCH process is in many ways qualitatively different than a GARCH model with the left hand side of (14.15) strictly less than 1, e.g., an IGARCH process has an infinite unconditional variance.
- Page 422: The code as shown longer works, perhaps due to a change in the `rugarch` package. If `solver="hybrid"` is added to line 19, then the code works again.
- Page 427–428: Using r_t as the return on day t, the distribution of $r_{t+h}|r_1, \ldots, r_t)$ is normal only for $h = 1$. Therefore, the coverage probability of the plotted intervals is not exactly $1 - \alpha$. To obtain $1 - \alpha$ coverage, one can use the function `ugarchboot()` in the `rugarch` package. Another possibility is a Bayesian analysis. The GARCH(1,1) is Section 20.11 can be expanded to include an AR(1) model for the conditional mean and future observations can be sampled.
- Page 448, Exercise 7 (c): "heavy" should be "heavier".
- Page 457, line −6: "some $r \leq d$" should be "some $r < d$".
- Page 474, (16.6); "$\boldsymbol{\omega}$" should be "$\boldsymbol{w}$".
- Page 485, Result 16.2: "Assumptions" should be "Assumption".
- Page 486: On line 5 and in the caption to Figure 16.7, the definition of $\tilde{U}(x;\lambda)$ should be $\tilde{U}(x;\lambda) = U(x;\lambda)/U(1;\lambda)$, not $\tilde{U}(x;\lambda) = U(x;\lambda)/U(0;\lambda)$. The paragraph beginning on line 3 should start "Assume that $X_0 = 1$. This assumption is without loss of generality, since $U(x;\lambda)$ depends on (x,λ) only through the product λx so that X_0 can be subsumed into λ.
- Page 508, first line in code of Example 17.3: "capm.csv" should be "capm2.csv" (We changed the name of the file so that it could be put in the same data set folder as "Capm.csv". `R` is case-sensitive but not Windows.)
- Page 518, line −13: "$\boldsymbol{\alpha}^{\mathsf{T}}\boldsymbol{Y}_i = \sum_{j=1}^{p} \alpha_j Y_{i,j}$, where $\|\boldsymbol{\alpha}\| = \sum_{j=1}^{p} \alpha_i^2 = 1$" should be "$\boldsymbol{\alpha}^{\mathsf{T}}\boldsymbol{Y}_i = \sum_{j=1}^{d} \alpha_j Y_{i,j}$, where $\|\boldsymbol{\alpha}\| = \sum_{j=1}^{d} \alpha_i^2 = 1$." (Both summations are from 1 to d, not 1 to p.)
- Page 537, line after the first displayed matrix: "The estimate of $\boldsymbol{\beta}$ is the matrix …" should be "The estimate of $\boldsymbol{\beta}^{\mathsf{T}}$ is the matrix …"
- Page 555, line 7: "from 46,527 and α is 0.025" should be "from 46,527 and α is 0.0025". (Change 0.025 to 0.0025.)
- Page 556, third line below (19.29): "Y_1" should be "Y_i".
- Page 565

  The matrix on the top of page 565 is the scale matrix, not the covariance matrix. Therefore, portion of Example 19.6 on page 565 should be changed to the following:

$$\widehat{\boldsymbol{\Sigma}} = \begin{pmatrix} 1.94\text{e}-04 & 7.68\text{e}-05 & 5.44\text{e}-05 \\ 7.68\text{e}-05 & 2.76\text{e}-04 & 3.66\text{e}-05 \\ 5.44\text{e}-05 & 3.66\text{e}-05 & 1.75\text{e}-04 \end{pmatrix}.$$

For an equally weighted portfolio with $w = (\,1/3 \quad 1/3 \quad 1/3\,)^{\mathsf{T}}$, the mean return for the portfolio is estimated to be

$$\widehat{\mu}_P = \widehat{\mu}^{\mathsf{T}} w = 0.0006$$

and the standard deviation of the portfolio's return is estimated as

$$\widehat{\sigma}_P = \sqrt{w^{\mathsf{T}} \widehat{\boldsymbol{\Sigma}} w} = 0.0104.$$

The return on the portfolio has a t-distribution with this mean and standard deviation, and the same tail index as the multivariate t-distribution of the three stock returns. The scale parameter, using $\widehat{\nu} = 5.81$, is

$$\widehat{\lambda}_P = 0.00846.$$

Therefore,

$$\widehat{\text{VaR}}^{\,t}(0.05) = -S \times \{\widehat{\mu}_P + \widehat{\lambda}_P\, \widehat{q}_{0.05,t}(\widehat{\nu})\} = S \times 0.0128,$$

so, for example, with $S = \$20{,}000$, $\widehat{\text{VaR}}^{\,t}(0.05) = \$319$.

The estimated ES using (**??**) and $S = \$20{,}000$ is

$$\widehat{\text{ES}}^{\,t}(0.05) = S \times \left\{ -\widehat{\mu}_P + \widehat{\lambda}_P \left(\frac{f_{\widehat{\nu}}\{\widehat{q}_{0.05,t}(\widehat{\nu})\}}{\alpha} \left[\frac{\widehat{\nu} + \{\widehat{q}_{0.05,t}(\widehat{\nu})\}^2}{\widehat{\nu} - 1} \right] \right) \right\} = \$451.$$

- Page 566, (19.16): $f(y) \sim A y^{-(a+1)}$ should be $f(y) \sim A|y|^{-(a+1)}$.
- Page 566, (19.17): $\frac{A}{a} y^{-a}$ should be $\frac{A}{a}|y|^{-a}$.
- Page 666, Exercise 3:

$$s(x) = (x)_+ - 3(x-1)_+ + (x-2)_+$$

should be

$$s(x) = (x)_+ - 2(x-1)_+ + (x-2)_+.$$