ii. It checks: $\bar{R}_{\mathrm{P}t} = 0.0325$.

iii. It checks: $s^2_{\mathrm{P}} = 0.00544$.

3.12 (a) i. The mean returns for IBM, Xerox, and treasury bills are $\bar{R}_1 = 0.0212$, $\bar{R}_2 = 0.0400$, and $\bar{R}_3 = 0.0034$. fama.dat

ii. The variances are $s_1^2 = 0.002246$, $s_2^2 = 0.010621$, $s_3^2 = 0.000000294$.

iii. The covariances are $s_{12} = 0.002612$, $s_{13} = 0.00000271$, $s_{23} = -0.0000105$.

iv. The correlation is $r_{12} = 0.5347$, $r_{13} = 0.1054$, $r_{23} = -0.1882$.

(b) i. The returns series is generated as $R_{Pt} = 0.2R_{1t} + 0.3R_{2t} + 0.5R_{3t}$.

ii. It checks: $\bar{R}_{\mathrm{P}t} = 0.0179$.

iii. It checks: $s^2_{\mathrm{P}} = 0.00136$.

3.13 (a) Yes, the below-diagonal entries in the table are all fractional.

(b) Yes, the above- and below-diagonal signs match throughout the table.

(c) Adding the variances and twice the covariances yields the variance of GNP changes:

$$\begin{aligned}&\text{sample variance of } \Delta\text{GNP}\\ &\quad = 33.1 + 32.9 + 16.7 + 10.6 + 7.1\\ &\qquad + 2 \times (-2.4 + 4.4 - 1.9 - 3.4 + 15.9 - 1.5 - 1.7 - 2.2 - 1.9 + 0.3)\\ &\quad \approx 111.5.\end{aligned}$$

Examination Questions

1. Consider the joint interaction of four random variables, say X_1, X_2, X_3, and X_4.

   (a) How many population means μ_j are there?

   (b) How many population variances σ_j^2 are there?

   (c) How many population covariances σ_{jk} are there?

   (d) How many population correlations ρ_{jk} are there?

   (e) How many parameters in total govern a multivariate normal distribution relating the variables?

   (f) How many parameters govern a regression model relating one of these variables to the other three?