

Typo list for the first printing of *Asset Pricing*

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Typos to equations, some additions, and things that are wrong

- p. 6. Add the following footnote to “The limit” at the bottom of the page: To be precise, if you want to think about this limit add a constant to the utility function and write it as

$$u(c_t) = \frac{c_t^{1-\gamma} - 1}{1-\gamma}.$$

p.11, second from last line, $x_{t+1}z_{t+1}$ should be $x_{t+1}z_t$

p.12, three lines above 1.4, “ R_t^e, r_{t+1} ” should read “ R_{t+1}^e, R_{t+1} ”.

p.19, below (1.15), β_{im} should be $\beta_{i,m}$

p.25, second line of (1.22) needs a negative sign. It should read

$$= -\frac{\sigma_t(m_{t+1})}{E_t(m_{t+1})}\sigma_t(R_{t+1})\rho_t(m_{t+1}R_{t+1})$$

Below the equation, add “where Δc_t denotes percentage or log consumption growth.”

p.26. The sum should read $\sum_{j=1}^{\infty}$

p.27, (1.23) both sums should read $\sum_{j=1}^{\infty}$ not $\sum_{j=0}^{\infty}$

p.27, 4 lines below (1.24) $\lim_{t \rightarrow \infty}$ should be $\lim_{j \rightarrow \infty}$

p. 30, top. Sum should read $\sum_{j=1}^{\infty} \beta^j$ not $\sum_{j=0}^{\infty} \beta^t$

p.31, 1.11 $p_t u'(c_t) = E_t(m_{t+1}(p_{t+1} + d_{t+1}))$ should read $p_t = E_t[m_{t+1}(p_{t+1} + d_{t+1})]$.

p.33, 1a, the equation needs a negative sign, it should read

$$-\frac{u''(c)}{u'(c)}$$

p.33, 1b. Another negative sign. The equation should read

$$rra = -\frac{cu''(c)}{u'(c)}$$

p.33 just below the equation in 1(b). “For power utility $u'(c) = c^{-\gamma}$ ” should read “For power utility $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$.”

p.38. Last formula (Taylor expansion) is missing a $u(c_t)$ term and a negative sign. It should read

$$u(c_t - v_t \xi) - u(c_t) = -u'(c_t)v_t \xi + \frac{1}{2}u''(c_t)(v_t \xi)^2 + \dots$$

p.39, middle, after “the value of a project not already taken,” $E \sum_j \beta^j u(c_{t+j} + x_{t+j})$ should read

$$E_t \sum_j \beta^j [u(c_{t+j} + x_{t+j}) - u(c_{t+j})]$$

p. 44, (2.3) $\left(\frac{c_{t+1}}{c_t}\right)^{-\gamma}$ should be $\beta \left(\frac{c_{t+1}}{c_t}\right)^{-\gamma}$

p.48, Q1, 3 lines from the end. $\gamma > 0$ should be $\gamma > 1$.

p.49. 2c. Delete the sentence “e and k are the only state variables, so the price should be a function of e and k.” Substitute “Express the price in terms of c_t .” Delete “Interpret that time variation in the price of the consumption stream” Substitute “Interpret the price of the consumption stream as a risk-neutral term, and a time-varying risk premium. Explain the intuition of the risk premium.”

p.59 4 lines below the second equation, should read “they must have the same inner product with pc and hence the same price.”

p.74, box, second equation. $\Sigma^{-1}dz$ should be $\Sigma^{-1}\sigma dz$.

p.87, fourth formula from bottom, $proj[(1|R^e) \times R^e]$ should read $proj[(1|\underline{R}^e) \times R^e]$

p.88, 3 lines above figure 5.2, “ $E = 1$, $E = 2$ ” should read “ $E = 0$, $E = 1$ ”.

p. 88 Below (5.11) $E(R^{e*}) \neq 0$ add :(unless the market is risk neutral, in which case the frontier is degenerate and every return has the same mean)

p.92, line 2, R^a should read R^α (alpha, not a)

p.93, (7) 2 lines below equation. $w^2 E(R^{e2})$ should read $w^2 E(R^{e*2})$

p.94. item (12). Remove underlines to R^* , R^{e*} .

p.96, last paragraph. “As we increase $E(m)$ ” should read “As we increase $1/E(m)$ ”

p.97, (5.25) add a ' before Σ , i.e. $[p - E(m)E(x)]' \Sigma^{-1} [x - E(x)]$

p.97, below (5.26). “cup-shaped” and “parabolic” should both read “hyperbolic”

p.99, equations below (5.28). The expression for $E(m^{*2})$ is wrong, as it's missing w . It's easiest to fix this by deleting “It is easiest...second moment” and below the equations, “Variance follows...(5.26)” and change the second equation to

$$\sigma^2(m^*) = [p - wE(x)]' cov(x, x') [p - wE(x)]$$

p.114, box, and p.118, (6.23), R^a should read R^γ (gamma, not a)

p.120 in the second line of the third paragraph replace at the beginning “spanning the unit payoff ...” by “spanned by the unit payoff ...” and at the end “plane containing the discount factor” by “line containing the discount factors”

p.137, paragraph 3, line 1, $x_{t+1}z_{t+1}$ should read $x_{t+1}z_t$

p.137, paragraph 3, line 8,(the equation) $\forall x_t$ should be $\forall x_{t+1}$

p. 139, second from last equation. Change this to $m_{t+1} = a_t + b_t R_{t+1}^W$ (or, better, change all following equations to $-b_t$)

p. 140-141. Strike from “Furthermore,..” on third to last line of 140 to end of paragraph on p. 141. Constant conditional betas *are* enough. (Thanks to Jonathan Lewellen for pointing this out.) Replace with the following.

Therefore, the conditional model does not in general lead to an unconditional model. Again, there are special cases in which the conditional model does condition down. If $b_t = b$ constant in the discount factor representation, we know the model conditions down. The risk premium in an expected return-beta model is given by $\lambda_t = \text{var}_t(f_t f_t') b_t$. Thus, if factor risk premia move in proportion to the conditional variance of the factors, this is equivalent to a constant b , so the model will condition down. There are additional special cases as well. If the covariance of returns with factors is constant over time, the model will condition down despite varying b_t . You can see this simply by $E_t(R^e) = \beta_t' \lambda_t = \text{cov}_t(R^e, f') \text{var}_t(f)^{-1} \lambda_t$, so with a constant conditional covariance, $E(R^e) = \text{cov}(R^e, f') E[\text{var}_t(f)^{-1} \lambda_t] = \text{cov}(R^e, f') \lambda$. (We do not need $\lambda = E_t(\lambda_t)$.) The model also conditions down if conditional betas are constant over time. A problem at the end of the chapter guides you through the algebra of these special cases, in both expected return - beta and discount factor representations.

p. 141 5 lines past ”a precise statement.” $p_t = E_{t+1}(\dots)$ should be $p_t = E_t(\dots)$

p. 146 (8.6) left hand variable should be m_{t+1} not m_t

p. 148 Add the following problems (see p.140-141 typos).

1.

(a) Show that $\sigma^2(x_{t+1}) = E[\sigma_t^2(x_{t+1})] + \sigma^2[E_t(x_{t+1})]$. When do variances condition down – when is the unconditional variance equal to the average conditional variance? (Hint: Start with $x_{t+1} = E_t(x_{t+1}) + [x_{t+1} - E_t(x_{t+1})]$.)

(b) Find the analogous decomposition for covariances. When is the unconditional covariance equal to the average conditional covariance?

2. A conditional model does not *necessarily* imply an unconditional model, but we never said that a conditional model *might*, with some other side conditions, condition down. Show that the following three conditions are each sufficient for a model to condition down, using the $ER - \beta$ representation and using the $m = a + bf$ representation. To keep things simple, consider only the case of excess returns $0 = E_t(mR^e)$; $E_t(R^e) = \beta_t' \lambda_t$, and without loss of generality normalize your factors to have conditional mean zero, $m = 1 + b' f_{t+1}$; $E_t(f_{t+1}) = 0$ (with excess returns, the mean $E_t(m)$ is unidentified).

(a) $b_t = b = \text{constant} \Leftrightarrow \lambda_t = -\text{var}_t(f f') b$; market prices of risk move one for one with conditional variance, no restriction on conditional betas.

(b) $\text{Cov}_t(R_{t+1}^e, f'_{t+1}) = \text{constant}$, even though b_t may vary over time.

- (c) Constant conditional betas, $var_t(ff')^{-1}cov_t(R_{t+1}^e, f'_{t+1}) = \beta$ even though the individual cov and var may vary arbitrarily over time. No limit on λ .

Note: These are interesting sets of sufficient conditions. I have not been able to derive clean general necessary conditions for conditioning down (i.e., beyond the obvious that E of some big mess equals the unconditional representation).

p.157. Remove $-\frac{1}{2}$ from equation

p. 162 third equation, $\frac{\partial g}{\partial t}$ should be multiplied by dt and $\frac{df_t}{f_t}$ should be just df_t . The equation should read

$$d\Lambda_t = \frac{\partial g}{\partial t} dt + \frac{\partial g}{\partial f} df_t + \frac{1}{2} \frac{\partial^2 g}{\partial f^2} df_t^2$$

p. 167 last equation ΔW_{t+1} should read $\Delta W_{t+1}/W_t$

p. 196 Delete $\frac{1}{T}$ from the first equation.

p. 208. (11.12) no need for hats over the β . Last two equations, $d = -E(x_t x'_t)$ minus sign missing, and $f(x_t, \beta) = \dots = x_t \varepsilon_t$ there is no need to separate errors ε from residuals e .

p. 210 just before 11.5. $\sum_{j=-k}^k$ should read $\sum_{j=-k+1}^{k-1}$.

p. 224 (11.20) $\sum_{j=-k}^k$ should read $\sum_{j=-k+1}^{k-1}$.

p. 228, Make question 2, question 2 part a. Add part b: Show in this case that conventional standard errors are ok if the x are uncorrelated over time, even if the errors ε are correlated over time.

p. 233, below $\hat{\Omega} = \dots$, add

$$\hat{\Sigma} = \frac{1}{T} \sum_{t=1}^T \hat{\varepsilon}_t \hat{\varepsilon}'_t$$

p. 237 line 7 begins a mistake. It doesn't affect many formulas, but it does affect some of the conclusions comparing various techniques. I state

$$cov(\alpha\alpha') = \frac{1}{T} \Sigma$$

This is wrong. The right formula is

$$cov(\alpha\alpha') = \frac{1}{T} \beta \Sigma_f \beta' + \frac{1}{T} \Sigma$$

This only has small effects in the end. 1) The simple standard error formulas for $\sigma(\hat{\lambda})$ do have Σ_f terms in them. 2) The Shanken correction is *only* the multiplicative correction, and thus typically small. The Σ_f term is already there. 3) The FMB standard errors do recover standard errors that have the all-important Σ_f term

To fix all this,

p. 237. Replace pp2 with

To apply these formulas we need $cov(\alpha, \alpha')$, the error covariance in the cross-sectional regression. With the traditional assumption that the factors and errors are i.i.d. over time, the answer is $cov(\alpha, \alpha') = \frac{1}{T} (\beta \Sigma_f \beta' + \Sigma)$ where $\Sigma_f \equiv cov(f_t, f'_t)$ and $\Sigma = cov(\varepsilon_t \varepsilon'_t)$. To see this, start with $\alpha =$

$E_T(R^e) - \beta\lambda$. With $R_t^e = a + \beta f_t + \varepsilon_t$, we have $E_T(R_t^e) = a + \beta E_T(f_t) + E_T(\varepsilon_t)$. Under the null that the model is correct, so $E(R^e) = a + \beta E(f) = \beta\lambda$, then, we have $cov(\alpha\alpha') = cov[E_T(R^e)E_T(R^e)'] = \frac{1}{T}(\beta\Sigma_f\beta' + \Sigma)$. (Don't confuse this covariance with the covariance of the *estimated* α in the cross sectional regression. Like a residual covariance vs. an error covariance, there are additional terms in the covariance of the estimated α , which I develop below. Yes, we want the covariance of $E_T(R^e)$, not of $E(R^e)$, which is a number and has no covariance, or of R_t^e . $E_T(R^e)$ is the y variable in the cross-sectional regression.)

Then, the conventional OLS formulas for the covariance matrix of OLS estimates and residual, accounting for correlated errors, give

$$\sigma^2(\hat{\lambda}) = \frac{1}{T} [(\beta'\beta)^{-1} \beta'\Sigma\beta(\beta'\beta)^{-1} + \Sigma_f] \quad (12.12)$$

$$cov(\hat{\alpha}) = \frac{1}{T} [I - \beta(\beta'\beta)^{-1}\beta'] \Sigma [I - \beta(\beta'\beta)^{-1}\beta']' \quad (12.13)$$

The correct formulas, (12.19) and (12.20), which account for the fact that β are estimated, are straightforward generalizations. (The Σ_f term cancels in (12.13).)

- p. 237, just before (12.15) replace “using $E(\alpha\alpha') = \frac{1}{T}\Sigma$ as the error covariance matrix” with “using $E(\alpha\alpha') = \frac{1}{T}(\Sigma + \beta\Sigma_f\beta')$ as the error covariance matrix (note that the $\beta\Sigma_f\beta'$ term cancels in $\hat{\lambda}$)”

- p. 237 delete footnote

- p. 238, (12.16) should read

$$\sigma^2(\hat{\lambda}) = \frac{1}{T} [(\beta\Sigma^{-1}\beta)^{-1} + \Sigma_f], \quad (12.16)$$

- p. 239, end of pp2., delete “and an additive correction Σ_f .”

- p. 239, last paragraph “Are the corrections” should be “Is the correction”

- p. 240 replace paragraphs 1-3 with this

Suppose the factor is in fact an excess return. Then the factor risk premium is $\lambda = E(f)$ and we would use Σ_f/T as the standard error of λ . The terms in β correct for the small differences between cross-sectional and time-series estimates. They are therefore likely to be small, and the Σ_f/T term is likely to be the most important term.

- p. 241, just above “The standard errors for λ ” add the following paragraph.

However, once we abandon i.i.d errors, the GLS cross-sectional regression weighted by Σ^{-1} is no longer the optimal estimate. Once you recognize the errors do not obey classical assumptions, and if you want efficient estimates, you might as well calculate the correct and fully efficient estimates. Having decided on a cross-sectional regression, the efficient estimates of the moments (12.23) are $d'S^{-1}g_T(a, \beta, \lambda) = 0$.

- p. 242. You might as well have the formulas for the vector case. The moments are

$$\begin{bmatrix} I_N \otimes I_{K+1} & \\ & \gamma' \end{bmatrix} \begin{bmatrix} E_T(R^e - a - \beta f) \\ E_T[(R^e - a - \beta f) \otimes f] \\ E_T[(R^e - \beta\lambda)] \end{bmatrix} = 0$$

where $\beta_i = N \times 1$, and $\gamma' = \beta'$ for OLS and $\gamma' = \beta'(\Sigma^{-1})$ for GLS. (Note that the GLS estimate is *not* the “efficient GMM” estimate when returns are not iid. The efficient GMM estimate would be $d'S^{-1}g_T = 0$. That reduces (I think!) to the GLS estimate under iid, but does not in general.) Then

$$d = \frac{\partial g_T}{\partial[\alpha' \beta'_1 \beta'_2 \lambda']} = - \left[\begin{array}{cc} 1 & E(f') \\ E(f) & E(ff') \\ 0 & \lambda' \end{array} \right] \otimes I_N \left[\begin{array}{c} 0 \\ 0 \\ \beta \end{array} \right]$$

p. 243 line one, “estimate should use the spectral density matrix as weighting matrix applied to all the moments, rather than Σ^{-1} applied only to the pricing errors.”

p. 249, two lines above “*Fama-MacBeth*” x^{-1} should be x . The formula should read

$$\sigma^2(\hat{\beta}_{XS}) = \frac{1}{T} (x'x)^{-1} x'\Sigma x (x'x)^{-1}.$$

p. 253, 254, 256 (twice), 257. $(d'S^{-1}d)$ should be $(d'S^{-1}d)^{-1}$ in all the second stage GMM formulas.

p. 255. second from last equation. b should be \hat{b} .

p. 256 Instead of “We have” and following equation, write

To economize on notation, define

$$d = -\frac{\partial g_T(b)}{\partial b'} = E(R^e f'),$$

the second-moment matrix of returns and factors. (This is the negative of the usual definition of d , but the sign of d drops from the formulas.) The first-order condition to $\min g_T' W g_T$ is

$$d'W [E_T(R^e) - db] = 0.$$

p. 257. Delete from “The distribution theory is straightforward.. ” to end of page. Add the following

The moments are in fact

$$g_T = \left[\begin{array}{c} E_T [R^e - R^e(f' - Ef)b] \\ E_T(f - Ef) \end{array} \right]$$

where Ef is the mean of the factors, a parameter to be estimated just like b . We can capture the first and second stage regressions above with the weighting matrix

$$a_T = \left[\begin{array}{cc} E_T(\tilde{f}R^{e'})W & 0 \\ 0 & I_K \end{array} \right]$$

with $W = I$ or $W = S_{11}^{-1}$. (I use the notation S_{11} to denote the first block of the spectral density matrix, corresponding to the $E_T [R^e - R^e \tilde{f}'b]$ moments only). The first block of estimates delivers the OLS and GLS cross sectional regression estimates of b , while the identity matrix in the second block delivers the sample mean estimate $Ef = E_T(f)$. Now the standard GMM standard error and $cov(g_T)$ formulas will correct for the fact that Ef is estimated. A problem at the end of the chapter leads you through the algebra to verify that the resulting standard errors resemble those of the Shanken correction in Chapter 12.

This correction only affects the standard errors of the b estimates. The distribution of the pricing errors and the χ^2 statistics are not affected. In my experience so far with this method, the correction for the fact that Ef is estimated is very small in practice, so that little damage is done in ignoring it (as is the case with the Shanken correction). On the other hand, once the issue is understood it's trivially easy to do it right.

As was the case with the Shanken corrections, the "second stage" regression here is not in fact the efficient GMM estimate. The efficient estimate does not use this a_T with $W = S_{11}^{-1}$, rather it uses $a_T = d'S^{-1}$ with

$$d = \frac{\partial g_T}{\partial [b' Ef']} = \begin{bmatrix} -E(R^e \tilde{f}') & E(R^e) b' \\ 0 & -I_K \end{bmatrix}.$$

and S the spectral density matrix of both sets of moments,

$$S = \sum_{j=-\infty}^{\infty} E \begin{bmatrix} u_t u'_{t-j} & u_t \tilde{f}'_{t-j} \\ \tilde{f}_t u'_{t-j} & \tilde{f}_t \tilde{f}'_{t-j} \end{bmatrix}$$

$$u_t \equiv R_t^e (1 - \tilde{f}_t b).$$

$d'S^{-1}$ does not have the block-diagonal form of a_T given above. Efficient GMM lets some moments deviate from their sample values if by doing so it can make other moments closer to zero, trading off these errors by the S^{-1} matrix. If an estimate $Ef \neq E_T(f)$ will make the pricing errors smaller, then efficient GMM will choose such an estimate. Thus, if one really wants efficiency, this is the way to do it, rather than the second stage cross sectional regression given above.

p. 259. bottom. Delete from "The GMM estimate." to "the estimated characteristics."

p. 267 last formula, no negative sign. $-\frac{1}{T}$ should be $\frac{1}{T}$.

p. 269 second to last formula needs a negative sign. \mathcal{I} should be $-\mathcal{I}$

p. 271, above (14.11). Remove "= 0".

p.297, the $(1 - \beta)$ should be in the numerator of the second equation, i.e.

$$c_t - c_{t-1} = (E_t - E_{t-1})(1 - \beta) \sum_{j=0}^{\infty} \beta^j y_{t+j} = \frac{(1 - \beta)}{(1 - \beta\rho)} \varepsilon_t$$

p.319, last equation. The t subscripts should be 0, i.e. should read

$$C_0 = E_0 \left\{ \frac{\Lambda_T}{\Lambda_0} \max(S_T - X, 0) \right\} = \int \frac{\Lambda_T}{\Lambda_0} \max(S_T - X, 0) df(\Lambda_T, S_T),$$

p.321 (17.6) and the equation below "Doing the Integral". Λ_t in the denominator should be Λ_0 .

p.322, last equation in the first group. $f(\varepsilon)$ should be $f(\varepsilon)d\varepsilon$

p.323, top equation. $\sigma\sqrt{T-t}$ should be $\sigma\sqrt{T}$ and $e^{-r(T-t)}$ should be e^{-rT} .

p. 323, (17.7) will be clearer with an extra set of parentheses, $\ln(S_0/X)$.

p. 323, middle, in the paragraph that starts "Guess that the solution.." Delete " $C_t =$ ". We'll reserve C_t for $\partial C/\partial t$

p. 350 middle term last equation is missing an exponential; it should be

$$e^{-\sum_{j=0}^{N-1} f_t^{(j \rightarrow j+1)}}.$$

A better version of the equation is

$$p_t^{(N)} = -\sum_{j=0}^{N-1} f_t^{(j \rightarrow j+1)}; P_t^{(N)} = \left(\prod_{j=0}^{N-1} F_t^{(j \rightarrow j+1)} \right)^{-1}$$

p. 356 equation (19.8) and p. 357 last equation in the middle of the page. ρ^{N+1} should be ρ^N .

p.359 (19.9) has several small typos. The right version:

$$\begin{aligned} y_t^{(1)} - E(y^{(1)}) &= \rho [y_{t-1}^{(1)} - E(y^{(1)})] - \rho \varepsilon_t \\ y_t^{(2)} &= \delta + \frac{1+\rho}{2} (y_t^{(1)} - E(y^{(1)})) - \frac{1+(1+\rho)^2}{4} \sigma_\varepsilon^2 \\ y_t^{(3)} &= \delta + \frac{1+\rho+\rho^2}{3} (y_t^{(1)} - E(y^{(1)})) - \frac{1+(1+\rho)^2+(1+\rho+\rho^2)^2}{6} \sigma_\varepsilon^2 \\ y_r^{(N)} &= \delta + \frac{1-\rho^N}{N(1-\rho)} (y_t^{(1)} - E(y^{(1)})) - \frac{\sigma_\varepsilon^2}{2N} \sum_{j=1}^N \left(\sum_{k=1}^j \rho^{k-1} \right)^2 \end{aligned}$$

p. 361 (19.12) $\sigma_\Lambda \sqrt{\Lambda} dz$ should read $\sigma_\Lambda \sqrt{r} dz$

p.362 (19.13) dz should be dz_s

p. 364, second equation from bottom. $\frac{\partial P}{\partial r^2}$ should be $\frac{\partial^2 P}{\partial r^2}$.

p. 365 Near the bottom of the page, should read as follows

The first step is

$$P(\Delta N, r) = P(0, r) + \frac{\partial P}{\partial N} \Delta N = 1 - r \Delta N$$

At the second step, $\partial P / \partial r = -\Delta N$, $\partial^2 P / \partial r^2 = 0$, so

$$\begin{aligned} P(2\Delta N, r) &= P(\Delta N, r) + \frac{\partial P(\Delta N, r)}{\partial N} \Delta N \\ &= 1 - 2r \Delta N + [r^2 - (\mu_r - \sigma_r \sigma_\Lambda)] \Delta N^2 \end{aligned}$$

Now the derivatives of μ_r and σ_r with respect to r will start to enter, and we let the computer take it from there. (In practice it would be better to solve in this way for the log price, of course.)

p. 367. 5 lines from bottom, $\frac{1}{P} \frac{\partial P_r}{\partial r} = -B(N)$ should be $\frac{1}{P} \frac{\partial P}{\partial r} = -B(N)$

p.368, last line. Delete ρ .

p. 374. Sign is wrong in $B(N)$. It should read

$$B(N) = \frac{2(e^{\gamma N} - 1)}{(\gamma + \phi + \sigma_r \sigma_\Lambda)(e^{\gamma N} - 1) + 2\gamma}$$

p. 375, (19.40)-(19.41). A Σ is missing in the $b_{\Lambda i}$ terms. They should read

$$\begin{aligned} \frac{\partial A(N)}{\partial N} &= \sum_i \left([\Sigma' B(N)]_i b_{\Lambda i} + \frac{1}{2} [\Sigma' B(N)]_i^2 \right) \alpha_i - B(N)' \phi \bar{y} - \delta_0 \\ \frac{\partial B(N)}{\partial N} &= -\phi' B(N) - \sum_i \left([\Sigma' B(N)]_i b_{\Lambda i} + \frac{1}{2} [\Sigma' B(N)]_i^2 \right) \beta_i + \delta. \end{aligned}$$

p. 376-377 A Σ is missing from the equation above (19.44) and following. It should all read as follows

$$\begin{aligned} -E_t \left(\frac{dP}{P} \frac{d\Lambda}{\Lambda} \right) &= -B(N)' \Sigma d w d w' b_\Lambda \\ -E_t \left(\frac{dP}{P} \frac{d\Lambda}{\Lambda} \right) &= -\sum_i [\Sigma' B(N)]_i b_{\Lambda i} (\alpha_i + \beta'_i y) \end{aligned} \quad (19.44)$$

Now, substituting..., we get

$$\begin{aligned} &-B(N)' \phi (\bar{y} - y) + \frac{1}{2} \sum_i [\Sigma' B(N)]_i^2 (\alpha_i + \beta'_i y) - \left(\frac{\partial A(N)}{\partial N} - \frac{\partial B(N)'}{\partial N} y + \delta_0 + \delta' y \right) \\ &= -\sum_i [\Sigma' B(N)]_i b_{\Lambda i} (\alpha_i + \beta'_i y). \end{aligned}$$

Once again, the terms on the constant and each y_i must separately be zero. The constant term:

$$-B(N)' \phi \bar{y} + \frac{1}{2} \sum_i [\Sigma' B(N)]_i^2 \alpha_i - \frac{\partial A(N)}{\partial N} - \delta_0 = -\sum_i [\Sigma' B(N)]_i b_{\Lambda i} \alpha_i.$$

$$\frac{\partial A(N)}{\partial N} = \sum_i \left([\Sigma' B(N)]_i b_{\Lambda i} + \frac{1}{2} [\Sigma' B(N)]_i^2 \right) \alpha_i - B(N)' \phi \bar{y} - \delta_0$$

The terms multiplying y :

$$B(N)' \phi y + \frac{1}{2} \sum_i [\Sigma' B(N)]_i^2 \beta'_i y + \frac{\partial B(N)'}{\partial N} y - \delta' y = -\sum_i [\Sigma' B(N)]_i b_{\Lambda i} \beta'_i y.$$

Taking the transpose and solving,

$$\frac{\partial B(N)}{\partial N} = -\phi' B(N) - \sum_i \left([\Sigma' B(N)]_i b_{\Lambda i} + \frac{1}{2} [\Sigma' B(N)]_i^2 \right) \beta_i + \delta.$$

p. 376. Add the following footnote to “applying the same algebra to our case” :

More elegantly, but less directly, we can use the fact that $Tr(AB) = Tr(BA)$ for square matrices and the fact that the last term is a scalar to write

$$\begin{aligned} E(dw'\Sigma' B(N)B'(N)\Sigma dw) &= Tr[E(dw'\Sigma' B(N)B'(N)\Sigma dw)] \\ &= Tr[E(B'(N)\Sigma dw dw'\Sigma' B(N))] \\ &= Tr(B'(N)\Sigma E(dw dw')\Sigma' B(N)) \\ &= \sum_i [\Sigma' B(N)]_i^2 E(dw_i^2) \end{aligned}$$

p.392, 5 lines from the bottom. “Small values of $b \dots$ ” should be ”Small values of $a \dots$ ” Two lines later, delete b .

p.396: below (20.7) add “where $k \equiv \log(1 + P/D) - \rho(p - d)$.”

p.399. (20.12) The last expression should read

$$\lim_{j \rightarrow \infty} E_t \left(\prod_{k=1}^j R_{t+k}^{-1} \Delta D_{t+k} \right) \frac{P_{t+j}}{D_{t+j}}$$

p. 400. Last equation should read

$$\text{prob} = \frac{P_t R (\gamma - 1)}{\gamma P_t R - 1}$$

p.403, (20.21) $E_t d_{t+j}$ should read $E_t \Delta d_{t+j}$. $E_t r_{t+1}$ should be $E_t r_{t+j}$.

p.408. Delete footnote. I got the construction of ETF’s wrong.

p. 414 (20.35) denominator only, $-(\rho + b)$ should be $-(1 + \rho b)$.

p. 415, 4 lines from bottom. “no dividend growth” should be “constant dividend growth.”

p. 419, below (20.40). $E(y_{t+1} y_t) = \dots - (\rho + b)\sigma(\varepsilon_d, \varepsilon_{dp})$ should be $\dots + (1 + \rho b)\sigma(\varepsilon_d, \varepsilon_{dp})$

p .420 top equation, denominator only, $-(\rho + b)$ should be $-(1 + \rho b)$.

p. 452, problem 6. “same variance ratio” should read “same limiting variance of k th differences (as $k \rightarrow \infty$)”.

p. 457, last equation. The left hand side should be $1/R_t^f$ instead of R_t^f .

p. 458. I omitted a term from the risk free rate equation. The top of the page to ”Real interest rates” should read as follows.

or, in continuous time,

$$r_t^f = \delta + \gamma E_t(\Delta c) - \frac{1}{2} \gamma (\gamma + 1) \sigma_t^2(\Delta c). \quad (21.3)$$

Real interest rates are typically quite low, about 1%. However, with a one percent mean and one percent standard deviation of consumption growth, the predicted interest rate rises quickly as we raise γ .

For example, with $\gamma = 50$ and a typical one percent $\delta = 0.01$, we predict $r^f = 0.01 + 50 \times 0.01 - \frac{1}{2} \times 50 \times 51 \times 0.01^2 = 0.38$ or 38%. To get a reasonable 1% real interest rate, we have to use a subjective discount factor of *negative* 37%. That is not impossible – an economic model can be well specified, and in particular present values can converge, with negative discount rates (Kocherlakota [1990]) – but it doesn't seem very reasonable. People prefer earlier utility.

The second term in (21.3) opens another possibility. As risk aversion increases, this precautionary saving term starts to offset the first, intertemporal substitution term. At an extreme value of risk aversion, $\gamma = 199$ (still using $E(\Delta c) = 0.01, \sigma(\Delta c) = 0.01$), they exactly offset, leaving $r^f = \delta$. The discrete time formula behaves similarly, though at a somewhat different very high value of γ .

Interest Rate Variation and the Conditional Mean of the Discount Factor

Again, however, maybe we are being too doctrinaire. What evidence is there against $\gamma = 50$ with $\delta = -0.38$ or $\gamma = 199$ with $\delta = 0.01$?

p. 463 ρ_t goes in the numerator. The equation should read

$$\frac{E_t(R_{t+1}^e)}{\sigma_t(R_{t+1}^e)} = -\rho_t(R_{t+1}^e, m_{t+1}) \frac{\sigma_t(m_{t+1})}{E_t(m_{t+1})}$$

p.469, last line. $\bar{S} = 0.057$ not $\bar{S} = 0.57$.

p.476. (21.17) change sign on right hand side, i.e.

$$\ln m_{t+1} \geq -\left(\delta + \gamma \ln \frac{C_{t+1}}{C_t}\right)$$

p.484. Add expectations to problem 1, i.e.

$$\max E \sum_{t=0}^{\infty} \delta^t \frac{(C_t - X_t)^{1-\gamma}}{1-\gamma} \text{ s.t. } E \sum_t \delta^t C_t = E \sum_t \delta^t e_t + W_0, X_t = \theta \sum_{j=1}^{\infty} \phi^j C_{t-j}$$

p.485, problem 2, the right hand side of the equation should read $= -\frac{1}{2}(c^* - c_t + \theta c_{t-1})^2$

p.491. Strike from the top of the page “for every sample path....to section A.2. It isn't this easy!

Minor typos

(minor to the reader, not to people whose names I have misspelled and articles mis-cited!)

p. v l.11 Pietro Veronesi's name is misspelled (sorry Pietro!)

p.6, line5: “convariance” should be “covariance”.

p. 19. Above (1.16) “in the continuous time limit” add a reference to equation (1.38).

p.40, 5 lines from the bottom: Cox, Ingersoll, and Ross (1986) should be (1985).

p.44, just below box. compete should be complete

- p.51, para 1, line 7: "...don't read..." should read "...don't need..."
- p.65, just above *The Law of One Price*. Should read " $\max [x(s) - K, 0]$."
- p.66, figure 4.11 caption. X should be \underline{X}
- p. 69 box. "Definition of arbitrage" should be "Definition of no-arbitrage."
- p.72 Just above the theorem. Delete "As you can see in Figure 4.4." You can't.
- p.72, 3 lines from the bottom. "left-hand panel" should read "top panel."
- p.75, line 10, "by this postulating" should read "by postulating".
- p.76, line 13-14 "formulas for a discount factors." should read "formulas for discount factors."
- p.76, below 3d equation, $E(dz_t dz_t') = Idt$
- p.89, 4 lines above *Algebraic Argument* "by projecting of 1 onto.." should read "by projecting 1 onto..."
- p.102 middle Roll (1976) should be Roll (1977)
- p.121. Below theorem, p. 123. Roll (1976) should be Roll (1977)
- p.129 in the second paragraph from bottom "Chapter 7" should read "Chapter 6"
- p. 155 1.5 "*absolute* risk aversion" should read "constant *absolute* risk aversion."
- p. 161 Brown and Gibbons is (1985) not (1981)
- p.164, last paragraph, "it allow" should read "it allows"
- p. 167, second equation. $\frac{dW}{W}$ should be $\frac{dW_t}{W_t}$
- p. 169, in "Should the CAPM price options?" line 5-6, "optimum pricing formula" should be "option pricing formula."
- p. 203 just above first equation $g_T'(b)'$ should be $g_T(b)'$
- p .203 (11.3), last term, comma missing. It should be $f(x_{t-j}, b)$
- p .205, line 4: "move" should be "more".
- p. 237, line 1, "Standard error" should read "variance."
- p.238, Equation below (12.18), $cov(\sqrt{T}C\alpha)$ should be $cov(\sqrt{T}C'\alpha)$
- p. 241 1.1 Shanken (1992b)
- p. 266, below equation (14.2). At the end of the sentence, add "and $\Sigma = E(\varepsilon_t \varepsilon_t')$ "
- p. 296: Two lines above the section *Lucas' money demand estimate*: Cochrane (1986) should be (1988).
- p. 327, pp2, second to last line. "Section 16.1.2" should be "Section 17.1"
- p. 326 (10th from the bottom), 333 (11th from the bottom), 336 (4th from the same place) Cochrane and Saá-Requejo is 2000 not 1999

- p. 353, (19.6) $f_t^{N \rightarrow N+1}$ should be $f_t^{(N \rightarrow N+1)}$.
- p. 379. The referece to Das and Foresi (1994) should be to Das, Sanjiv, 2002, "The Surprise Element: Jumps in Interest Rates", *Journal of Econometrics* 106, 27-65.
- p. 379. Rather than Knez Litterman and Scheinkman (1994), Litterman and Scheinkman, 1991, "Common factors affecting bond returns." *Journal of Fixed Income* 1, 51-61. is a better citation for the eigenvalue decomposition like Table 19.1
- p.385, 2 lines from the bottom: "Kocheralkota" should be "Kocherlakota".
- p.390, line 5: "price/divided" should be "price/dividend".
- p. 390 "Cochrane [1991]" should be "Cochrane [1991d]"
- p.390, 11 lines from the bottom. Fama and French (1999) should be (1989)
- p.392, 5 lines from the bottom. "Small values of $b \dots$ " should be "Small values of $a \dots$ " Two lines later, delete b .
- p.393, middle: Hodrick (1991) should be (1992).
- p.394, 2 lines below the box: Cochrane (1991) should be (1991c).
- p.395, last line: Cochrane (1991) should be (1991a).
- p.396, first line: Campbell and Shiller (1988) should be (1988a).
- p.396: below (20.7) add "where $k \equiv \log(1 + P/D) - \rho(p - d)$."
- p.397, 12 lines from the bottom: Cochrane (1991b) should be (1991a)
- p.399, middle: Vuolteenaho (2000) should be (1999).
- p.401, l. 6. Replace "be around" with "die out".
- p.403, eq. (20.21): $E_{tr}r_{t+1}$ should be $E_{tr}r_{t+j}$.
- p.411, 2 lines from the bottom: "...3-5 year range." should be "...2-4 year range."
- p.424, 10 lines from the bottom: "Engel" should be "Engle".
- p.434, 12 lines from the bottom: Lintner (1965) should be (1965b).
- p.437, 3 lines below the box, and p.444, 6.line from the bottom: Merton (1971b) should be Merton (1971, 1973a).
- p.441, 16 lines from the bottom: Fama and French (1995) should be (1996).
- p.442, first line: Heaton and Lucas (1997) should be (1997b)
- p.445, just above "Reversal." Jegadeesh is spelled wrong.
- p. 445. In "Reversal" "Fama and French (1998a)" should be "Fama and French (1988a)".
- p. 466. (21.5) and (21.6) should have - the second term, e.g. $-\frac{zV_{Wz}}{V_W}$.

- p. 481 3/4 of the way down. Eichenbaum Hansen Singleton is 1988 not 1989.
- p. 498 add Boldrin, Michele, Lawrence Christiano and Jonas Fisher, 1997, "Habit Persistence, Assets Returns and the Business Cycle", forthcoming *American Economic Review*
- p.499: Cochrane (1991a) and all references to it should be (1992)
- p.501. Add Craine, Roger, 1993, "Rational Bubbles," *Journal Of Economic Dynamics And Control* 17, 829-846.
- p. 501 add Duffie, Darrell,1992, *Dynamic Asset Pricing Theory* Princeton, N.J. Princeton University Press
- p.501 add DeSantis (1993).
- p.502: Fama and MacBeth (1973) delete *Financial*
- p. 503 add A. Ronald Gallant, Lars Peter Hansen and George Tauchen, 1990, "Using Conditional Moments of Asset Payoffs to Infer the Volatility of Intertemporal Marginal Rates of Substitution," *Journal of Econometrics*, 45, 141-180
- p.504: Heaton and Lucas. references should be 1997a and 1997b.
- p. 498 add Brown, David P. and Michael R. Gibbons, 1985, "A Simple Econometric Approach for Utility-based Asset Pricing Models," *Journal of Finance* 40, 359-81.
- p.499 add Zhiwu Chen, and Peter J. Knez, 1995, "Measurement of Market Integration and Arbitrage," *Review of Financial Studies*, 8, 287-325.
- p.499 add Zhiwu Chen, and Peter J. Knez, 1996, "Portfolio Performance Measurement: Theory and Applications," *Review of Financial Studies*,. 9, 511-555.
- p.502. Fama and French (1997a) should be (1995). (1997b) should be just (1997).
- p.507: Merton: (1973) should be (1973b).
- p.508: Ogaki (1992) should be (1993).
- p.508 add Stephen A. Ross 1978, "A Simple Approach to the Valuation of Risky Streams," *Journal of Business*, 51, 453-475.
- p.509 add Shiller, Robert J., 2000, *Irrational Exuberance* Princeton N.J.: Princeton University Press