

Corrections and Further Explanations for *Statistics and Data Analysis of Financial Engineering*

Last updated: March 23, 2015

- Page 11, displayed line: “Stock_bond.xsv” should be “Stock_FX_bond.csv”.
- Page 12, Problem 2: The question mark at the end of the first sentence should be a period.
- Page 13, line –9: “stayed between \$950,000 and \$1,000,000” should be “stayed between \$950,000 and \$1,100,000”
- Page 14, Exercise 3: “price” should be “prices”.
- Page 14: Exercise 5 (c) should be “What is the covariance between $r_2(1)$ and $r_2(2)$?”
- Page 26, first displayed equation in Example 3.3: “993.40” should be “943.40.”
- Page 36 and elsewhere throughout the book: `fEcofin` package: At the time the book was written `fEcofin` was available on CRAN. However, `fEcofin` is no available longer on CRAN. I was able to install it using `install.packages("fEcofin", repos="http://R-Forge.R-project.org", type="source")`.
- Page 37, problem 7 (c): “\$828” should be “\$818”.
- Page 38: 7th line in problem 12: “0.03” should be “0.036”.
- Page 41, line –2: “random” should be “randomly”.
- Page 51, line –10: “replaced by the medium” should be “replaced by the median”
- Page 60, 1st paragraph: The description of the Shapiro-Wilk test contains some inaccuracies. First, the test uses the expected normal order statistics, not $\Phi^{-1}\{i/(n+1)\}$, though the former are approximately equal to the latter in large samples. Moreover, in the Shapiro-Wilk test, the vector of expected order statistics is multiplied by the inverse of its covariance matrix. The test is based on the correlation between this product and the $Y_{(i)}$ (the sample order statistics).
- Page 77, Exercise 1 (d): “choice” should be “choices”.
- Page 96: “F-N skewed distribution” should be “F-S skewed distribution”.
- Examples 5.4–5.6 on pages 106–109:

`stdFit` and `gedFit` use the `nlminb` optimizer while `sstdFit` uses the `nlm` optimizer. No optimizer is guaranteed to find the global optimum. I sometimes use the `optim` function for optimization. The following example shows how to fit the standardized t -model with `optim`. Using `optim` requires somewhat more work since the user needs to supply a function that computes minus the log-likelihood. However, as seen here, that can often be done with a single line of code. Minus the log-likelihood is used because, by default, `optim` minimizes the objective function. However, `optim` will maximize the objective function if the `control` parameter `fnscale` is negative (see the documentation); in this case, the objective function should be the log-likelihood.

Some R functions that compute densities, e.g., `dt()`, have the option to return the log-density. If available, this option should be used since it is more numerically stable than computing the density and then applying the `log()` function. However, this option is not available with `dstd()` and so is not used in this example.

```
library(fGarch)
library(MASS)
data(Capm,package="Ecdat")
diffrf=diff(Capm$rf)
n = length(diffrf)
start=c(mean(diffrf),sd(diffrf),4)
fit_std = optim(start,fn=function(theta)
  { -sum(log(dstd(diffrf,theta[1],theta[2],theta[3]))) },
  method="L-BFGS-B",lower=c(-1,.03,2.5) )
fit_std
```

- Page 126, Problem 8: “Sections 2.8 and 3.16 of the lecture notes” should be “Section 4.8” and “Problem 1” should be “Problem 6”.
- Page 128: “F-N skewed distribution” should be “F-S skewed distribution”.
- Page 144, lines 4–5: “quantKurt” should be “quKurt”.
- Page 146, Problem 2: Use $p_1 = 0.025$ and $p_2 = 0.25$. (This is suggested by the text immediately before the problem, but should be explicit.)
- Page 154, line 3: “Let \mathbf{W} be a nonrandom $N \times q$ matrix” should be “Let \mathbf{W} be a nonrandom $d \times q$ matrix”
- Page 158, lines 3–4: “Extreme values of \mathbf{Z} tend to occur when W is near zero.” should be “Extreme values of \mathbf{Y} tend to occur when W is near zero.”
- Page 160, line –6: AIC is 15.42, not 7.42.
- Page 161, line –6: ν was fixed at 6, not 5.94.
- Pages 164-5, Example 7.5: The estimates given here are incorrect, because the algorithm did not converge. By using non-default values of the control parameters, specifically `eval.max=1000` and `iter.max=500` which are larger than the defaults, the following estimates are obtained:

```
$beta
      ge      ibm      mobil      crsp
[1,] -0.001233907 -0.001855562 -0.0004461505 0.001050890

$Omega
      ge      ibm      mobil      crsp
ge      1.289738e-04 5.219954e-05 3.604621e-05 4.512069e-05
ibm      5.219954e-05 1.860970e-04 2.491078e-05 3.756661e-05
mobil    3.604621e-05 2.491078e-05 1.163636e-04 2.754968e-05
```

```
crsp 4.512069e-05 3.756661e-05 2.754968e-05 3.657415e-05
```

```
$alpha
```

```
      ge      ibm      mobil      crsp
0.4976872 0.3058549 0.2024128 -0.6142384
```

```
$df
```

```
[1] 5.915498
```

Also, AIC was not computed correctly both because the algorithm did not converge and because the number of parameters was miscounted. AIC should be 5.33 plus 64,000, which is smaller, not larger, than the symmetric t -model. Therefore, AIC favors the skewed t . However, BIC is 116.2 for the skewed t -model and only 102.9 for the symmetric t -model, so BIC favors the symmetric t . There is not a lot of skewness in this data set (see Figure 7.1), and the symmetric t -model seems reasonable to me.

- Page 165, Caption to Fig. 7.7: “because X_2 is left-skewed” should be “because X_2 is right-skewed”
- Page 171, line 2: “three bivariate samples” should be “four bivariate samples.”
- Page 186, equation (8.23)

$$2 + \lim_{q \uparrow 1} \frac{1 - C_Y(q, q)}{1 - q}.$$

should be

$$2 - \lim_{q \uparrow 1} \frac{1 - C_Y(q, q)}{1 - q}.$$

- Page 196, problem 2 (c): “effects of correlation” should be “effects of independence”.
- Page 198: There have been changes in `fitCopula` since this material was written. In particular, “method” is now “optim.method.” Immediately before Problem 5 make the following changes.

```
ft1 = fitCopula(cop_t_dim2, data1, optim.method="L-BFGS-B", method="ml",
  start=c(omega,5),lower=c(0,2.5),upper=c(.5,15) )
ft2 = fitCopula(cop_t_dim2,data2, optim.method="L-BFGS-B", method="ml",
  start=c(omega,5),lower=c(0,2.5),upper=c(.5,15) )
```

- Page 199: Because of changes in `fitCopula`, replace the R code on this page by:

```
fnorm = fitCopula(data=data1,copula=normalCopula(-.3,dim=2),method="mpl",
  optim.method="BFGS",start=.5)
fgumbel = fitCopula(data=data1,optim.method="BFGS",method="mpl",
  copula=gumbelCopula(3,dim=2))
ffrank = fitCopula(data=data1,optim.method="BFGS",method="mpl",
  copula=frankCopula(3,dim=2),start=1)
fclayton = fitCopula(data=data1,optim.method="BFGS",method="mpl",
  copula=claytonCopula(1,dim=2),start=1)
```

and

```

u1 = data1[,1]
u2 = data1[,2]
dem = pempiricalCopula(u1,u2)
par(mfrow=c(3,2))
contour(dem$x,dem$y,dem$z,main="Empirical")
contour(tCopula(param=ft2@estimate[1],df=ft2@estimate[2]),
  pcopula,main="t")
contour(normalCopula(fnorm@estimate),pcopula,main="Normal")
contour(gumbelCopula(fgumbel@estimate,dim=2),pcopula,
  main="Gumbel")
contour(franksCopula(ffrank@estimate,dim=2),pcopula,main="Frank")
contour(claytonCopula(fclayton@estimate,dim=2),pcopula,
  main="Clayton")

```

- Page 200: Because of changes in `fitCopula`, replace the R code on this page by:

```

par(mfrow=c(3,2))
contour(kde2d(u1,u2),main="KDE")
contour(tCopula(param=ft2@estimate[1],df=ft2@estimate[2]),
  dcopula,main="t",nlevels=25)
contour(normalCopula(fnorm@estimate),dcopula,
  main="Normal",nlevels=25)
contour(gumbelCopula(fgumbel@estimate,dim=2),
  dcopula,main="Gumbel",nlevels=25)
contour(franksCopula(ffrank@estimate,dim=2),
  dcopula,main="Frank",nlevels=25)
contour(claytonCopula(fclayton@estimate,dim=2),
  dcopula,main="Clayton",nlevels=25)

```

- page 202, second paragraph, third line: “For example, if the process is stationary” should be “For example, if the process is weakly stationary”.
- page 206, first line in Section 9.3: “stationary” should be “weakly stationary”.
- page 206, subsection 9.3.1, last sentence of second paragraph: $\rho(1) = \rho(2) = \dots = \rho(K)$ should be $\rho(1), \rho(2), \dots, \rho(K)$.
- page 208, second paragraph of Section 9.4: In the first line, “WN(0, σ_ϵ^2)” should be “weak WN(0, σ_ϵ^2)”. Later in this paragraph “ Y_t is WN(μ, σ_ϵ^2)” should be “ Y_t is weak WN(μ, σ_ϵ^2)”
- page 209, first line in Section 9.4.1: “stationary” should be “weakly stationary”.
- page 213, line 2: “They similar” should be “They are similar”.
- Page 218, equation (9.18):

$$\left(\frac{1}{\sqrt{2\pi\sigma_\epsilon^n}} \right) \exp \left\{ -\frac{(Y_1 - \mu)^2}{2\sigma_\epsilon^2(1 - \phi^2)} \right\} \prod_{i=2}^n \exp \left(-\frac{[Y_i - \{\mu + \phi(Y_{i-1} - \mu)\}]^2}{2\sigma_\epsilon^2} \right). \quad (1)$$

should be

$$\left(\frac{1}{\sqrt{2\pi}\sigma_\epsilon}\right)^n \sqrt{1-\phi^2} \exp\left\{-\frac{(Y_1-\mu)^2}{2\sigma_\epsilon^2/(1-\phi^2)}\right\} \prod_{i=2}^n \exp\left(-\frac{[Y_i - \{\mu + \phi(Y_{i-1} - \mu)\}]^2}{2\sigma_\epsilon^2}\right). \quad (2)$$

- Page 218, equation (9.19):

$$\left(\frac{1}{\sqrt{2\pi}\sigma_\epsilon^n}\right) \quad (3)$$

should be

- Page 218, equation (9.19):

$$\left(\frac{1}{\sqrt{2\pi}\sigma_\epsilon}\right)^n \quad (4)$$

- page 219, line 8: “WN(0, σ_ϵ^2)” should be “weak WN(0, σ_ϵ^2)”.
- page 223, line after equation (9.21): “WN(0, σ_ϵ^2)” should be “weak WN(0, σ_ϵ^2)”.
- page 224, line 3: “armaACF” should be “ARMAacf”.
- Page 229, equation (9.34):

$$w_t = w_{t_0} + Y_{t_0} + Y_{t_0+1} + \cdots + Y_t.$$

should be

$$w_t = w_{t_0} + Y_{t_0+1} + \cdots + Y_t.$$

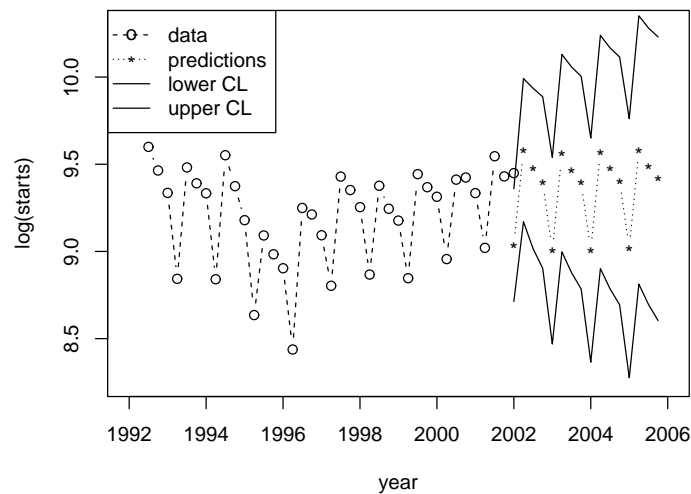
- Page 229, (9.35): The derivation of this equation is

$$\Delta w_t = w_t - w_{t-1} = (w_{t_0} + Y_{t_0+1} + \cdots + Y_t) - (w_{t_0} + Y_{t_0+1} + \cdots + Y_{t-1}) = Y_t.$$

- Page 232, last two lines: Δ^2 should be Δ^d .
- Page 233, (9.37): $1 - \phi_1 x - \cdots - \phi_k x^k$ should be $1 - \phi_1 x - \cdots - \phi_p x^p$. (Change k to p .)
- Page 238: “ $-\theta$ ” should be “ θ ” (six times) to be consistent with earlier notation for MA processes. (Notation for MA process varies between books and software, but we will use the notation introduced in Section 9.7.)
- Page 250, line -3: The mean of the residuals is nearly, but not exactly, equal to 0. The residuals can be mean-centered by replacing `resid2 = residuals(fit1)^2` by `resid2 = (fit1$residual - mean(fit1$residual))^2`. However, doing this has no noticeable effect on the ACF plot and the p -value of the Box-Ljung test is changed only very slightly.
- Page 251: Add the following to the R script after the first line of code:

```
dat = as.data.frame(Tbrate)
attach(dat)
library(forecast)
```

- Page 251, problem 7 (b): More accurately, the predictions do not “wobble” but rather decay to zero.
- Page 252, exercise 2: “AR(p)” should be “AR(2)”.
- Page 258, line –11: “first -rder” should be “first-order”
- Page 260, equation (10.4) and six lines below this equation: “ θ_{q_s} ” should be “ $\theta_{q_s}^*$ ”
- Page 261, Figure 10.3: The x-axis is mislabel. The plot should be:



- Page 265, line 1: “at positive lags” should be “at negative lags”
- page 266, line after equation (10.7): “WN(0, Σ)” should be “weak WN(0, Σ)”.
- Page 280, line –11: “ARIMA(2,0,0)” should be “ARIMA(2,1,0)”.
- Page 303, 1st line of Example 11.10: “shrinkage estimation” should be “prohibiting short sales”

- Page 308: Exercise 6 should not ask for the one-week VaR(0.05), since Value-at-Risk is not covered until Chapter 19.
- Page 317, formula for the quadratic regression model with two predictors: “ $\beta_2 X_{i,2}^2$ ” should be “ $\beta_2 X_{i,1}^2$ ”.
- Page 336, code before Problem 1: Change this code to the following:

```
library(AER)
data("USMacroG")
MacroDiff=as.data.frame(apply(USMacroG,2,diff))
attach(MacroDiff)
pairs(cbind(consumption,dpi,cpi,government,unemp))
```

- Page 337, code after problem 6 and elsewhere: “`cr.plot`” should be changed throughout to “`crPlot`” because “`cr.plot`” has been deprecated and may not work with newer versions of R. (However, “`cr.plot`” works with version 3.0.0 of R although it results in a warning.)
- Page 351, 2nd line in 2nd paragraph: “`catterplot`” should be “`scatterplot`”.
- Page 374, second line in Example 14.2: “ $WN(0, \sigma_u^2)$ ” should be “ $\text{weak } WN(0, \sigma_u^2)$ ”.
- Page 416, line 7: “ $E \{ \Delta(Y_{1,t} - \lambda Y_{2,t}) | \mathcal{F}_t \}$ ” should be “ $E \{ \Delta(Y_{1,t} - \lambda Y_{2,t}) | \mathcal{F}_{t-1} \}$ ”.
- Page 416, fourth line before Example 15.2: $\phi_1 - \lambda \phi_2 < -2$ should be $\phi_1 - \lambda \phi_2 \leq -2$.
- Page 417, line 1: “so that \mathbf{Y}_t and $\boldsymbol{\epsilon}_t$ ” should be “so that \mathbf{Y}_t and $\boldsymbol{\epsilon}_t$ are”
- Page 437, second displayed line in Section 16.7 “ $\sigma_{\epsilon_j}^2$ ” should be “ $\sigma_{\epsilon,j}^2$ ”.
- Throughout chapter 17: “Small minus large” and “SML” should be “Small minus big” and “SMB”.
- Page 456, line 2: “large stock” should be “large stocks”.
- Page 457, line 16: “GE behaves as a value stock” should be “GE behaves as a growth stock”
- Page 467: Replace

“Therefore, to determine $\boldsymbol{\beta}$ a further set of constraints is needed. One set of constraints in common usage, that is, by the function `factanal` in R, is that $\boldsymbol{\beta} \boldsymbol{\Sigma}_{\boldsymbol{\epsilon}}^{-1} \boldsymbol{\beta}^T$ is diagonal.”

by

“Therefore, to determine $\boldsymbol{\beta}$ a further set of constraints is needed. One possible set of constraints is that $\boldsymbol{\beta} \boldsymbol{\Sigma}_{\boldsymbol{\epsilon}}^{-1} \boldsymbol{\beta}^T$ is diagonal (Mardia et al., 1979, p. 258). I have been unable to determine the constraints used by R’s function `factanal`. ”
- Page 470: Add to Section 17.7 “The `yields.txt` data set is from the `Rsafd` package distributed by Professor René Carmona.
- Page 470: Add to references

Mardia, K. V., Kent, J. T., and Bibby, J. M. (1979) *Multivariate Analysis*, Academic Press, London.

- Page 472, 2nd line after Problem 3: “default,princomp” should be “default, princomp” (insert a space after “default”)
- Page 475, 2nd line in Section 17.9.3: “costing” should be “closing”.
- Page 475, Problem 15: “Regardless of your answer to Problem 6” should be “Regardless of your answer to Problem 14”.
- Page 479, second line after (18.4): “ α_0 ” should be “ ω ”.
- Page 480, equation (18.6): “ α_0 ” should be “ ω ”.
- Page 482, last line before Example 18.2: “nonconstan” should be “nonconstant”.
- Pages 482 and 483: “ARCH(q)” should be “ARCH(p)” throughout Sections 18.5 and 18.6.
- Page 489, line 6: “Assume that $p \leq q$ ” should be “Assume that $p \geq q$,” and after the sentence containing this string, add the sentence “If $p > q$ then define $\beta_i = 0$ for $i = q + 1, \dots, p$.”
- Page 491, equation (18.17): “ a_{t-1} ” should be “ a_{t-i} ” (twice).
- Page 502, problems 3 and 4: “WN(0, 1)” should be “*i.i.d.* WN(0, 1)”.
- Page 525

$$0.96 \Phi(x; 2000, 4) + 0.04 \Phi(x; -100, 4),$$

should be

$$0.04 \Phi(x; 2000, 4) + 0.96 \Phi(x; -100, 4),$$

and

$$0.96^2 \Phi(x; 2000, 2) + 2(0.96)(0.04) \Phi(x; 950, 2) + 0.04^2 \Phi(x; -100, 2).$$

should be

$$0.04^2 \Phi(x; 2000, 2) + 2(0.96)(0.04) \Phi(x; 950, 2) + 0.96^2 \Phi(x; -100, 2).$$

- Page 528, Exercise 1: Add “Assume that an investor owns \$1000 in BMW stock.”
- Page 528, Exercise 4: Add “Assume that an investor owns \$1000 in MSFT stock.”
- Page 543, Theorem 20.6: “Fisher information” should be “Fisher information matrix”
- Page 565 (bottom) and 566 (top): The MLE of the correlation matrix is incorrect and should be


```

$cor
      [,1] [,2] [,3] [,4]
[1,] 1.0000 0.3192 0.2845 0.6765
[2,] 0.3192 1.0000 0.1584 0.4698
[3,] 0.2845 0.1584 1.0000 0.4301
[4,] 0.6765 0.4698 0.4301 1.0000

```

- Page 612, second line in the paragraph before Section A.13.1: “ $E(Y|X) = E(X)$ ” should be “ $E(Y|X) = E(Y)$ ”.
- Page 621, second line after (A.49): $\mathbf{O}\mathbf{o}_k^\top$ should be $\mathbf{O}^\top\mathbf{o}_k$.
- Page 628: “F-N skewed distribution” should be “F-S skewed distribution”.