B.14 (a) Stochastic independence requires $P(r_{\text{Steel}} = x, r_{\text{Shipping}} = y) = P(r_{\text{Steel}} = x)P(r_{\text{Shipping}} = y)$ for all x and y. In our case we have

$$P(r_{\text{Steel}} = -0.2) = 0.16, \qquad P(r_{\text{Shipping}} = -0.2) = 0.16$$
$$P(r_{\text{Steel}} = -0.2, r_{\text{Shipping}} = -0.2) = 0.02 \neq 0.16 \times 0.16,$$

implying that the two variables are not independent.

(b) Expected value is found by taking every possible value of the random variable in question, multiplying it by the corresponding probability and adding all the contributions together. Numerically,

$$\begin{aligned} \mathrm{E}\left[r_{\text{Steel}}\right] &= 0.1\%, \\ \mathrm{E}\left[r_{\text{Shipping}}\right] &= 2.5\%. \end{aligned}$$

(c) Standard deviation is square root of variance; variance equals expected squared deviation from the mean. Numerically,

$$\begin{aligned} \sigma_{\text{Steel}} &= 13.82\% \\ \sigma_{\text{Shipping}} &= 14.03\% \end{aligned}$$

(d) By definition $\mathrm{Cov}(X,Y) = \mathrm{E}\left[XY\right] - \mathrm{E}\left[X\right]\mathrm{E}[Y]$. Numerically,

$$\sigma_{\text{Steel,Shipping}} = -0.001225.$$

(e)

```
r1=-20|-10|0|10|20;
r2=r1;
P=(0.02|0.03|0.03|0.04|0.04)~/* joint distribution matrix */
(0.03|0.05|0.03|0.03|0.03)~
(0.03|0.05|0.03|0.03|0.03)~
(0.04|0.07|0.03|0.05|0.07)~
(0.04|0.07|0.05|0.05|0.03);
/*values of r1 correspond to STEEL, r2 corresponds to SHIPPING */
v1=ones(5,1); /* random variable equal to 1 in all states */
mean1=r1'P*v1; /* expected rate of return in STEEL sector */
mean2=v1'P*r2;
std1=((r1^2)'P*v1-mean1^2)^0.5; /* st dev of rtns in STEEL sector */
std2=(v1'P*(r2^2)-mean2^2)^0.5;
cov12=r1'P*r2-mean1*mean2; /* covariance btw STEEL and SHIP returns
*/
print mean1~mean2~std1~std2~cov12;
```