APPENDIX

R Graphics code

In this appendix, we reproduce the R code used to produce several of the graphs contained in the book. Note that in most cases you must first run the code in the book for the simulation preceding the figure before you run the code to produce the figure itself. This and all the code we use is available in R script files in the online supplement to this book, located at www.sagepub.com/carsey.

A.1 CHAPTER 1

Figure 1.1

```
# OLS Example
eq <- expression(hat(Y)[i] == hat(beta)[0] + hat(beta)[1]*X[i])
slope <- expression(hat(beta)[1])
intercept <- expression(hat(beta)[0])
error4 <- expression(epsilon[4])
brace <- expression("}")
x <- c(1, 2, 3, 4, 5)
y <- c(3, .5, 5, 2.5, 5.5)
m <- lm(y ~ x)
m
yhat <- predict(m)

par(mar = c(5, 5.25, .5, .5))
plot(x, y, xlim = c(0, 5), ylim = c(0, 6), pch = 19, cex = 1.2, xlab = "",
 ylab = "", axes = FALSE)
abline(m, lwd = 3)
text(1, 4, eq, cex = 1.5)
arrows(1.675, 3.85, 2.5, 3, length = .1)
arrows(4, y[x = 4] + .1, 4, yhat[x = 4] -.1, code = 3, length =.1 ,
 lty = 2)
segments(1, yhat[x == 1], 2, yhat[x == 1], lty = 2)
segments(2, yhat[x == 1], 2, yhat[x == 2], lty = 2)
text(2, (yhat[x == 1] + yhat[x == 2])/2, slope, pos = 4, cex = 1.5)
text(4, (y[x == 4] + yhat[x == 4])/2, error4, pos = 4, cex = 1.5)
text(0, .5, brace, cex = 4)
```

```
text(.05, .5, intercept, pos = 4, cex = 1.5)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X (Independent Variable)"), cex.lab = 1.5)
title(ylab = expression("Y (Dependent Variable)"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 1.2 (also Figure 4.1)

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
hist(par.est[ , 1], breaks = 25, col = "gray50", ylim = c(0, 80), xlab = "",
 ylab = "", main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta)[0]), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = b0, lwd = 4)
text(.16, 70, expression("True"~beta[0]~"= 0.20"), cex = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
hist(par.est[ , 2], breaks = 25, col = "gray50", ylim = c(0, 50), xlab = "",
 ylab = "", main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta)[1]), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 4)
text(.56, 40, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
```

Figure 1.3

```
# Theory Simulation
Data <- read.csv("FrankTop40.csv", header = TRUE, sep = ",")
MaxCount <- max(Data$count)
Zcount <- MaxCount*Data$rank^(-1)

Model1 <- lm(log(Data$rank) ~ log(Data$count))
summary(Model1)
confint(Model1)

par(mar = c(5, 5, .5, .5))
plot(Data$rank, Data$count, xlab = "", ylab = "", type = "o", lwd = 3,
 pch = 19, axes = FALSE)
lines(Data$rank, Zcount, lty = 2, lwd = 3)
```

```
axis(1, cex.axis = 1.25)
axis(2, at = seq(0, 4000, 500), cex.axis = 1.25, las = 2)
title(xlab = expression("Word Rank"), cex.lab = 1.5)
title(ylab = expression("Word Frequency"), line = 3.75, cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Actual"),
 expression("Predicted")), lty = c(1, 2), lwd = 3, cex = 1.5)
box()
```

A.2 CHAPTER 2

Figure 2.1

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(seq(-3, 3, length = 1000), dnorm(seq(-3, 3, length = 1000), 0, 1),
 type = "l", lwd = 2, main = "", xlab = "", ylab = "", cex.lab = 1.5,
   axes = FALSE)
axis(1, seq(-3, 3, by = 1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(seq(-3, 3, length = 1000), pnorm(seq(-3, 3, length = 1000), 0, 1),
 type = "l", lwd = 2, main = "", xlab = "", ylab = "", cex.lab = 1.5,
   axes = FALSE)
axis(1, seq(-3, 3, by = 1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()
```

Figure 2.2

```
par(mar = c(5, 5.25, .5, .5))
plot(n, c.heads, type = "l", lwd = 2, ylim = c(0, 1), main = "", xlab = "",
 ylab = "", cex.lab = 1.5, axes = FALSE)
axis(1, seq(0, 200, by = 50), cex.axis = 1.25)
axis(2, seq(0, 1, by = .1), cex.axis = 1.25, las = 2)
abline(h = .5)
title(xlab = expression("Number of Trials"), cex.lab = 1.5)
title(ylab = expression("Cumulative Proportion of Heads"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 2.3

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(0:10, dbinom(0:10, 10, .5), type = "h", lwd = 2, main = "", xlab = "",
 ylab = "", axes = FALSE)
points(0:10, dbinom(0:10, 10, .5), pch = 19)
axis(1, 0:10, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(0:10, pbinom(0:10, 10, .5), type = "h", lwd = 2, main = "", xlab = "",
 ylab = "", axes = FALSE)
points(0:10, pbinom(0:10, 10, .5), pch = 19)
axis(1, 0:10, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()
```

Figure 2.4

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(0:20, dpois(0:20, 5), type = "h", lwd = 2, main = "", xlab = "",
 ylab = "", axes = FALSE)
points(0:20, dpois(0:20, 5), pch = 19)
axis(1, seq(0, 20, 2), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(0:20, ppois(0:20, 5), type = "h", lwd = 2, main = "", xlab = "",
 ylab = "", axes = FALSE)
points(0:20, ppois(0:20, 5), pch = 19)
axis(1, seq(0, 20, 2), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()
```

Figure 2.6

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(-2:2, dunif(-2:2, -2, 2), xlim = c(-3, 3), ylim = c(0, .35), lwd = 2,
 type = "l", main = "", xlab = "", ylab = "", axes = FALSE)
segments(c(-3, 3, -2, 2), c(0, 0, 0, 0), c(-2, 2, -2, 2),
 c(0, 0, .25, .25), lwd = 2)
axis(1, -3:3, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(-2:2, punif(-2:2, -2, 2), xlim = c(-3, 3), ylim = c(0, 1), lwd = 2,
 type = "l", main = "", xlab = "", ylab = "", axes = FALSE)
segments(c(-3, 3), c(0, 1), c(-2, 2), c(0, 1), lwd = 2)
axis(1, -3:3, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()
```

Figure 2.7

```
par(mar = c(5, 5.25, .5, .5))
plot(.3:35, dchisq(.3:35, 1), xlim = c(0, 35), ylim = c(0, .625), lwd = 2,
 type = "l", main = "", xlab = "", ylab = "", axes = FALSE)
lines(.3:35, dchisq(.3:35, 5), lwd = 2, lty = 2)
lines(.3:35, dchisq(.3:35, 10), lwd = 2, lty = 3)
axis(1, seq(0, 35, 5), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
text(4, .4, expression(italic(df)~"= 1"), cex = 1.5)
text(7, .15, expression(italic(df)~"= 5"), cex = 1.5)
text(15, .085, expression(italic(df)~"= 10"), cex = 1.5)
box()
```

Figure 2.8

```
par(mar = c(5, 5.25, .5, .5))
plot(seq(-3, 3, length = 1000), dnorm(seq(-3, 3, length = 1000), 0, 1),
 type = "l", ylim = c(0, .5), lwd = 2, main = "", xlab = "", ylab = "",
  cex.lab = 1.5, axes = FALSE)
lines(seq(-3, 3, length = 1000), dt(seq(-3, 3, length = 1000), 1),
 lwd = 2, lty = 2)
```

```
lines(seq(-3, 3, length = 1000), dt(seq(-3, 3, length = 1000), 3),
 lwd = 2, lty = 3)
lines(seq(-3, 3, length = 1000), dt(seq(-3, 3, length = 1000), 10),
 lwd = 2, lty = 4)
axis(1, seq(-3, 3, by = 1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
legend("topleft", bty = "n", c(expression("Standard Normal"),
 expression(italic("t, df")~"= 1"), expression(italic("t, df")~"= 3"),
  expression(italic("t, df")~"= 10")), lwd = 2, lty = c(1, 2, 3, 4),
   cex = 1.75)
box()
```

Figure 2.9

```
par(mar = c(5, 5.25, .5, .5))
plot(seq(0, 5, length = 1000), df(seq(0, 5, length = 1000), 3, 100),
 type = "l", ylim = c(0, 1), lwd = 2, main = "", xlab = "", ylab = "",
  cex.lab = 1.5, axes = FALSE)
lines(seq(0, 5, length = 1000), df(seq(0, 5, length = 1000), 10, 100),
 lwd = 2, lty = 2)
axis(1, seq(0, 5, by = 1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
text(3, .12, expression(italic(F)~"(3, 100)"), cex = 1.5)
text(1.75, .8, expression(italic(F)~"(10, 100)"), cex = 1.5)
box()
```

A.3 CHAPTER 5

Figure 5.2

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
hist(par.est[ , 3], breaks = 25, col = "gray50", xlab = "", ylab = "",
 main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Standard Error Estimates for"~hat(beta[0])),
 cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = sd.beta0, lwd = 4)
text(.03275, 115, expression("SD of"~hat(beta[0])~"="~"0.0313973"),
 cex = 1.5)
box()
```

```
# Panel (b)
par(mar = c(5, 5.25, .5, .5))
hist(par.est[ , 4], breaks = 25, col = "gray50", xlab = "", ylab = "",
 main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Standard Error Estimates for"~hat(beta[1])),
 cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = sd.beta1, lwd = 4)
text(.057, 150, expression("SD of"~hat(beta[1])~"="~"0.05501627"),
 cex = 1.5)
box()
```

Figure 5.3

```
# Panel (a)
par(mar = c(5, 6, .5, .5))
plot(seq(1, 100, length = 100), seq(.05, .4, length = 100), type = "n",
 axes = FALSE, xlab = "", ylab = "")
title(xlab = expression("100 Simulated Samples"), cex.lab = 1.5)
title(ylab = expression(hat(beta[0])), line = 3.75, cex.lab = 1.5)
box()
axis(1, at = seq(0, 100, 10), cex.axis = 1.25)
axis(2, at = seq(.05, 4, .05), cex.axis = 1.25, las = 2)
abline(h = b0, lwd = 2)
for (i in 1:100){
points(i, par.est[i, 1], lwd = 2, col = ifelse(cp.beta0$true.in.ci[i] == 1,
 "gray70", "gray20"), pch = 19)
segments(i, cp.beta0$ci[i, 1], i, cp.beta0$ci[i, 2], lwd = 2,
 col = ifelse(cp.beta0$true.in.ci[i] == 1, "gray70", "gray20"))
}
legend("topleft", bty = "n", c(expression("CI includes true"~beta[0]),
 expression("CI does not include true"~beta[0])),
  fill = c("gray70", "gray20"), cex = 1.5)

# Panel (b)
par(mar = c(5, 6, .5, .5))
plot(seq(100, 200, length = 100), seq(.25, .8, length = 100), type = "n",
 axes = FALSE, xlab = "", ylab = "")
title(xlab = expression("100 Simulated Samples"), cex.lab = 1.5)
title(ylab = expression(hat(beta[1])), line = 3.75, cex.lab = 1.5)
box()
axis(1, at = seq(100, 200, 10), labels = seq(0, 100, 10), cex.axis = 1.25)
axis(2, at = seq(.25, .75, .05), cex.axis = 1.25, las = 2)
abline(h = b1, lwd = 2)
for (i in 101:200){
points(i, par.est[i, 2], lwd = 2, col = ifelse(cp.beta1$true.in.ci[i] == 1,
 "gray70", "gray20"), pch = 19)
```

```
segments(i, cp.beta1$ci[i, 1], i, cp.beta1$ci[i, 2], lwd = 2,
 col = ifelse(cp.beta1$true.in.ci[i] == 1, "gray70", "gray20"))
}
legend("topleft", bty = "n", c(expression("CI includes true"~beta[1]),
 expression("CI does not include true"~beta[1])),
  fill = c("gray70", "gray20"), cex = 1.5)
```

Figure 5.4

```
par(mar = c(5, 5.25, .5, .5))
plot(X, Y, ylim = c(-10, 10), axes = FALSE, xlab = "",
 ylab = "", pch = 19)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("Y"), line = 3.75, cex.lab = 1.5)
box()
abline(lsfit(X, Y), lwd = 3)
axis(1, cex.axis = 1.25)
axis(2, at = seq(-10, 10, 2), cex.axis = 1.25, las = 2)
```

Figure 5.5

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.ncv[ , 1]), lty = 2, ylim = c(0, 16), lwd = 3,
 xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est[ , 1]), lwd = 3)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[0])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b0, lwd = 2)
text(.1, 12, expression("True"~beta[0]~"= 0.20"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("Homoskedastic"),
 expression("Heteroskedastic")), lty = c(1, 2), lwd = 3, cex = 1.5)

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.ncv[ , 2]), lty = 2, ylim = c(0, 9), lwd = 3,
 xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est[ , 2]), lwd = 3)
axis(1, at = seq(0, 1, .1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.25, 7, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("Homoskedastic"),
 expression("Heteroskedastic")), lty = c(1, 2), lwd = 3, cex = 1.5)
```

Figure 5.6

```
par(mar = c(5, 5.25, .5, .5))
plot(mc.level, sd.betas[ , 1], lwd = 3, ylim = c(0, .25), type = "b",
 xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, at = mc.level, cex.axis = 1)
axis(2, at = seq(0, .25, .05), cex.axis = 1.25, las = 2)
title(xlab = expression("Correlation between"~X[1]~"and"~X[2]),
 cex.lab = 1.5)
title(ylab = expression("SD of"~hat(beta[1])), line = 3.75, cex.lab = 1.5)
box()
```

Figure 5.7

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.merror[ , 2, 1]), lty = 1, xlim = c(0, 1),
 ylim = c(0, 15), lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est.merror[ , 2, 11]), lwd = 3, lty = 2)
axis(1, at = seq(0, 1, .1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.75, 7, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression(sigma[ME]~"= 0"),
 expression(sigma[ME]~"= 1")), lty = c(1, 2), lwd = 3, cex = 1.5)

# Panel (b)
par(mar = c(5, 6, .5, .5))
plot(rep(e.level[1], times = reps), ab.merror[ , 1], xlim = c(0, 1),
 ylim = c(0, .5), col = "gray60", xlab = "", ylab = "", axes = FALSE)
for(i in 2:length(e.level)){
points(rep(e.level[i], times = reps), ab.merror[ , i], col = "gray60")
lines(lowess(e.level, apply(ab.merror, 2, mean), f = .2), lwd = 3)
}
axis(1, at = e.level, cex.axis = 1)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("SD of Measurement Error"), cex.lab = 1.5)
title(ylab = expression(hat(beta[1])~"Absolute Bias"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 5.8

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.ov[ , 1]), lty = 1, xlim = c(.25, 1.5), ylim = c(0, 16),
 lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
```

```
lines(density(par.est.ov[ , 11]), lwd = 3, lty = 2)
axis(1, at = seq(.25, 1.5, .25), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.8, 10, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression(r[X[1]~X[2]]~"= 0"),
 expression(r[X[1]~X[2]]~"= 0.99")), lty = c(1, 2), lwd = 2, cex = 1.5)

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(cor.level, mse.ov, type = "b", xlim = c(0, 1), lwd = 3, xlab = "",
 ylab = "", axes = FALSE)
axis(1, at = cor.level, cex.axis = 1)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Correlation between"~X[1]~"and"~X[2]),
 cex.lab = 1.5)
title(ylab = expression(hat(beta[1])~"Mean Squared Error"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 5.9

```
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.sc[ , 1]), lty = 2, ylim = c(0, 3), lwd = 3, xlab = "",
 ylab = "", main = "", axes = FALSE)
lines(density(par.est.sc[ , 2]), lwd = 3, lty = 1)
axis(1, at = seq(-.5, 1.5, .5), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(0, 1.5, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("With lagged"~Y),
 expression("Without lagged"~Y)), lty = c(1, 2), lwd = 3, cex = 1.5)
```

Figure 5.10

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.cluster[ , 1]), lty = 1, xlim = c(.2, .8),
 ylim = c(0, 20), lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est.cluster[ , 2]), lwd = 3, lty = 2)
lines(density(par.est.cluster[ , 3]), lwd = 3, lty = 3)
axis(1, at = seq(0, 1, .1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
```

```
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.7, 7, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("OLS"), expression("OLS with FE"),
 expression("MLM")), lty = c(1, 2, 3), lwd = 3, cex = 1.5)

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(1, ols.cp$coverage.probability, pch = 19, xlim = c(0, 8),
 ylim = c(.5, 1), lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
segments(1, ols.cp$mc.eb[1], 1, ols.cp$mc.eb[2], lwd = 2)
points(3, rcse.cp$coverage.probability, pch = 1, lwd = 3)
segments(3, rcse.cp$mc.eb[1], 3, rcse.cp$mc.eb[2], lwd = 2)
points(5, fe.cp$coverage.probability, pch = 19, lwd = 3)
segments(5, fe.cp$mc.eb[1], 5, fe.cp$mc.eb[2], lwd = 2)
points(7, mlm.cp$coverage.probability, pch = 19, lwd = 3)
segments(7, mlm.cp$mc.eb[1], 7, mlm.cp$mc.eb[2], lwd = 2)
axis(1, at = c(1, 3, 5, 7), labels = c(expression("OLS"), expression("RCSE"),
 expression("OLS with FE"), expression("MLM")), cex.axis = 1.25)
axis(2, at = seq(.5, 1, .05), cex.axis = 1.25, las = 2)
title(xlab = expression("Estimator"), cex.lab = 1.5)
title(ylab = expression("Coverage Probability"), line = 3.75, cex.lab = 1.5)
abline(h = .95, lwd = 2, lty = 2)
box()
```

Figure 5.11

```
library(VGAM)

par(mar = c(5, 5.25, .5, .5))
plot(seq(-3, 3, length = 1000), dnorm(seq(-3, 3, length = 1000), 0, 1),
 ylim = c(0, .55), type = "l", lwd = 2, main = "", xlab = "", ylab = "",
  cex.lab = 1.5, axes = FALSE)
lines(seq(-3, 3, length = 1000), dlaplace(seq(-3, 3, length = 1000), 0, 1),
 lwd = 2, lty = 2)
axis(1, seq(-3, 3, by = 1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("X"), cex.lab = 1.5)
title(ylab = expression("P(X)"), line = 3.75, cex.lab = 1.5)
box()
legend("topright", bty = "n", c(expression("Normal"), expression("Laplace")),
 lwd = 2, lty = c(1, 2), cex = 1.5)
```

Figure 5.12

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
```

```
plot(density(par.est.htail[ , 1]), lty = 1, xlim = c(.1, .9),
 ylim = c(0, 10), lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est.htail[ , 2]), lwd = 3, lty = 2)
axis(1, at = seq(0, 1, .1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.7, 7, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("OLS"), expression("MR")),
 lty = c(1, 2), lwd = 3, cex = 1.5)

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.htail[ , 3]), lty = 1, xlim = c(.1, .9),
 ylim = c(0, 10), lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est.htail[ , 4]), lwd = 3, lty = 2)
axis(1, at = seq(0, 1, .1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.7, 7, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("OLS"), expression("MR")),
 lty = c(1, 2), lwd = 3, cex = 1.5)
```

Figure 5.13

```
par(mar = c(5, 5.25, .5, .5))
plot(mse.ols/mse.mr, cvdm.select, type = "n", main = "", axes = FALSE,
 ylab = "", xlab = "", xlim = c(.5, 1.8), ylim = c(0, 1))
rect(1, .5, 3, 1.1, col = "gray75")
rect(0, -.25, 1, .5, col = "gray75")
abline(v = 1); abline(h = .5); box()
points(mse.ols/mse.mr, cvdm.select, pch = 16)
axis(1, at = seq(.5, 2, .25), cex.axis = 1.25)
axis(2, at = seq(0, 1, by = .1), labels = c(expression("0%"),
 expression("10%"), expression("20%"), expression("30%"),
  expression("40%"), expression("50%"), expression("60%"),
   expression("70%"), expression("80%"), expression("90%"),
    expression("100%")), cex.axis = 1.25, las = 2)
title(ylab = expression("% CVDM Selection of OLS"), line = 4, cex.lab = 1.5)
title(xlab = expression("Relative MSE (OLS MSE/MR MSE)"), line = 3,
 cex.lab = 1.5)
legend("topright", legend = expression("Incorrect Selection Region"),
 fill = "gray75", bg = "white", cex = 1.25)
```

A.4 CHAPTER 6

Figure 6.1

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
hist(par.est.logit[ , 1], breaks = 25, col = "gray50", ylim = c(0, 150),
 xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[0])), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = b0, lwd = 4)
text(.05, 70, expression("True"~beta[0]~"= 0.20"), cex = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
hist(par.est.logit[ , 2], breaks = 25, xlim = c(.1, .9), col = "gray50",
 ylim = c(0, 200), xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, at = seq(.1, .9, .1), cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta)[1]), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 4)
text(.75, 125, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
```

Figure 6.2

```
par(mar = c(5, 5.25, .5, .5))
plot(Y.star, Y, xlim = c(-3, 3), xlab = "", ylab = "", main = "",
 axes = FALSE, pch = 19)
axis(1, at = seq(-3, 3, 1), cex.axis = 1.25)
axis(2, at = 1:4, cex.axis = 1.25, las = 2)
title(xlab = expression("Y* (Unobserved/Continuous)"), cex.lab = 1.5)
title(ylab = expression("Y (Observed/Categorical)"), line = 3.75,
 cex.lab = 1.5)
abline(v = c(tau1, tau2, tau3), lwd = 2, lty = 3)
text(tau1 - .25, 3.5, expression(tau[1]), cex = 2)
text(tau2 - .25, 3.5, expression(tau[2]), cex = 2)
text(tau3 - .25, 3.5, expression(tau[3]), cex = 2)
box()
```

Figure 6.3

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
```

```
plot(1:n, Y, ylim = c(0, 20), col = "gray50", xlab = "", ylab = "",
 main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, at = 0:20, cex.axis = 1.25, las = 2)
title(xlab = expression("Observations"), cex.lab = 1.5)
title(ylab = expression("Y"), line = 3.75, cex.lab = 1.5)
abline(h = mean(Y), lwd = 2)
abline(h = var(Y), lwd = 2, lty = 2)
box()
legend("topleft", bty = "n", c(expression("Mean of Y"),
 expression("Variance of Y")), lty = c(1, 2), lwd = 2, cex = 1.5)

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(1:n, Y, ylim = c(0, 20), col = "gray50", xlab = "", ylab = "",
 main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, at = 0:20, cex.axis = 1.25, las = 2)
title(xlab = expression("Observations"), cex.lab = 1.5)
title(ylab = expression("Y"), line = 3.75, cex.lab = 1.5)
abline(h = mean(Y), lwd = 2)
abline(h = var(Y), lwd = 2, lty = 2)
box()
legend("topleft", bty = "n", c(expression("Mean of Y"),
 expression("Variance of Y")), lty = c(1, 2), lwd = 2, cex = 1.5)
```

Figure 6.4

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.zinb[ , 1]), xlim = c(-.5, 1.5), ylim = c(0, 3.5),
 lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est.zinb[ , 3]), lwd = 3, lty = 2)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(1, 2, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("Standard NB"),
 expression("ZINB")), lty = c(1, 2), lwd = 3, cex = 1.5)

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.zinb[ , 2]), xlim = c(-.5, 1.5), ylim = c(0, 5),
 lwd = 3, xlab = "", ylab = "", main = "", axes = FALSE)
lines(density(par.est.zinb[ , 4]), lwd = 3, lty = 2)
axis(1, cex.axis = 1.25)
```

```
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(1, 2, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("Standard NB"),
 expression("ZINB")), lty = c(1, 2), lwd = 3, cex = 1.5)
```

Figure 6.5

```
par(mar = c(5, 5.25, .5, .5))
plot(density(par.est.cox[ , 1]), xlim = c(.15, .65), lwd = 3, xlab = "",
 ylab = "", main = "", axes = FALSE)
lines(density(par.est.cox[ , 2]), lwd = 3, lty = 2)
lines(density(par.est.cox[ , 3]), lwd = 3, lty = 3)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression(hat(beta[1])), cex.lab = 1.5)
title(ylab = expression("Density"), line = 3.75, cex.lab = 1.5)
abline(v = b1, lwd = 2)
text(.58, 6, expression("True"~beta[1]~"= 0.50"), cex = 1.5)
box()
legend("topleft", bty = "n", c(expression("PLM"), expression("IRR 5%"),
 expression("IRR 20%")), lty = c(1, 2, 3), lwd = 3, cex = 1.5)
```

A.5 CHAPTER 7

Figure 7.1

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(Data$rank, Data$count, xlab = "", ylab = "", type = "o", lwd = 3,
 pch = 19, axes = FALSE)
lines(Data$rank, Zcount, lty = 2, lwd = 3)
axis(1, cex.axis = 1.25)
axis(2, at = seq(0, 4000, 500), cex.axis = 1.25, las = 2)
title(xlab = expression("Word Rank"), cex.lab = 1.5)
title(ylab = expression("Word Frequency"), line = 3.75, cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Actual"),
  expression("Predicted")), lty = c(1, 2), lwd = 3, cex = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(log(Data$rank), log(Data$count), xlim = c(0, 5), ylim = c(5, 9),
 xlab = "", ylab = "", lwd = 2, pch = 19, axes = FALSE)
abline(lm(log(Data$count) ~ log(Data$rank)), lwd = 2)
```

```
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Natural Log of Rank"), cex.lab = 1.5)
title(ylab = expression("Natural Log of Word Frequency"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 7.2

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(Rank[27:400], Count[27:400], ylim = c(25, 45), xlab = "", ylab = "",
 type = "p", lwd = 3, axes = FALSE)
axis(1, at = seq(0, 400, 50), cex.axis = 1.25)
axis(2, at = seq(25, 45, 5), cex.axis = 1.25, las = 2)
title(xlab = expression("Word Rank"), cex.lab = 1.5)
title(ylab = expression("Word Frequency"), line = 3.75, cex.lab = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(log(Rank[27:400]), log(Count[27:400]), xlab = "", ylab = "",
 type = "p", lwd = 3, axes = FALSE)
abline(lm(log(Count[27:400]) ~ log(Rank[27:400])), lwd = 2)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Natural Log of Rank"), cex.lab = 1.5)
title(ylab = expression("Natural Log of Frequency"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 7.3

```
X <- seq(-4, 4, length.out = 10000)
pdf.norm <-dnorm(X, mean = 0, sd = 1)
pdf.logistic <- dlogis(X, scale = sqrt(3)/pi)
pdf.t <- dt(X, df = 5)

par(mar = c(5, 5.25, .5, .5))
plot(X, pdf.norm, type = "l", lwd = 3, xlab = "", ylab = "", ylim=c(0, .55),
 xaxt = 'n', yaxt = 'n')
lines(X,pdf.logistic, type = "l", lty = 2, lwd = 3)
lines(X,pdf.t, type = "l", lty = 3, lwd = 3)
title(xlab = expression("Range of Observed Values"), cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Normal"),
 expression("Scaled Logistic"), expression(italic("t, df")~"= 5")),
  lty = c(1, 2, 3), lwd = 3, cex = 1.5)
box()
```

Figure 7.5

```
# Panel (a)
par(mar = c(5, 2, .5, .5))
X <- seq(mean(DiffDemand) - 4*sd(DiffDemand), mean(DiffDemand) +
 4*sd(DiffDemand), length.out = 1000)
pdf.norm <- dnorm(X, mean = mean(DiffDemand), sd = sd(DiffDemand))
plot(density(DiffDemand), lty = 2, lwd = 3, main = "", xlab = "", ylab = "",
 yaxt = 'n', ylim = c(0, .4))
lines(X, pdf.norm, type="l", lwd = 3)
title(xlab = expression("Change in Demand"), cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Simulation"),
 expression("Normal")), lty = c(2, 1), lwd = 3, cex = 1.5)
box()
text(4, .25, expression("Kurtosis = 2.993"), cex = 1.25)

# Panel (b)
par(mar = c(5, 2, .5, .5))
X <- seq(mean(DiffPolicy) - 4*sd(DiffPolicy), mean(DiffPolicy) +
 4*sd(DiffPolicy), length.out = 1000)
pdf.norm <- dnorm(X, mean = mean(DiffPolicy), sd = sd(DiffPolicy))
plot(density(DiffPolicy), lty = 2, lwd = 3, main = "", xlab = "", ylab = "",
 yaxt = 'n', ylim = c(0, .4))
lines(X, pdf.norm, type="l", lwd = 3)
title(xlab = expression("Change in Total Policy"), cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Simulation"),
 expression("Normal")), lty = c(2, 1), lwd = 3, cex = 1.5)
box()
text(4, .25, expression("Kurtosis = 2.993"), cex = 1.25)
```

Figure 7.6

```
# Panel (a)
par(mar = c(5, 2, .5, .5))
X <- seq(mean(DiffSpend) - 4*sd(DiffSpend), mean(DiffSpend) +
 4*sd(DiffSpend), length.out = 1000)
pdf.norm <- dnorm(X, mean = mean(DiffSpend), sd = sd(DiffSpend))
plot(density(DiffSpend), lty = 2, lwd = 3, main = "", xlab = "", ylab = "",
 yaxt = 'n')
lines(X, pdf.norm, type="l", lwd = 3)
title(xlab = expression("Change in Spending"), cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Simulation"),
 expression("Normal")), lty = c(2, 1), lwd = 3, cex = 1.5)
box()
text(3, .4, expression("Kurtosis = 4.145"), cex = 1.25)

# Panel (b)
par(mar = c(5, 2, .5, .5))
```

```
X <- seq(mean(DiffReg) - 4*sd(DiffReg), mean(DiffReg) +
 4*sd(DiffReg), length.out = 1000)
pdf.norm <- dnorm(X, mean = mean(DiffReg), sd = sd(DiffReg))
plot(density(DiffReg), lty = 2, lwd = 3, main = "", xlab = "", ylab = "",
 yaxt = 'n')
lines(X, pdf.norm, type="l", lwd = 3)
title(xlab = expression("Change in Regulation"), cex.lab = 1.5)
legend("topright", bty = "n", c(expression("Simulation"),
 expression("Normal")), lty = c(2, 1), lwd = 3, cex = 1.5)
box()
text(3, .4, expression("Kurtosis = 4.126"), cex = 1.25)
```

Figure 7.7

```
par(mar = c(5, 5.25, .5, .5))
plot(Time, P1[ , 1], type = "l", ylim = c(0, 1), xlab = "", ylab = "",
 lwd = 3, axes = FALSE)
for(i in 2:Sim){
  lines(Time, P1[ , i], lwd = 3)
}
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Time Period"), cex.lab = 1.5)
title(ylab = expression("Probability of Selecting Choice 1"), line = 3.75,
 cex.lab = 1.5)
box()
```

Figure 7.8

```
par(mar = c(5, 5.25, .5, .5))
plot(Time, P1[ , 1], type = "l", ylim = c(0, 1), xlab = "", ylab = "",
 lwd = 3, axes = FALSE)
for(i in 2:Sim){
  lines(Time, P1[ , i], lwd = 3)
}
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Time Period"), cex.lab = 1.5)
title(ylab = expression("Probability of Selecting Choice 1"),
 line = 3.75, cex.lab = 1.5)
box()
```

Figure 7.9

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
plot(Time, P1[ , 1], type = "l", ylim = c(0, 1), xlab = "", ylab="",
 lwd = 3, axes = FALSE)
for(i in 2:Sim){
  lines(Time, P1[ , i], lwd = 3)
}
```

```
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Time Period"), cex.lab = 1.5)
title(ylab = expression("Probability of Selecting Choice 1"), line = 3.75,
 cex.lab = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
plot(Time, P1[ , 1], type = "l", ylim = c(0, 1), xlab = "", ylab="",
 lwd = 3, axes = FALSE)
for(i in 2:Sim){
  lines(Time, P1[ , i], lwd = 3)
}
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Time Period"), cex.lab = 1.5)
title(ylab = expression("Probability of Selecting Choice 1"), line = 3.75,
 cex.lab = 1.5)
box()
```

A.6 CHAPTER 8

Figure 8.1

```
par(mar = c(5, 5.25, .5, .5))
hist(p.test.dm[ , 7], breaks = seq(-6, 6, by = 2), xlim = c(-6, 6),
 ylim = c(0, 7), col = "gray50", xlab = "", ylab = "", main = "",
  axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Differences-in-Means"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = observed.dm, lwd = 4)
text(2, 6.5, expression("Observed DM = 4.79"), cex = 1.5)
box()
```

Figure 8.2

```
par(mar = c(5, 5.25, .5, .5))
hist(r.test.lalonde, breaks = 25, xlim = c(-3000, 3000), col = "gray50",
 xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Differences-in-Means of Earnings Change"),
 cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = lalonde.dm, lwd = 4)
```

```
text(1700, 130, expression("Observed DM ="), cex = 1.5)
text(2050, 123, expression("$2,888.64"), cex = 1.5)
box()
```

Figure 8.3

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
hist(boot.b, breaks = 25, xlim = c(3.25, 4.75), ylim = c(0, 100),
 col = "gray50", xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, at = seq(3, 5, .25), cex.axis = 1.25)
axis(2, at = seq(0, 100, 20), cex.axis = 1.25, las = 2)
title(xlab = expression("Bootstrap Sample Means"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = 4, lwd = 4)
text(3.5, 60, expression("True"~mu~"= 4"), cex = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
hist(dgp.b, breaks = 25, xlim = c(3.25, 4.75), ylim = c(0, 100),
 col = "gray50", xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, at = seq(3, 5, .25), cex.axis = 1.25)
axis(2, at = seq(0, 100, 20), cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated DGP Sample Means"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = 4, lwd = 4)
text(3.5, 60, expression("True"~mu~"= 4"), cex = 1.5)
box()
```

A.7 CHAPTER 9

Figure 9.1

```
par(mar = c(5, 5.25, .5, .5))
hist(crime.expected, breaks = 25, col = "gray50", xlab = "", ylab = "",
 main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated Expected Values"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = mean(crime.expected), lwd = 4)
text(1000, 90, expression("Mean EV = 905"), cex = 1.5)
box()
```

Figure 9.2

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
```

```
hist(crime.expected2[ , 1], breaks = 25, xlim = c(-400, 2700),
 col = "gray70", xlab = "", ylab = "", main = "", axes = FALSE)
hist(crime.expected2[ , 2], breaks = 25, col = "gray30", add = TRUE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated Expected Values"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = apply(crime.expected2, 2, mean), lwd = 4)
text(750, 90, expression(mu[Low]~"= 211"), cex = 1.5)
text(2300, 90, expression(mu[High]~"= 1742"), cex = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
hist(crime.expected2[ , 2] - crime.expected2[ , 1], breaks = 25,
 xlim = c(-400, 2700), ylim = c(0, 120), col = "gray50", xlab = "",
  ylab = "", main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated First Differences"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = mean(crime.expected2[ , 2] - crime.expected2[ , 1]), lwd = 4)
text(500, 80, expression(mu[Difference]~"= 1531"), cex = 1.5)
box()
```

Figure 9.3

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
hist(crime.predicted, breaks = 25, col = "gray50", ylim = c(0, 200),
 xlab = "", ylab = "", main = "", axes = FALSE)
hist(crime.expected, breaks = 12, col = "white", add = TRUE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated Expected and Predicted Values"),
 cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = mean(crime.predicted), lwd = 4)
text(1500, 90, expression("Mean PV = 891"), cex = 1.5)
text(1300, 160, expression("Mean EV = 905"), cex = 1.5)
box()
legend("topright", bty = "n", c(expression("Predicted Values"),
 expression("Expected Values")), fill = c("gray50", "white"), cex = 1.5)

# Panel (b)
par(mfrow = c(2, 1), mar = c(5, 5, .5, .5))
hist(crime.predicted2[ , 1], breaks = 25, xlim = c(-1000, 3100),
 ylim = c(0, 135), col = "gray70", xlab = "", ylab = "", main = "",
  axes = FALSE)
```

```
hist(crime.predicted2[ , 2], breaks = 25, col = "gray30", add = TRUE)
hist(crime.expected2[ , 1], breaks = 25, col = "white", add = TRUE)
hist(crime.expected2[ , 2], breaks = 25, col = "white", add = TRUE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated Expected and Predicted Values"),
 cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = apply(crime.predicted2, 2, mean), lwd = 4)
text(900, 105, expression(mu[Low]~"= 206"), cex = 1.5)
text(2650, 90, expression(mu[High]~"= 1733"), cex = 1.5)
box()
legend("topleft", bty = "n", c(expression("PV (Low)"),
 expression("PV (High)"), expression("EV")),
  fill = c("gray70", "gray30", "white"), cex = 1.25)

hist(crime.predicted2[ , 2] - crime.predicted2[ , 1], breaks = 25,
 xlim = c(-1000, 3100), col = "gray50", xlab = "", ylab = "",
  main = "", axes = FALSE)
hist(crime.expected2[ , 2] - crime.expected2[ , 1], breaks = 25,
 col = "white", add = TRUE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated First Differences"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = mean(crime.predicted2[ , 2] - crime.predicted2[ , 1]), lwd = 4)
text(0, 80, expression(mu[Difference]~"= 1527"), cex = 1.5)
box()
legend("topleft", bty = "n", c(expression("Predicted Values"),
 expression("Expected Values")), fill = c("gray50", "white"),
  cex = 1.25)
```

Figure 9.4

```
par(mar = c(5, 5.25, .5, .5))
plot(inc.range, pe, type = "l", lwd = 3, col = "black", ylim = c(0, 1.05),
 xlab = "", ylab = "", axes = FALSE)
lines(inc.range, lo, lwd = 3, lty = 2, col = "black")
lines(inc.range, hi, lwd = 3, lty = 2, col = "black")
title(ylab = expression("Probability of Voting"), line = 3.75, cex.lab = 1.5)
title(xlab = expression("Income ($1000s)"), cex.lab = 1.5)
axis(1, at = c(4, 6, 8, 10, 12, 14, 16),
 labels = c("10-12.5", "15-20", "25-30", "35-40", "50-60", "75-100", "150+"))
axis(2, at = seq(0, 1, .1), las = 2)
box()
rug(jitter(voteincome$income, factor = 2), ticksize = .015)
# These two lines add a grid to the plot
grid(col = "gray70")
abline(h = seq(.1, .9, .2), col = "gray70", lty = 3)
```

```
legend("topleft", inset = 0, bty = "n",
 legend = c(expression("Point Estimate"), expression("95% Conf. Interval")),
  lwd = 3, lty = c(1, 2), bg = "white", cex = 1.5)
```

Figure 9.5

```
# Panel (a)
par(mar = c(5, 5.25, .5, .5))
hist(crime.sim2$qi$fd, breaks = 25, xlim = c(-400, 2700), ylim = c(0, 120),
 col = "gray50", xlab = "", ylab = "", main = "", axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Simulated First Differences"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = mean(crime.sim2$qi$fd), lwd = 4)
text(500, 80, expression(mu[Difference]~"= 1536"), cex = 1.5)
text(500, 73, expression(sigma[Difference]~"= 394"), cex = 1.5)
box()

# Panel (b)
par(mar = c(5, 5.25, .5, .5))
hist(crime.sim.boot$qi$fd, breaks = 25, xlim = c(-400, 2700),
 ylim = c(0, 120), col = "gray50", xlab = "", ylab = "", main = "",
  axes = FALSE)
axis(1, cex.axis = 1.25)
axis(2, cex.axis = 1.25, las = 2)
title(xlab = expression("Bootstrapped First Differences"), cex.lab = 1.5)
title(ylab = expression("Frequency"), line = 3.75, cex.lab = 1.5)
abline(v = mean(crime.sim.boot$qi$fd), lwd = 4)
text(500, 80, expression(mu[Difference]~"= 1542"), cex = 1.5)
text(500, 73, expression(sigma[Difference]~"= 453"), cex = 1.5)
box()
```

Figure 9.6

```
par(mar = c(5, 5.25, .5, .5))
plot(distance, pe.ac, type = "n", ylim = c(0, 1.00), xlab = "", ylab = "",
 axes = FALSE)
grid(col = "gray70")
abline(h = seq(.1, .9, .2), col = "gray70", lty = 3)
lines(distance, pe.ac, lwd = 3, col = "black")
lines(distance, lo.ac, lwd = 3, lty = 2, col = "black")
lines(distance, hi.ac, lwd = 3, lty = 2, col = "black")
title(ylab = expression("Probability of a 'Yea' Vote"), line = 3.75,
 cex.lab = 1.5)
title(xlab = expression("Ideological Distance"), line = 3.5, cex.lab = 1.5)
axis(1, at = c(min(nominees$eucldist), mean(nominees$eucldist),
  quantile(nominees$eucldist, .95), max(nominees$eucldist)), labels = FALSE)
labels <- paste(c(expression("No"), expression("Distance"),
```

```
expression("Mean"), expression("Distance"), expression("95%"),
 expression("Maximum"), expression("Distance")), sep = " ")
text(c(min(nominees$eucldist) - .025, min(nominees$eucldist) + .025,
 mean(nominees$eucldist) - .025, mean(nominees$eucldist) + .025,
  quantile(nominees$eucldist, .95), max(nominees$eucldist) - .025,
   max(nominees$eucldist) + .025), -.09, srt = 45, adj = 1,
    labels = labels, xpd = TRUE)
axis(2, at = seq(0, 1, .1), las = 2, cex.axis = 1.1)
box()
rug(jitter(nominees$eucldist), ticksize = .015)
lines(distance, pe.ov, lwd = 3, col = "gray50")
lines(distance, lo.ov, lwd = 3, lty = 2, col = "gray50")
lines(distance, hi.ov, lwd = 3, lty = 2, col = "gray50")
legend("left", inset = 0, bty = "n",
 legend = c(expression("Average Case"), expression("Observed Value")),
  lwd = 3, col = c("black", "gray50"), bg = "white", cex = 1.5)
```

Figure 9.7

```
par(mar = c(5, 5.25, .5, .5))
plot(seq(.2, 5, length = 10), seq(0, 100, length = 10), type = "n",
 xlab = "", ylab = "", axes = FALSE)
abline(h = seq(0, 100, 5), lty = 3, col = "gray80")
dd <- barplot(c(correct.null*100, correct.is*100, correct.cv1*100, correct.cv2*100),
 col = c("gray20", "gray40", "gray60", "gray80"), names.arg = c("", "", "", ""),
  axes = FALSE, add = TRUE)
axis(1, at = c(.63, 1.9, 3.17, 4.3), labels = c(expression("Intercept-Only"),
 expression("In-Sample"), expression("K-Fold CV"), expression("LOO CV")),
   cex.axis = 1.25)
axis(2, at = seq(0, 100, 10), las = 2)
title(xlab = expression("Prediction Model"), cex.lab = 1.5)
title(ylab = expression("% Correctly Predicted"), line = 3.75, cex.lab = 1.5)
text(.63, correct.null*100 + 5, expression("49%"), cex = 1.5)
text(1.9, correct.is*100 + 5, expression("59%"), cex = 1.5)
text(3.17, correct.cv1*100 + 5, expression("52%"), cex = 1.5)
text(4.3, correct.cv2*100 + 5, expression("56%"), cex = 1.5)
box()
```