Corrections to:

Computational Finance
numerical methods for pricing financial instruments

George Levy 23/4/2004

Page 45

In the first sentence at the top of the page

ofthe

should be changed to

of the

Page 49

The sentence

This demonstration considers an optimal portfolio selection problem, see Markowitz (1989) and Markowitz (1994), of the type:

should be replaced with

This demonstration considers an optimal portfolio selection problem, see Markowitz (1989, 1994), of the type:

Page 58

The sentence

Once we have defined the schema the XML file can be validated using it.

should be replaced with

Once we have defined the schema the XML file can be validated by using *Microsoft's Internet Explorer Tools for Validating XML and Viewing XSLT Output*. These tools are currently distributed in the file `iexmltls.exe` and are freely available at http://www.microsoft.com/downloads; the precise location can be found by using the search string "XML Tools".

Page 59

The text on this page:

In this section we will briefly describe the Extensible Stylesheet Language (XSL), and show how it can be used to *transform* XML files into HTML files. The transformation from XML to HTML occurs dynamically as the XML file is loaded into a Web browser, and is achieved by interpreting the contents of an associated XSL file. This means the manner in which information contained in single XML file is displayed within a Web browser entirely depends on the associated XSL file. We will now describe a few of the features of XSL. It contains the usual features that one might expect, for instance there is:

Iteration through a list of items using `<xsl:for-each>`, and variable assignment using `<xsl:variable>`.

```
<xsl:for-each select="stock_xdr:ITEM">
    <xsl:variable name="v1" select="@SHARE" />
    <xsl:variable name="v2" select="stock_xdr:PRICE" />
        .     .     .
</xsl:for-each>
```

Sets the variable `v1` to the value of the attribute `SHARE` and the variable tt v2 to the value contained in the child element `PRICE`.

Selection from a set of alternatives using `xsl:choose`, output the value of a variable `xsl:value-of`, and evaluating expressions using `test`.

should be replaced with :

In this section we will briefly describe the Extensible Stylesheet Language (XSL), and show how it can be used to *transform* XML files into HTML files. The transformation from XML to HTML occurs dynamically as the XML file is loaded into a Web browser, and is achieved by interpreting the contents of an associated XSL file. This means the manner in which information contained in a single XML file is displayed within a Web browser depends entirely on the associated XSL file. We will now describe a few of the features of XSL. For instance we can iterate through a list of items using `<xsl:for-each>`, and perform variable assignment using `<xsl:variable>`.

```
<xsl:for-each select="stock_xdr:ITEM">
    <xsl:variable name="v1" select="@SHARE" />
    <xsl:variable name="v2" select="stock_xdr:PRICE" />
        .     .     .
</xsl:for-each>
```

The code fragment above sets the variable `v1` to the value of the attribute `SHARE` and the variable `v2` to the value contained in the child element `PRICE`.

It is also possible to select from a set of alternatives using `xsl:choose`, output the value of a variable using `xsl:value-of`, and evaluate expressions using `test`.

Page 60

The sentence

Here if the variable `return` is less 0.1 then the background colour of the cell is set to pink to indicate a bad share, but if value of `return` is greater than 0.2 then the background colour of the cell is set to yellow and red stars are output to indicate that this is a good share.

should be replaced with

In this code fragment if the variable `return` is less 0.1 then the background colour of the cell is set to pink to indicate a bad share, but if the value of `return` is greater than 0.2 then the background colour of the cell is set to yellow and red stars are output to indicate that this is a good share.

Page 78

The sentence

He first observed the random motion of pollen particles (obtained from the American species *Clarkia pulchella*) suspended in water, and wrote:

should be replaced with

He was the first to observe the random motion of pollen particles (obtained from the American species *Clarkia pulchella*) suspended in water, and wrote:

Page 93

The sentence

Proceeding as in Section 9.3.1 we will use the n-dimensional version of Ito's lemma to find the process followed by the the value of a multi-asset financial derivative.

should be replaced with

Proceeding as in Section 9.3.1 we will use the n-dimensional version of Ito's lemma to find the process followed by the value of a multi-asset financial derivative.

Page 94

The text

Cancelling terms we obtain:

$$\Delta\Pi = -\Delta t \left\{ \frac{\partial f}{\partial t} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \sigma_i\sigma_j\rho_{ij}S_iS_j\frac{\partial^2 f}{\partial S_i \partial S_j} \right\}$$

If this portfolio is to grow at the riskless interest rate, r we have:

$$r\Pi\Delta t = \Delta\Pi$$

So from Equation 9.28 we have that:

$$r\Pi\Delta t = -\Delta t \left\{ \frac{\partial f}{\partial t} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \sigma_i\sigma_j\rho_{ij}S_iS_j\frac{\partial^2 f}{\partial S_i \partial S_j} \right\}$$

Substituting for Π and we obtain:

should be replaced with

This expression simplies to

$$\Delta\Pi = -\Delta t \left\{ \frac{\partial f}{\partial t} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \sigma_i\sigma_j\rho_{ij}S_iS_j\frac{\partial^2 f}{\partial S_i \partial S_j} \right\}$$

and if the portfolio is to grow at the riskless interest rate, r then:

$$r\Pi\Delta t = \Delta\Pi$$

So from Equation 9.28 we have

$$r\Pi\Delta t = -\Delta t \left\{ \frac{\partial f}{\partial t} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \sigma_i\sigma_j\rho_{ij}S_iS_j\frac{\partial^2 f}{\partial S_i \partial S_j} \right\}$$

and substituting for Π yields

Page 95

The line

Rearranging equation 9.30 gives:

should be replaced with

Rearranging equation 9.30 then gives:

Page 101

In code excerpt 9.1 the line

```
if( (x < eps) || (sigma < eps) || (t < eps) ) { /* Check if any of the the input ar
```

should be replaced with

```
if( (x < eps) || (sigma < eps) || (t < eps) ) { /* Check if any of the input argume
```

Page 106

The line

$$d_1 = \frac{\log(S/E)(r-\sigma^2/2)\tau}{\sigma\sqrt{\tau}} = d_1 - \sigma\sqrt{\tau}$$

should be replaced by the line

$$d_1 = \frac{\log(S/E)(r-\sigma^2/2)\tau}{\sigma\sqrt{\tau}}, \quad \text{and} \quad d_2 = d_1 - \sigma\sqrt{\tau}$$

Page 113

In code excerpt 9.7 the line

```
if (barrier_level == 0) { printf ("ERROR barrier must be > zero \n");
```

should be changed to

```
if (barrier_level <= 0) { printf ("ERROR barrier must be > zero \n");
```

Page 140

Correction 1

At the top of the page the equation

$$\begin{aligned} Var[S_t + \Delta t] &= S_t^2 \exp(2r\Delta t)\left\{\exp(\sigma^2\Delta t) - 1\right\} \\ &= S_t^2\left(pu^2 + (1-p)d^2\right) - S_t^2 \exp(2r\Delta t), \end{aligned}$$

should be changed to

$$
\begin{aligned}
Var[S_{t+dt}] &= S_t^2 \exp(2r\Delta t)\left\{\exp(\sigma^2\Delta t) - 1\right\} \\
&= S_t^2\left(pu^2 + (1-p)d^2\right) - S_t^2\exp(2r\Delta t),
\end{aligned}
$$

Correction 2

Near the bottom of the page the equations:

$$pu^3 = (a - pu) - a^2u - b^2u = 0$$

or

$$p(u^3 - u) + a - a^2 - b^2u = 0$$

should be changed to:

$$pu^3 + (a - pu) - a^2u - b^2u = 0$$

or

$$p(u^3 - u) + a - a^2u - b^2u = 0$$

Page 141

The following extract

In these circumstances we have:

$$a^2 + b^2 + 1 = \exp(2r\Delta t) + \exp(2r\Delta t)\left\{\exp(\sigma^2\Delta t) - 1\right\} + 1$$

$$\sim 1 + 2r\Delta t + (1 + 2r\Delta t)\sigma^2\Delta t + 1 \sim 2 + 2r\Delta t + \sigma^2\Delta t$$

Therefore

$$\sqrt{(a^2+b^2+1)^2 - 4a^2} \sim \sqrt{(2 + 2r\Delta t + \sigma^2\Delta t)^2 - 4(1 + 2r\Delta t)}$$

$$\sim \sqrt{4 + 8r\Delta t + 4\sigma^2 - 4 - 8r\Delta t} = \sqrt{4\sigma^2\Delta t} = 2\sigma\sqrt{\Delta t}$$

and so

$$u \sim \frac{2 + 2r\Delta t + \sigma^2\Delta t + 2\sigma\sqrt{\Delta t}}{2\exp(r\Delta t)}$$

$$u \sim \left(1 + r\Delta t + \frac{\sigma^2\Delta t}{2} + \sigma\sqrt{\Delta t}\right)(1 - r\Delta t)$$

$$u \sim 1 + r\Delta t + \frac{\sigma^2\Delta t}{2} + \sigma\sqrt{\Delta t} - r\Delta t = 1 + \sigma\sqrt{\Delta t} + \frac{\sigma^2\Delta t}{2}$$

which to order Δt gives:

$$u = \exp(\sigma\sqrt{\Delta t}) \qquad (10.90)$$

since

$$\exp(\sigma\sqrt{\Delta t}) = 1 + \sigma\sqrt{\Delta t} + \frac{\sigma^2\Delta t}{2} + \frac{\sigma^3(\Delta t)^{3/2}}{6} + +.. \qquad (10.91)$$

which gives:

$$d = \frac{1}{u} = \exp(-\sigma\sqrt{\Delta t}) \qquad (10.92)$$

should be replaced with the following

In these circumstances

$$a^2 + b^2 + 1 = \exp(2r\Delta t) + \exp(2r\Delta t)\left\{\exp(\sigma^2\Delta t) - 1\right\} + 1$$

$$\sim 1 + 2r\Delta t + (1 + 2r\Delta t)\sigma^2\Delta t + 1 \sim 2 + 2r\Delta t + \sigma^2\Delta t$$

Therefore

$$\sqrt{(a^2 + b^2 + 1)^2 - 4a^2} \sim \sqrt{(2 + 2r\Delta t + \sigma^2\Delta t)^2 - 4(1 + 2r\Delta t)}$$

$$\sim \sqrt{4 + 8r\Delta t + 4\sigma^2\Delta t - 4 - 8r\Delta t} = \sqrt{4\sigma^2\Delta t} = 2\sigma\sqrt{\Delta t}$$

and so

$$u \sim \frac{2 + 2r\Delta t + \sigma^2\Delta t + 2\sigma\sqrt{\Delta t}}{2\exp(r\Delta t)}$$

$$u \sim \left(1 + r\Delta t + \frac{\sigma^2\Delta t}{2} + \sigma\sqrt{\Delta t}\right)(1 - r\Delta t)$$

$$u \sim 1 + r\Delta t + \frac{\sigma^2\Delta t}{2} + \sigma\sqrt{\Delta t} - r\Delta t = 1 + \sigma\sqrt{\Delta t} + \frac{\sigma^2\Delta t}{2}$$

which to order Δt gives:

$$u = \exp(\sigma\sqrt{\Delta t}), \text{ and } \quad d = \exp(-\sigma\sqrt{\Delta t}), \qquad (10.90)$$

where we have used

$$\exp(\sigma\sqrt{\Delta t}) \sim 1 + \sigma\sqrt{\Delta t} + \frac{\sigma^2\Delta t}{2} + \frac{\sigma^3(\Delta t)^{3/2}}{6}, \text{ and } \ d = \frac{1}{u} \qquad (10.91)$$

Page 195

The sentence

The disadvantage of this approach is that there will be an unspecified pricing error that depends on the distance, d_s, of the barrier level, B, to the the nearest asset grid line.

should be replaced by

The disadvantage of this approach is that there will be an unspecified pricing error that depends on the distance, d_s, of the barrier level, B, to the nearest asset grid line.

Page 216

The text

The final value of the option is for this particular lattice is therefore:

$$f_1^1 = \max(h_0^1, g_0^1) = \max(11.9, 1) = 11.9$$

should be replaced with

The final value of the option is for this particular lattice is therefore:

$$f_0^1 = \max(h_0^1, g_0^1) = \max(11.9, 1) = 11.9$$

Page 217

The sentence

The only modification to the code is to replace the call to `g05ddc` with that of another probability distribution and supply the time varying parameters to it.

should be changed

The only modification to the code is to replace `g05ddc` with that a function which generates another probability distribution and supply the time varying parameters to it.

Page 234

The sentence

Multivariate generalisation of univariate distributions, see for example Mardia *et. al.* (1988).

should be changed to

For more information on multivariate generalisation of univariate distributions see Mardia *et. al.* (1988).

Page 226

The sentence

The transaction costs, ϕ_i, that are used in equation are $\phi_i = \phi_s$ when $X_i^I > X_i$, and $\phi_i = \phi_b$ when $X_i^I < X_i$, where ϕ_s is the cost of selling shares and ϕ_b is the cost of buying shares.

should be changed to

The transaction costs, ϕ_i, that are used in Equation 11.4 are $\phi_i = \phi_s$ when $X_i^I > X_i$, and $\phi_i = \phi_b$ when $X_i^I < X_i$; where ϕ_s is the cost of selling shares and ϕ_b is the cost of buying shares.

Page 259

At the top of the page the two sentences:

Write (that is sell) one option on the minimum of S_1 and S_2 with an exercise price of zero. Purchase one option on the minimum of S_1 and S_2 with exercise price E.

should be replaced with

Write (that is sell) one call option on the minimum of S_1 and S_2 with an exercise price of zero. Purchase one call option on the minimum of S_1 and S_2 with exercise price E.

At the bottom of the page the two sentences:

Write (that is sell) one option on the maximum of S_1 and S_2 with an exercise price of zero. Purchase one option on the maximum of S_1 and S_2 with exercise price E.

should be replaced with

Write (that is sell) one call option on the maximum of S_1 and S_2 with an exercise price of zero. Purchase one call option on the maximum of S_1 and S_2 with exercise price E.

Page 260

In the following six lines:

<u>If $\max(S_1, S_2) = S_2 < E$</u>

Portfolio A: Pays $E - S_1$

Portfolio B: Pays $E - S_1 + 0 = E - S_1$.

<u>If $\max(S_1, S_2) = S_2 < E$</u>

Portfolio A: Pays $E - S_2$

Portfolio B: Pays $E - S_2 + 0 = E - S_2$

the first line should read:

<u>If $\max(S_1, S_2) = S_1 < E$</u>

Page 278

The last line on the page

$$\bar{X}_{[i]} = \bar{X}_{[i-1]} + \frac{1}{i}\left(X_i - \bar{X}_{[i-1]}\right)$$

should be replaced by

$$\tilde{\mu} = \bar{X}_{[i]} = \bar{X}_{[i-1]} + \frac{1}{i}\left(X_i - \bar{X}_{[i-1]}\right)$$

Page 279

The text

For each vector X_j with missing values let $x_j^{(1)}$ denote the missing components and $x_j^{(2)}$ denote those components which are known. Thus we have: $X_j = [x_j^{(1)}, x_j^{(2)}]$, and $\mu = [\mu_j^{(1)}, \mu_j^{(2)}]$

Given the estimates $\tilde{\mu}$ and $\tilde{\Sigma}$ from the estimation step we use the mean of the conditional normal distribution of $x^{(1)}$, given $x^{(2)}$, to predict the missing values. That is:

$$\tilde{x}_j^{(1)} = E(x_j^{(1)}|x_j^{(2)}; \tilde{\mu}, \tilde{\Sigma}) = \tilde{\mu}^{(1)} + \tilde{\Sigma}_{12}\tilde{\Sigma}_{22}^{-1}(x_j^{(2)} - \tilde{\mu}^{(2)}),$$

In Equation (13.5) we have used the result, see Appendix E, that if:

$$X_j \sim N(\mu, \Sigma),$$

with $\mu = \begin{bmatrix} \mu^{(1)} \\ \hline \mu^{(2)} \end{bmatrix}$ and $\Sigma = \begin{bmatrix} \Sigma_{11}|\Sigma_{12} \\ \hline \Sigma_{21}|\Sigma_{22} \end{bmatrix}$, and $|\Sigma_{22}| > 0$ then:

$$x_j^{(1)} \sim N(\mu', \Sigma'),$$

where

$$\mu' = \mu^{(1)} + \Sigma_{12}\Sigma_{22}^{-1}(x^{(2)} - \mu^{(2)})$$

and

$$\Sigma' = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21}$$

It can thus be seen that the covariance matrix does not depend on the value of the conditioning variable, $x^{(2)}$.

should be replaced with

For each p element observation vector X_i let $x_i^{(1)}$ denote the missing values and $x_i^{(2)}$ denote those components which are known. We can thus partition X_i as $X_i = [x_i^{(1)}, x_i^{(2)}]$, and its mean (based on the first i observations) as $\tilde{\mu} = [\tilde{\mu}^{(1)}, \tilde{\mu}^{(2)}]$

The missing values in X_i are predicted by using $E(x_i^{(1)}|x_i^{(2)})$, the mean of the conditional distribution of $x_i^{(1)}$ given $x_i^{(2)}$. We use the result, see Appendix E for more detail, that:

$$\tilde{x}_i^{(1)} = E(x_i^{(1)}|x_i^{(2)}; \tilde{\mu}, \tilde{\Sigma}) = \tilde{\mu}^{(1)} + \tilde{\Sigma}_{12}\tilde{\Sigma}_{22}^{-1}(x_j^{(2)} - \tilde{\mu}^{(2)}), \tag{13.5}$$

where the estimates for $\tilde{\mu}$, and $\tilde{\Sigma}$ have been computed by the previous E-step.

Page 297

Equation 14.39 should read: $\log(P_t) = \log(P_{t-1}) + \mu + \sigma_t\epsilon_t$

Page 301

The phrase:

further details can be found in the Box and Jenkins (1976), Hamilton (1994), and Engle (1995).

should be replaced with:

further details can be found in Box and Jenkins (1976), Hamilton (1994), and Engle (1995).

Page 302

The phrase:

An autoregressive processes can be generalised into a autoregressive moving average process by the inclusion of extra lagged terms as follows::

should be changed to:

An autoregressive processes can be generalised into an autoregressive moving average process by the inclusion of extra lagged terms as follows::

Page 303

The following text:

In a similar manner to the Box Jenkins approach described above in Section 15.1, we can define an autoregressive conditional heteroskedastic process of order q,ARCH(q), process, with Gaussian residuals as follows:

$$h_i = \alpha_0 + \sum_{j=1}^{q} \alpha_j \epsilon_{i-j}^2 i = 1, \ldots, n, \qquad \epsilon_i|\psi_{i-1} \sim NID(0, h_i)$$

This can then be generalised to a GARCH(p,q) process in the same way that an ARMA(p,q) is a generalisation of an AR(q) process.

In the same way that an ARMA(p,q) is a generalisation of an AR(q) process, we can define a generalised autoregressive autoregressive conditional heteroskedastic of order (p, q), GARCH(p,q) as follows:

should be replaced with

Following the Box Jenkins approach described above in Section 15.1, we can define a Gaussian autoregressive conditional heteroskedastic process of order q, ARCH(q), as

$$h_i = \alpha_0 + \sum_{j=1}^{q} \alpha_j \epsilon_{i-j}^2 i = 1, \ldots, n, \qquad \epsilon_i | \psi_{i-1} \sim NID(0, h_i)$$

In the same way that an ARMA(p,q) is a generalisation of an AR(q) process, we can then define a Gaussian generalised autoregressive autoregressive conditional heteroskedastic of order (p, q), GARCH(p,q) as

Page 308

Correction 1

The line

Proceeding in a similar manner we have:

should be replaced with

Proceeding in a similar manner gives:

Correction 2

The sentence:

Equation 15.13 is the sum of T terms of a G.P with first term α_0 and common factor $(\alpha_1 + \beta_1)$, and there is also an additional term $(\alpha_1 + \beta_1)^T E[h_i | \psi_{i-1}]$.

should be replaced with

Equation 15.13 is the sum of T terms of a G.P with first term α_0 and common factor $(\alpha_1 + \beta_1)$; there is also an additional term $(\alpha_1 + \beta_1)^T E[h_i | \psi_{i-1}]$.

Page 343

The sentence:

Once these terms have been computed it is easy to calculatethe information matrix.

should be replaced with:

Once these terms have been computed it is easy to calculate the information matrix.

Page 360

Correction 1

The sentence

Detailed information concerning the construction of these applications is provided elsewhere in the book.

should be deleted

Correction 2

The text:

A popular approach for testing the significance of parameters estimated using maximum likelihood techniques is the *likelihood ratio test*. It is useful in the following situation.

Suppose we have modelled data using a GARCH process N_p parameters, $\theta_k, k = 1, \ldots, N_p$, and have obtained a maximised log likelihood $\mathcal{L}(\hat{\theta})$. We now want to know if by increasing the number of model parameters to $N_p + m$ we can obtain obtain a *significantly* better model to the data. If we let the (improved) maximised log likelihood using the increased number of parameters be $\mathcal{L}(\bar{\theta})$, then we can use the result that:

$$2\left[\mathcal{L}(\bar{\theta}) - \mathcal{L}(\hat{\theta})\right] \approx \chi^2(m)$$

should be replaced with:

A popular approach for testing the significance of parameters estimated using maximum likelihood techniques is the *likelihood ratio test*.

Suppose we have modelled data using a GARCH process with N_p parameters, $\theta_k, k = 1, \ldots, N_p$, and have obtained a maximised log likelihood $\mathcal{L}(\hat{\theta})$. We now want to know if by increasing the number of parameters to $N_p + m$ we can obtain obtain a *significantly* better model of the data. If we let the (improved) maximised log likelihood using the increased number of parameters be $\mathcal{L}(\bar{\theta})$, then we have:

$$\mathcal{LR} = 2\left[\mathcal{L}(\bar{\theta}) - \mathcal{L}(\hat{\theta})\right] \approx \chi^2(m),$$

more detail can be found in Hamilton(1994), page 144.

For example the inclusion of a single extra model parameter ($m = 1$) is only significant at the 5 percent level if $\mathcal{LR} > 3.84$; since the probability that a $\chi^2(1)$ variable exceeds 3.84 is 0.05.

Page 361

Correction 1

The line at the top of the page:

Gives rise to an ARMA(κ, p) process in ϵ_i^2 of the form:

should be changed to

gives rise to an ARMA(κ, p) process in ϵ_i^2 of the form:

Correction 2

The sentence:

High values of $\mathcal{Q}_{stat}$ lead to reject of the hypothesis that the standardised residuals are independently distributed.

should be changed to

High values of $\mathcal{Q}_{stat}$ lead to rejection of the hypothesis that the standardised residuals are independently distributed.

Page 365

Correction 1

The sentence

Figure 22.4 shows the results of using a GARCH(0,10).

should be changed to

Figure 22.4 shows the results of using GARCH(0,10).

Correction 2

The sentence

Figure 22.5 shows the results of using an AGARCH-I(0,10).

should be changed to

Figure 22.5 shows the results of using AGARCH-I(0,10).

Page 368

The text:

In Figures 22.6 and 22.7 we see if a GARCH(1,1) models will do better than the ARCH(10) models.

Figure 22.6 shows the results of using a GARCH(1,1). Here the likelihood is 4340.95 and the normality test statistic, N_{stat} is 12.39. All the parameters have t statistic values above 3, and the value β_1 is 56.922. However, these results are not as good those we obtained from the AGARCH-I(0,10) model.

Figure 22.7 shows the results of using an AGARCH-I(1,1). Here the likelihood is 4357.67 and the normality test statistic, N_{stat} is 0.575. All the parameters have t statistic values above 3, and the value β_1 is 59.886. Clearly this is the preferred model is an AGARCH-I(1,1) model with:

$$\alpha_0 = 5.55 \times 10^{-5}, \quad \alpha_1 = 0.128, \quad \beta_1 = 0.852, \quad \gamma = 0.0175$$

It is interesting to note that the asymmetry parameter γ is positive.

should be replaced with

In Figures 22.6 and 22.7 we investigate whether a GARCH(1,1) model does better than the ARCH(10) model.

Figure 22.6 shows the results of using a GARCH(1,1) model. Here the log likelihood is 4340.95 and the normality test statistic, N_{stat} is 12.39. All the parameters have t statistic values above 3, and the value β_1 is 56.922. However, these results are not as good as those we obtained from the AGARCH-I(0,10) model.

Figure 22.7 shows the results of using an AGARCH-I(1,1) model. Here the log likelihood is 4357.67 and the normality test statistic, N_{stat} is 0.575. All the parameters have t statistic values above 3, and the value of β_1 is 59.886. Also the likelihood ratio test, see Section 22.1, indicates that the inclusion of the extra asymmetry parameter, γ, is certainly significant at the 5 percent level; we have $\mathcal{LR} = 4357.67 - 4340.95 = 16.72$.

Clearly the preferred model is AGARCH-I(1,1) with:

$$\alpha_0 = 5.55 \times 10^{-5}, \quad \alpha_1 = 0.128, \quad \beta_1 = 0.852, \quad \gamma = 0.0175$$

It is interesting to note that here the asymmetry parameter γ is positive.

Page 379

The sentence:

A binary *cash or nothing* call option pays nothing if the stock price ends up below the the strike and an amount Q if it ends up above the strike price.

should be replaced by

A binary *cash or nothing* call option pays nothing if the stock price ends up below the strike and an amount Q if it ends up above the strike price.

Page 393

The text:

Let $X = [X_1/X_2]$ be distributed as $N_p(\mu, \Sigma)$ with $\mu = [\mu_1/\mu_2]$, and $\Sigma = [\Sigma_{11}|\Sigma_{12}/\Sigma_{21}|\Sigma_{22}]$, and $|\Sigma_{22}| > 0$.

We will prove that the conditional distribution of X_1, given that $X_2 = x_2$, is normal and has:

Mean $= \mu_1 + \Sigma_{11}\Sigma_{22}^{-1}(x_2 - \mu_2)$, and covariance $= \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21}$.

Let the inverse of Σ be Σ^{-1}, where:

$$\Sigma^{-1} = \begin{pmatrix} \Sigma^{11} & \Sigma^{12} \\ \Sigma^{21} & \Sigma^{22} \end{pmatrix}$$

should be replaced with

Let the p element vector X be distributed as $N_p(\mu, \Sigma)$, where μ is a p element vector of mean values and Σ is a $p \times p$ covariance matrix. If X is partitioned into two portions X_1 and X_2 with q and $p-q$ elements respectively, then we can write:

$$X = [X_1, X_2], \quad \mu = [\mu_1, \mu_2], \text{ and } \Sigma = \begin{pmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22}, \end{pmatrix}$$

where the dimensions of the matrices Σ_{11}, Σ_{22}, Σ_{12}, and Σ_{21} are $q \times q$, $(p-q) \times (p-q)$, $q \times (p-q)$, and $(p-q) \times q$ respectively.

We will now prove that (provided $|\Sigma_{22}| > 0$) the conditional distribution of X_1 given $X_2 = x_2$, is $N_q(\mu^*, \Sigma^*)$; with $\mu^* = \mu_1 + \Sigma_{11}\Sigma_{22}^{-1}(x_2 - \mu_2)$, and $\Sigma^* = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21}$.

Let the inverse of Σ be Σ^{-1}, where:

$$\Sigma^{-1} = \begin{pmatrix} \Sigma^{11} & \Sigma^{12} \\ \Sigma^{21} & \Sigma^{22} \end{pmatrix}$$

Page 394

Add the following sentence to the bottom of the page.

It can thus be seen that the covariance matrix does not depend on the value of the conditioning variable x_2.

Page 399

The sentence:

Let the mean of the first $i-1$ observations be denoted by $\bar{X}_{[i-1]} = \sum_{k=1}^{i-1} X_k / i - 1$

should be replaced by:

Let the mean of the first $i-1$ observations be denoted by $\bar{X}_{[i-1]} = \frac{\sum_{k=1}^{i-1} X_k}{(i-1)}$

Page 430

The following reference

Markowitz, H. M., *The general mean-variance portfolio selection problem*, Phil. Trans. R. Soc. Lond. A. 347, 543-549, 1994

should be omitted from this page.

Page 434

The reference:

Einstein, A. (1905) *On the movement of small particles suspended in a stationary liquid demanded by the molecular-kinetic theory of meat*, Ann. Physik 17

should be changed to:

Einstein, A. (1905) *On the movement of small particles suspended in a stationary liquid demanded by the molecular-kinetic theory of heat*, Ann. Physik 17

Page 435

The reference:

Levy, G. F. (2003) *Analytic derivatives of Asymmetric GARCH models*, Journal of Computational Finance, 6(3)

should be changed to:

Levy, G. F. (2003) *Analytic derivatives of Asymmetric GARCH models*, Journal of Computational Finance, 6(3), 21-63