BACK COVER

- Middle of the back cover, change the affiliations as follows:

Jakša Cvitanić is Professor of Mathematical Finance at California Institute of Technology. Fernando Zapatero is a Professor of Finance at the Marshall School of Business and in the Department of Economics at the University of Southern California.

PREFACE

- p. xix, line 6: change the web page to

http://www.hss.caltech.edu/ cvitanic/book.html

- p. xxii, last line: change address cvitanic@math.usc.edu

to

cvitanic@hss.caltech.edu

CHAPTER 1: FINANCIAL MARKETS

- p. 11: 15 lines from the bottom, the long side payoff should be reversed, $S(T) - F(t)$.

CHAPTER 2: INTEREST RATES

- p. 34: $e = 2.7182...$

- p. 38, Example 2.2 and 2.3: The monthly payment should be \$ 2,946 throughout, not \$2,936.

- p.45: The 8% bond in Example 2.7 matures on 6/30/05, not on 6/30/04.

- p. 46: Equation (2.10) should read

$$(1 + r_{uy})^u = (1 + r_{ty})^t (1 + f_{t,u})^{u-t} \quad .$$

CHAPTER 3: MODELS OF SECURITIES PRICES

- p.66, in equation (3.12), it should be $\mathcal{F}(s)$, and not $\mathcal{F}(t)$.

- p. 68, expression $+E\left[\sum_{j=k}^{l-1} Y(t_j)(W(t_{j+1}) - W(t_j))\right]$ should be replaced by

$$+E\left[\sum_{j=k}^{l-1} Y(t_j) E[(W(t_{j+1}) - W(t_j))|W(t_j)]|W(0), \ldots, W(t_k)\right]$$

- p. 68: Towards the end of the page, 2 is missing in front of $E[Y(t_0)Y(t_1)\{...\}]$

- p.69: $df(x(t))$ should be $df(t, x(t))$.

- p.72, in equation (3.24) several terms are missing. It should read

$$\begin{aligned} df(X,Y) &= f_x dX + f_y dY + \sigma_{X,1}\sigma_{X,2} f_{xx} + \sigma_{Y,1}\sigma_{Y,2} f_{yy} \\ &\quad + [\frac{1}{2}(\sigma_{X,1}^2 + \sigma_{X,2}^2 + 2\rho\sigma_{X,1}\sigma_{X,2}) f_{xx} + \frac{1}{2}(\sigma_{Y,1}^2 + \sigma_{Y,2}^2 + 2\rho\sigma_{Y,1}\sigma_{Y,2}) f_{yy} \\ &\quad + f_{xy}(\sigma_{X,1}\sigma_{Y,1} + \sigma_{X,2}\sigma_{Y,2} + \rho\sigma_{X,1}\sigma_{Y,2} + \rho\sigma_{X,2}\sigma_{Y,1})] dt \quad . \end{aligned}$$

- p.73, the equation for dY is incorrect. It should be

$$dY = e^{aW}\left[1 + \frac{1}{2}a^2W^2 + 2Wa\right] dt + e^{aW}[aW^2 + 2W] dW \quad .$$

- p95: In the last term for B_n, 1/2 is missing in front of the first expression.

CHAPTER 4: OPTIMAL CONSUMPTION/PORTFOLIO STRATEGIES

- p104, line 10: "chapter 3", not "chapter 2".

- p105, line 5: "chapter 3", not "chapter 2".

- p106, line 7: "when project A pays $100", not "when project B pays $100".

- page 110: For this reason exponential utility is said to belong to the family of utility functions with Constant Absolute Risk Aversion, or CARA family.

- p126: A bracket is missing in (4.39): $dX^\pi = X^\pi[[r + \ldots$.

- p127: In (4.41) the integral should start from t, not from zero.

- p131, line 8: "as well as process $Z(t)\bar{S}(t)$"

- p131, line 17: $E_{T-1}[Z(T)\bar{X}(T)]$

-p134, equation (4.63): should be $+\lambda$, not $-\lambda$

- p137, equation (4.79): should be $\bar{Z}(t)$, not $\hat{Z}(t)$

- page 140, line 11: should be $\max_\delta[-e \ldots]$, not $\max_\delta E[e \ldots]$.

- page 141: σ^{-1} is missing in this definition: $\tilde{W}(t) := W(t) + \int_0^t \sigma^{-1}[\mu(u) - \tilde{\mu}(u)]du$.

- page 144, equation (4.87): It should be conditional expectation E_t^*, not unconditional E^*.

-p148, Problem 19: $X^\gamma(2)$

-p148, Problem 20: $X(2)$

-p 164; line 7: "56% in asset 2" should be "55% in asset 2".

CHAPTER 6: ARBITRAGE AND RISK-NEUTRAL PRICING

- page 184, 2 lines after equation (6.7), it should be $P(t) \geq p(t)$ instead of $P(t) > p(t)$.

- page 195: The third paragraph from bottom should read:

"On the other hand, suppose next that the price c is less than $C(0)$, say equal to $0.50. Then, Taf can use the strategy $-\delta$, that is, sell short 0.5 shares of the stock and deposit $\delta_0 = \$49.2537$ in the bank, and also buy the option. This will leave him with extra $0.246. Suppose first that the stock price is $S(1) = 101$ at time $T = 1$. This means that Taf's option is worth one dollar, which is exactly how much Taf owes in this replicating strategy. But, Taf still has $0.246 that was set aside at time $t = 0$. This is an arbitrage opportunity again. Similarly, if $S(1) = 99$."

- page 197, line 9 from bottom should read:

$$E^*[\bar{C}(1)] = p^* \frac{101 - 100}{1.005} = 0.746$$

page 202: Before "and the boundary" the right-hand side should be $-f$, not just f.

- page 205, 206: Last paragraph on page 205; All the expected values $E[S(T)]$ should be conditional, $E_t[S(T)]$.

CHAPTER 7: OPTION PRICING

- page 239: "dt" is missing in the second equation for $dX(t)$.

- page 241: The equation preceding (7.37) should read

$$dQ^* = Q^*[(\mu_Q + r_f)dt + \sigma_Q dW]$$

- page 243, the first part of equation (7.41) should be

$$C_t + \frac{1}{2}\sigma^2 f^2 C_{ff} - rC = 0.$$

- page 257: "S" is missing in the term $C_{sv}\gamma\sigma_2$ (in both equations).

- page 262: Square missing: $\sigma_k^2 := \sigma^2 + k\beta^2/T$

CHAPTER 8: FIXED INCOME MARKET MODELS AND DERIVATIVES

- page 284, equations (8.15), (8.16), there is a superscript missing in the right hand-side. It should be

$$\frac{h^u(j+1)h^d(j)}{h^u(1)} = \frac{h^d(j+1)h^u(j)}{h^d(1)}$$

- page 286: "period two and the end of period three ..."

- p290, line 13: $B(T,T) = 0$

- p 293, equation (8.41) should read:

$$f(0,T) = -\frac{\partial \log P(0,T)}{\partial T} \quad .$$

- pages 297, 298: "d" missing in front of W – should be dW in equations (8.50), (8.51), (8.56).

- p302, Problem 23: Delete the last sentence.

- p304, second line: Should be $e^{-0.05 \cdot 0.25} - (1 + 0.1 \cdot 0.5)e^{-0.07 \cdot 0.75}$

CHAPTER 10: BOND HEDGING

- **1. Definitions of Duration and Convexity.** In this chapter the duration and convexity formulas apply only if we measure the time units in integers. In particular, if the coupons are paid once a year and the yield is annual yield the formulas do apply. However, if we measure yield in annual terms and coupons are paid at times t_i (in annual terms), then the time values i in the formulas have to be replaced by the values t_i. Similarly, the discounting has to be done in the appropriate way.

For example, suppose that a bond pays the amount C_i at regular intervals of length $1/n$ years and that there are T years left until maturity, for a total of $T \cdot n = m$ periods, and the current bond price is denoted P. The definition of the duration would be then the following, if we use the compounding interest rule,

$$D := \sum_{i=1}^{m} \frac{i}{n} \cdot \frac{\frac{C_i}{(1+y)^{i/n}}}{P} \quad . \tag{0.1}$$

or the following, using the simple interest rule.

$$D := \sum_{i=1}^{m} \frac{i}{n} \cdot \frac{\frac{C_i}{(1+y/n)^i}}{P} \quad . \tag{0.2}$$

These definitions are needed to solve some of the problems in the chapter.

- page 344, Example 10.2: There should be no i in the bond price P:

$$P = \sum_{i=1}^{30} \frac{8}{1.05^i} + \frac{100}{1.05^{30}}$$

Also, the maturity should be 30 not 5, in the two computations of D:

$$D = \sum_{i=1}^{30} i \frac{\frac{8}{1.05^i}}{146.12} + 30 \frac{\frac{100}{1.05^{30}}}{146.12}$$

$$D = \sum_{i=1}^{30} i \frac{\frac{8}{1.1^i}}{81.15} + 30 \frac{\frac{100}{1.1^{30}}}{81.15}$$

CHAPTER 11: NUMERICAL METHODS

- page 357: in the middle of the page, square root is missing, $e = e^{\sigma\sqrt{\Delta t}}$.
- page 367, Section 11.2.4: In the equation for $dS(t)$, "]" should be at the end.
- page 367 fourth line from the bottom, it should read: $k = 0, ..., N;$, not $k = 0, ..., t_N;$.
- pages 372 and 373: The two expressions for $\hat{\pi}$ should have the factor e^{rt} instead of $e^{r(T-t)}$.
- page 376, it should be

$$\frac{\partial C}{\partial s} \approx \frac{C_{i+1,j+1} - C_{i+1,j-1}}{2\Delta s} \quad .$$

CHAPTER 12: EQUILIBRIUM FUNDAMENTALS

- p 404, line 2: dU'

CHAPTER 13: CAPM

- page 414, equation (13.5) should read

$$Var\,[r_i] = Var[a_i + b_i r_M + \epsilon_i] = \beta_i^2 Var[r_M] + Var[\epsilon_i] + 2\beta_i Cov[\epsilon_i, r_M]$$

- page 421, signs in the quadratic terms are wrong, it should be:

$$E\left[e^{-\gamma_j (\pi^j)^{Tr}\vec{R}}\right] = e^{-\gamma_j (\pi^j)^{Tr}\vec{\mu} + \frac{1}{2}\gamma_j^2 (\pi^j)^{Tr}\Sigma\pi^j} \quad .$$

$$\begin{aligned} & \max_{\{\pi^j\}} E\left[-e^{-\gamma_j\left((\pi^j)^{Tr}\vec{R} + \left(X_j(0) - \sum_{i=1}^N \pi_i^j\right)R\right)}\right] \\ = \; & \max_{\{\pi^j\}} \left[-e^{-\delta_j (\pi^j)^{Tr}\vec{\mu} + \frac{1}{2}\gamma_j^2 (\pi^j)^{Tr}\Sigma\pi^j + \gamma_j\left(X_j(0) - (\pi^j)^{Tr}\mathbf{1}\right)R}\right] \end{aligned}$$

- Page 425, before equation (13.33) it should be the "expected return rate" (instead of just "return rate").

- page 428, the line before equation (13.48), and in equation (13.48) should be β_{iC} instead of β_C

CHAPTER 14: MULTIFACTOR MODELS

- Page 438, equation (14.26),should be

$$dS_i(t) = S_i(t)\left[\mu_i(t, Y(t))dt + \sigma_{i1}(t, Y(t))dW_1(t) + \sigma_{i2}(t, Y(t))dW_2(t)\right]$$

- page 440: It should be

$$V_{xx}\Sigma\Sigma^{Tr}\pi = -V_x(\mu - r\mathbf{1}) - V_{xy}\sigma_{YS} \quad .$$

- page 443, equation (14.50) should be:

$$\Gamma = \begin{pmatrix} \sigma_{M1} & \sigma_{M2} \\ \sigma_{Y1}/X_Y & \sigma_{Y2}/X_Y \end{pmatrix}$$

and in the equation of Theorem 14.1 the matrix Γ should be transposed.

- page 450, second line, quotation mark: it should be "production technology" instead of "production technology".

- page 459, equation (15.42): the very last term $\frac{1-p}{R_1-r}$ should have the minus sign.

- page 459, equation (15.43): In the last term X_2 should be X^B, and the whole expression in the second line should have the minus sign.

CHAPTER 15: OTHER PURE EXCHANGE EQUILIBRIA

- p. 457: (15.37) should read

$$dr(t) = \frac{\delta(t)}{\rho^2}[\bar{r} - r(t)]dt + \frac{\delta(t)}{\rho}dW(t)$$

SOLUTIONS MANUALS TO THE END OF CHAPTER PROBLEMS

- Problem 4.14: Should be

$$f(t) = e^{-\theta^2(T-t)/2}$$

- Problem 5.6: Wrong computations:

In our case, since $\sigma_{12} = \rho\sigma_1\sigma_2 = 0.03$,

$$\sigma^2 = 9(\mu - 0.2)^2 + (-0.5 + 5\mu)^2 - 0.6(\mu - 0.2)(-1 + 10\mu) \quad .$$

Setting the derivative with respect to μ equal to zero, we obtain $\mu = 0.1214$. The variance corresponding to this mean is $\sigma^2 = 0.0771$, and it is the minimum variance for the portfolios consisting of these two assets. The proportions to be held in the two assets are

$$\Pi_1 = 0.786 = 78.6\%, \quad \Pi_2 = \ 0.214 = 21.4\%.$$

- Problem 5.10: The second part of the solution should read:

$$\sigma^2 = 1.5^2\Pi_0^2 0.3^2 + (1 + 0.5\Pi_0)^2 0.5^2 - 2 \cdot 0.2 \cdot 0.3 \cdot 0.5 \cdot 1.5\Pi_0(1 + 0.5\Pi_0) \quad ,$$

Setting the derivative with respect to Π_0 equal to zero, we obtain

$$\Pi_0 = -4/11, \quad \text{and} \quad \Pi_1 = 6/11 \ , \quad \Pi_2 = 9/11 \quad .$$

- Problem 6.2: "Suppose that (6.5) does not hold ..."
- Problem 6.5: Extra bracket) in

$$S(t) + P(t) > C(t) + \bar{D}(t) + K \quad .$$

- Problem 6.11: Extra equality = in

$$F(t) = S(t)e^{r(T-t)} = 10e^{0.08 \cdot 7/12} = 10.4777 \quad .$$

- Problem 6.12: Extra bracket in

$$F(t) + \bar{D}(t)e^{r(T-t)} > S(t)e^{r(T-t)} \quad ,$$

and

$$F(t) < S(t)e^{r(T-t)} - \bar{D}(t))e^{r(T-t)} \quad .$$

- Problem 6.22: In the "Solution", s and t should be interchanged in the first two terms.
- Problem 7.15: Wrong computations:

In node I, the price of the option is

$$\max\{0, e^{-0.05}(1 - p^*) \cdot 2\} = \max\{0, 0.4634\} = 0.4634$$

In node II, the price of the option is

$$\max\{11, e^{-0.05}\left(p^* \cdot 2 + (1 - p^*) \cdot 20\right)\} = \max\{11, 6.074\} = 11$$

The price of the American put at the initial time is, then,

$$\max\{1, e^{-0.05}\left(p^* \cdot 0.4634 + (1 - p^*) \cdot 11\right)\} = \max\{1, 2.8823\} = 2.8823$$

- Problem 7.39: Time t should be replaced by time T in the formulas.
- Problem 8.10: In the expression for "r(t)" the volatility σ is missing in the stochastic integral.
- Problem 8.12: In the equation for A(t), a minus sign is missing in front of the integral. Moreover, in the equation for $f(0, t)$ the sign before the integral term should be positive.
- Problem 8.18: Stochastic integrals should have dW not just W.

- Problem 8.22: In the third line of equations, there's a term with an integral from T_{j-1} to T. It should be from T_{j-1} to T_j.

- Problem 9.12: In the solution for x the exponent should have the negative sign, which gives $x = -0.04511$ and $y = -271.83$.

- Problem 9.15: The solution in the manual has the wrong sign. This would be the solution if you sell the option, not if you buy it.

- Problem 13.7: Wrong computations:

b. From the CAPM we get

$$\beta_A = \frac{\mu_A - R}{\mu_M - R} = 2.1459, \quad \beta_B = \frac{\mu_B - R}{\mu_M - R} = 0.4292 \quad .$$

c. We have $\sigma_{MA} = \sigma_M^2 \beta_A = 0.0858$.

INSTRUCTORS MANUAL

- Problem 4.25: Wrong $f(t)$. Replace the solution with:

Solution: We assume $U_1(x) = U_2(x) = x^\gamma/\gamma$. Maximizing the term $U_2(c) - cV_x$ in HJB PDE (4.43) in the book, we get

$$\hat{c}(t,x) = I_2(V_x(t,x)) \quad ,$$

where I_2 is the inverse function of U_2'. For $U_2(c) = U_1(c) = c^\gamma/\gamma$ we have $I_2(z) = z^{1/(\gamma-1)}$. Thus, the HJB PDE becomes

$$V_t - \frac{\theta^2}{2}\frac{(V_x)^2}{V_{xx}} + rxV_x + \frac{1-\gamma}{\gamma}V_x^{\frac{\gamma}{\gamma-1}} = 0, \quad V(T,x) = x^\gamma/\gamma \quad , \tag{0.3}$$

Trying the function $V(t,x) = f^{1-\gamma}(t)x^\gamma/\gamma$ as a solution, we get

$$x^\gamma \left[f'(t) + \alpha f(t) + 1\right] = 0$$

where

$$\alpha = \frac{\gamma}{(1-\gamma)^2}[\theta^2/2 + r(1-\gamma)].$$

This means that

$$f(t) = \frac{1+\alpha}{\alpha}e^{\alpha(T-t)} - 1/\alpha.$$

The optimal portfolio is

$$\hat{\pi}(t,x) = -\sigma^{-1}\theta\frac{V_x(t,x)}{V_{xx}(t,x)} = \frac{\theta}{(1-\gamma)\sigma}x \quad . \tag{0.4}$$

The optimal consumption is

$$\hat{c}(t,x) = V_x(t,x)^{\frac{1}{\gamma-1}} = f^{-1}(t)x \quad . \tag{0.5}$$

- page 87, problem 38, second line from the bottom should be (there is a m in one exponent which is currently missing)

$$= e^{-\lambda t}\sum_{k=0}^{\infty} E^*[X^k]e^{-\lambda m t}\frac{(lambdat)^k}{k!} = e^{-\lambda(m+1)t}\sum_{k=0}^{\infty}\frac{[(m+1)\lambda t]^k}{k!}$$