Student Solutions Manual

to accompany

Applied Linear Regression Models

Fourth Edition

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PREFACE

This Student Solutions Manual gives intermediate and final numerical results for all starred (*) end-of-chapter Problems with computational elements contained in *Applied Linear Regression Models*, 4th edition. No solutions are given for Exercises, Projects, or Case Studies.

In presenting calculational results we frequently show, for ease in checking, more digits than are significant for the original data. Students and other users may obtain slightly different answers than those presented here, because of different rounding procedures. When a problem requires a percentile (e.g. of the t or F distributions) not included in the Appendix B Tables, users may either interpolate in the table or employ an available computer program for finding the needed value. Again, slightly different values may be obtained than the ones shown here.

The data sets for all Problems, Exercises, Projects and Case Studies are contained in the compact disk provided with the text to facilitate data entry. It is expected that the student will use a computer or have access to computer output for all but the simplest data sets, where use of a basic calculator would be adequate. For most students, hands-on experience in obtaining the computations by computer will be an important part of the educational experience in the course.

While we have checked the solutions very carefully, it is possible that some errors are still present. We would be most grateful to have any errors called to our attention. Errata can be reported via the website for the book: http://www.mhhe.com/KutnerALRM4e.

We acknowledge with thanks the assistance of Lexin Li and Yingwen Dong in the checking of this manual. We, of course, are responsible for any errors or omissions that remain.

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Chapter 1

LINEAR REGRESSION WITH ONE PREDICTOR VARIABLE

1.20. a. $\hat{Y} = -0.5802 + 15.0352X$

d. $\hat{Y}_h = 74.5958$

1.21. a. $\hat{Y} = 10.20 + 4.00X$

b. $\hat{Y}_h = 14.2$

c. 4.0

d. $(\bar{X}, \bar{Y}) = (1, 14.2)$

1.24. a.

i:	1	2	...	44	45
e_i:	-9.4903	0.4392	...	1.4392	2.4039

$\sum e_i^2 = 3416.377$

Min $Q = \sum e_i^2$

b. $MSE = 79.45063$, $\sqrt{MSE} = 8.913508$, minutes

1.25. a. $e_1 = 1.8000$

b. $\sum e_i^2 = 17.6000$, $MSE = 2.2000$, σ^2

1.27. a. $\hat{Y} = 156.35 - 1.19X$

b. (1) $b_1 = -1.19$, (2) $\hat{Y}_h = 84.95$, (3) $e_8 = 4.4433$,

(4) $MSE = 66.8$

Chapter 2

INFERENCES IN REGRESSION AND CORRELATION ANALYSIS

2.5. a. $t(.95; 43) = 1.6811$, $15.0352 \pm 1.6811(.4831)$, $14.2231 \leq \beta_1 \leq 15.8473$

b. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$. $t^* = (15.0352 - 0)/.4831 = 31.122$. If $|t^*| \leq 1.681$ conclude H_0, otherwise H_a. Conclude H_a. P-value= 0+

c. Yes

d. H_0: $\beta_1 \leq 14$, H_a: $\beta_1 > 14$. $t^* = (15.0352 - 14)/.4831 = 2.1428$. If $t^* \leq 1.681$ conclude H_0, otherwise H_a. Conclude H_a. P-value= .0189

2.6. a. $t(.975; 8) = 2.306$, $b_1 = 4.0$, $s\{b_1\} = .469$, $4.0 \pm 2.306(.469)$,

$2.918 \leq \beta_1 \leq 5.082$

b. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$. $t^* = (4.0 - 0)/.469 = 8.529$. If $|t^*| \leq 2.306$ conclude H_0, otherwise H_a. Conclude H_a. P-value= .00003

c. $b_0 = 10.20$, $s\{b_0\} = .663$, $10.20 \pm 2.306(.663)$, $8.671 \leq \beta_0 \leq 11.729$

d. H_0: $\beta_0 \leq 9$, H_a: $\beta_0 > 9$. $t^* = (10.20 - 9)/.663 = 1.810$. If $t^* \leq 2.306$ conclude H_0, otherwise H_a. Conclude H_0. P-value= .053

e. H_0: $\beta_1 = 0$: $\delta = |2 - 0|/.5 = 4$, power = .93

H_0: $\beta_0 \leq 9$: $\delta = |11 - 9|/.75 = 2.67$, power = .78

2.14. a. $\hat{Y}_h = 89.6313$, $s\{\hat{Y}_h\} = 1.3964$, $t(.95;\ 43) = 1.6811$, $89.6313 \pm 1.6811(1.3964)$, $87.2838 \leq E\{Y_h\} \leq 91.9788$

b. $s\{\text{pred}\} = 9.0222$, $89.6313 \pm 1.6811(9.0222)$, $74.4641 \leq Y_{h(\text{new})} \leq 104.7985$, yes, yes

c. $87.2838/6 = 14.5473$, $91.9788/6 = 15.3298$, $14.5473 \leq$ Mean time per machine ≤ 15.3298

d. $W^2 = 2F(.90;\ 2, 43) = 2(2.4304) = 4.8608$, $W = 2.2047$, $89.6313 \pm 2.2047(1.3964)$, $86.5527 \leq \beta_0 + \beta_1 X_h \leq 92.7099$, yes, yes

2.15. a. $X_h = 2$: $\hat{Y}_h = 18.2$, $s\{\hat{Y}_h\} = .663$, $t(.995;\ 8) = 3.355$, $18.2 \pm 3.355(.663)$, $15.976 \leq E\{Y_h\} \leq 20.424$

$X_h = 4$: $\hat{Y}_h = 26.2$, $s\{\hat{Y}_h\} = 1.483$, $26.2 \pm 3.355(1.483)$, $21.225 \leq E\{Y_h\} \leq 31.175$

b. $s\{\text{pred}\} = 1.625$, $18.2 \pm 3.355(1.625)$, $12.748 \leq Y_{h(\text{new})} \leq 23.652$

c. $s\{\text{predmean}\} = 1.083$, $18.2 \pm 3.355(1.083)$, $14.567 \leq \bar{Y}_{h(\text{new})} \leq 21.833$, $44 = 3(14.567) \leq$ Total number of broken ampules $\leq 3(21.833) = 65$

d. $W^2 = 2F(.99; 2, 8) = 2(8.649) = 17.298$, $W = 4.159$

$X_h = 2$: $18.2 \pm 4.159(.663)$, $15.443 \leq \beta_0 + \beta_1 X_h \leq 20.957$

$X_h = 4$: $26.2 \pm 4.159(1.483)$, $20.032 \leq \beta_0 + \beta_1 X_h \leq 32.368$

yes, yes

2.24. a.

Source	SS	df	MS
Regression	76,960.4	1	76,960.4
Error	3,416.38	43	79.4506
Total	80,376.78	44	

Source	SS	df	MS
Regression	76,960.4	1	76,960.4
Error	3,416.38	43	79.4506
Total	80,376.78	44	
Correction for mean	261,747.2	1	
Total, uncorrected	342,124	45	

b. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$. $F^* = 76,960.4/79.4506 = 968.66$, $F(.90; 1, 43) = 2.826$. If $F^* \leq 2.826$ conclude H_0, otherwise H_a. Conclude H_a.

c. 95.75% or 0.9575, coefficient of determination

d. +.9785

e. R^2

2.25. a.

Source	SS	df	MS
Regression	160.00	1	160.00
Error	17.60	8	2.20
Total	177.60	9	

b. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$. $F^* = 160.00/2.20 = 72.727$, $F(.95; 1, 8) = 5.32$. If $F^* \leq 5.32$ conclude H_0, otherwise H_a. Conclude H_a.

c. $t^* = (4.00 - 0)/.469 = 8.529$, $(t^*)^2 = (8.529)^2 = 72.7 = F^*$

d. $R^2 = .9009$, $r = .9492$, 90.09%

2.27. a. H_0: $\beta_1 \geq 0$, H_a: $\beta_1 < 0$. $s\{b_1\} = 0.090197$,

$t^* = (-1.19 - 0)/.090197 = -13.193$, $t(.05; 58) = -1.67155$.
If $t^* \geq -1.67155$ conclude H_0, otherwise H_a. Conclude H_a.
P-value$= 0+$

c. $t(.975; 58) = 2.00172$, $-1.19 \pm 2.00172(.090197)$, $-1.3705 \leq \beta_1 \leq -1.0095$

2.28. a. $\hat{Y}_h = 84.9468$, $s\{\hat{Y}_h\} = 1.05515$, $t(.975; 58) = 2.00172$,
$84.9468 \pm 2.00172(1.05515)$, $82.835 \leq E\{Y_h\} \leq 87.059$

b. $s\{Y_{h(\text{new})}\} = 8.24101$, $84.9468 \pm 2.00172(8.24101)$, $68.451 \leq Y_{h(\text{new})} \leq 101.443$

c. $W^2 = 2F(.95; 2, 58) = 2(3.15593) = 6.31186$, $W = 2.512342$,
$84.9468 \pm 2.512342(1.05515)$, $82.296 \leq \beta_0 + \beta_1 X_h \leq 87.598$, yes, yes

2.29. a.

i:	1	2	...	59	60
$Y_i - \hat{Y}_i$:	0.823243	-1.55675	...	-0.666887	8.09309
$\hat{Y}_i - \bar{Y}$:	20.2101	22.5901	...	-14.2998	-19.0598

b.

Source	SS	df	MS
Regression	11,627.5	1	11,627.5
Error	3,874.45	58	66.8008
Total	15,501.95	59	

c. H_0: $\beta_1 = 0$, H_a: $\beta_1 \neq 0$. $F^* = 11,627.5/66.8008 = 174.0623$,
$F(.90; 1, 58) = 2.79409$. If $F^* \leq 2.79409$ conclude H_0, otherwise H_a. Conclude H_a.

d. 24.993% or .24993

e. $R^2 = 0.750067$, $r = -0.866064$

2.42. b. .95285, ρ_{12}

c. $H_0 : \rho_{12} = 0$, $H_a : \rho_{12} \neq 0$. $t^* = (.95285\sqrt{13})/\sqrt{1 - (.95285)^2} = 11.32194$,
$t(.995; 13) = 3.012$. If $|t^*| \leq 3.012$ conclude H_0, otherwise H_a. Conclude H_a.

d. No

2.44. a. $H_0 : \rho_{12} = 0$, $H_a : \rho_{12} \neq 0$. $t^* = (.87\sqrt{101})/\sqrt{1 - (.87)^2} = 17.73321$, $t(.95; 101) = 1.663$. If $|t^*| \leq 1.663$ conclude H_0, otherwise H_a. Conclude H_a.

b. $z' = 1.33308$, $\sigma\{z'\} = .1$, $z(.95) = 1.645$, $1.33308 \pm 1.645(.1)$, $1.16858 \leq \zeta \leq 1.49758$, $.824 \leq \rho_{12} \leq .905$

c. $.679 \leq \rho_{12}^2 \leq .819$

2.47. a. -0.866064,

b. $H_0 : \rho_{12} = 0$, $H_a : \rho_{12} \neq 0$. $t^* = (-0.866064\sqrt{58})/\sqrt{1 - (-0.866064)^2} = -13.19326$, $t(.975; 58) = 2.00172$. If $|t^*| \leq 2.00172$ conclude H_0, otherwise H_a. Conclude H_a.

c. -0.8657217

d. H_0 : There is no association between X and Y
H_a : There is an association between X and Y
$t^* = \dfrac{-0.8657217\sqrt{58}}{\sqrt{1 - (-0.8657217)^2}} = -13.17243$. $t(0.975,\ 58) = 2.001717$. If $|t^*| \leq 2.001717$, conclude H_0, otherwise, conclude H_a. Conclude H_a.

Chapter 3

DIAGNOSTICS AND REMEDIAL MEASURES

3.4. c and d.

i:	1	2	...	44	45
$\hat{Y}_i$:	29.49034	59.56084	...	59.56084	74.59608
e_i:	-9.49034	0.43916	...	1.43916	2.40392

e.

Ascending order:	1	2	...	44	45
Ordered residual:	-22.77232	-19.70183	...	14.40392	15.40392
Expected value:	-19.63272	-16.04643	...	16.04643	19.63272

H_0: Normal, H_a: not normal. $r = 0.9891$. If $r \geq .9785$ conclude H_0, otherwise H_a. Conclude H_0.

g. $SSR^* = 15,155$, $SSE = 3416.38$, $X^2_{BP} = (15,155/2) \div (3416.38/45)^2 = 1.314676$, $\chi^2(.95; 1) = 3.84$. If $X^2_{BP} \leq 3.84$ conclude error variance constant, otherwise error variance not constant. Conclude error variance constant.

3.5. c.

i:	1	2	3	4	5	6	7	8	9	10
e_i:	1.8	-1.2	-1.2	1.8	-.2	-1.2	-2.2	.8	.8	.8

e.

Ascending Order:	1	2	3	4	5	6	7	8	9	10
Ordered residual:	-2.2	-1.2	-1.2	-1.2	-.2	.8	.8	.8	1.8	1.8
Expected value:	-2.3	-1.5	-1.0	-.6	-.2	.2	.6	1.0	1.5	2.3

H_0: Normal, H_a: not normal. $r = .961$. If $r \geq .879$ conclude H_0, otherwise H_a. Conclude H_0.

g. $SSR^* = 6.4$, $SSE = 17.6$, $X^2_{BP} = (6.4/2) \div (17.6/10)^2 = 1.03$, $\chi^2(.90; 1) = 2.71$. If $X^2_{BP} \leq 2.71$ conclude error variance constant, otherwise error variance not constant. Conclude error variance constant.

Yes.

3.7. b and c.

i:	1	2	...	59	60
e_i:	0.82324	-1.55675	...	-0.66689	8.09309
$\hat{Y}_i$:	105.17676	107.55675	...	70.66689	65.90691

d.

Ascending order:	1	2	...	59	60
Ordered residual:	-16.13683	-13.80686	...	13.95312	23.47309
Expected value:	-18.90095	-15.75218	...	15.75218	18.90095

H_0: Normal, H_a: not normal. $r = 0.9897$. If $r \geq 0.984$ conclude H_0, otherwise H_a. Conclude H_0.

e. $SSR^* = 31,833.4$, $SSE = 3,874.45$,

$X^2_{BP} = (31,833.4/2) \div (3,874.45/60)^2 = 3.817116$, $\chi^2(.99; 1) = 6.63$. If $X^2_{BP} \leq 6.63$ conclude error variance constant, otherwise error variance not constant. Conclude error variance constant. Yes.

3.13. a. H_0: $E\{Y\} = \beta_0 + \beta_1 X$, H_a: $E\{Y\} \neq \beta_0 + \beta_1 X$

b. $SSPE = 2797.66$, $SSLF = 618.719$, $F^* = (618.719/8) \div (2797.66/35) = 0.967557$, $F(.95; 8, 35) = 2.21668$. If $F^* \leq 2.21668$ conclude H_0, otherwise H_a. Conclude H_0.

3.17. b.

λ:	.3	.4	.5	.6	.7
SSE:	1099.7	967.9	916.4	942.4	1044.2

c. $\hat{Y}' = 10.26093 + 1.07629X$

e.

i:	1	2	3	4	5
e_i:	-.36	.28	.31	-.15	.30
$\hat{Y}'_i$:	10.26	11.34	12.41	13.49	14.57
Expected value:	-.24	.14	.36	-.14	.24

i:	6	7	8	9	10
e_i:	-.41	.10	-.47	.47	-.07
$\hat{Y}'_i$:	15.64	16.72	17.79	18.87	19.95
Expected value:	-.36	.04	-.56	.56	-.04

f. $\hat{Y} = (10.26093 + 1.07629X)^2$

Chapter 4

SIMULTANEOUS INFERENCES AND OTHER TOPICS IN REGRESSION ANALYSIS

4.3. a. Opposite directions, negative tilt

b. $B = t(.9875; 43) = 2.32262$, $b_0 = -0.580157$, $s\{b_0\} = 2.80394$, $b_1 = 15.0352$, $s\{b_1\} = 0.483087$

$-0.580157 \pm 2.32262(2.80394) \qquad -7.093 \leq \beta_0 \leq 5.932$

$15.0352 \pm 2.32262(0.483087) \qquad 13.913 \leq \beta_1 \leq 16.157$

c. Yes

4.4. a. Opposite directions, negative tilt

b. $B = t(.9975; 8) = 3.833$, $b_0 = 10.2000$, $s\{b_0\} = .6633$, $b_1 = 4.0000$, $s\{b_1\} = .4690$

$10.2000 \pm 3.833(.6633) \qquad 7.658 \leq \beta_0 \leq 12.742$

$4.0000 \pm 3.833(.4690) \qquad 2.202 \leq \beta_1 \leq 5.798$

4.6. a. $B = t(.9975; 14) = 2.91839$, $b_0 = 156.347$, $s\{b_0\} = 5.51226$, $b_1 = -1.190$,$s\{b_1\} = 0.0901973$

$156.347 \pm 2.91839(5.51226) \qquad 140.260 \leq \beta_0 \leq 172.434$

$-1.190 \pm 2.91839(0.0901973) \qquad -1.453 \leq \beta_1 \leq -0.927$

b. Opposite directions

c. No

4.7. a. $F(.90; 2, 43) = 2.43041$, $W = 2.204727$

$X_h = 3$: $44.5256 \pm 2.204727(1.67501) \qquad 40.833 \leq E\{Y_h\} \leq 48.219$

$X_h = 5$: $74.5961 \pm 2.204727(1.32983) \qquad 71.664 \leq E\{Y_h\} \leq 77.528$

$X_h = 7$: $104.667 \pm 2.204727(1.6119) \qquad 101.113 \leq E\{Y_h\} \leq 108.221$

b. $F(.90; 2, 43) = 2.43041$, $S = 2.204727$; $B = t(.975;\ 43) = 2.01669$; Bonferroni

c. $X_h = 4$: $59.5608 \pm 2.01669(9.02797) \qquad 41.354 \leq Y_{h(\text{new})} \leq 77.767$

$X_h = 7$: $104.667 \pm 2.01669(9.05808)$ $86.3997 \leq Y_{h(\text{new})} \leq 122.934$

4.8. a. $F(.95; 2, 8) = 4.46$, $W = 2.987$

$X_h = 0$: $10.2000 \pm 2.987(.6633)$ $8.219 \leq E\{Y_h\} \leq 12.181$

$X_h = 1$: $14.2000 \pm 2.987(.4690)$ $12.799 \leq E\{Y_h\} \leq 15.601$

$X_h = 2$: $18.2000 \pm 2.987(.6633)$ $16.219 \leq E\{Y_h\} \leq 20.181$

b. $B = t(.99167; 8) = 3.016$, yes

c. $F(.95; 3, 8) = 4.07$, $S = 3.494$

$X_h = 0$: $10.2000 \pm 3.494(1.6248)$ $4.523 \leq Y_{h(\text{new})} \leq 15.877$

$X_h = 1$: $14.2000 \pm 3.494(1.5556)$ $8.765 \leq Y_{h(\text{new})} \leq 19.635$

$X_h = 2$: $18.2000 \pm 3.494(1.6248)$ $12.523 \leq Y_{h(\text{new})} \leq 23.877$

d. $B = 3.016$, yes

4.10. a. $F(.95; 2, 58) = 3.15593$, $W = 2.512342$

$X_h = 45$: $102.797 \pm 2.512342(1.71458)$ $98.489 \leq E\{Y_h\} \leq 107.105$

$X_h = 55$: $90.8968 \pm 2.512342(1.1469)$ $88.015 \leq E\{Y_h\} \leq 93.778$

$X_h = 65$: $78.9969 \pm 2.512342(1.14808)$ $76.113 \leq E\{Y_h\} \leq 81.881$

b. $B = t(.99167; 58) = 2.46556$, no

c. $B = 2.46556$

$X_h = 48$: $99.2268 \pm 2.46556(8.31158)$ $78.734 \leq Y_{h(\text{new})} \leq 119.720$

$X_h = 59$: $86.1368 \pm 2.46556(8.24148)$ $65.817 \leq Y_{h(\text{new})} \leq 106.457$

$X_h = 74$: $68.2869 \pm 2.46556(8.33742)$ $47.730 \leq Y_{h(\text{new})} \leq 88.843$

d. Yes, yes

4.16. a. $\hat{Y} = 14.9472X$

b. $s\{b_1\} = 0.226424$, $t(.95; 44) = 1.68023$, $14.9472 \pm 1.68023(0.226424)$, $14.567 \leq \beta_1 \leq 15.328$

c. $\hat{Y}_h = 89.6834$, $s\{\text{pred}\} = 8.92008$, $89.6834 \pm 1.68023(8.92008)$, $74.696 \leq Y_{h(\text{new})} \leq 104.671$

4.17. b.

i:	1	2	...	44	45
e_i:	-9.89445	0.21108	...	1.2111	2.2639

No

c. H_0: $E\{Y\} = \beta_1 X$, H_a: $E\{Y\} \neq \beta_1 X$. $SSLF = 622.12$, $SSPE = 2797.66$, $F^* = (622.12/9) \div (2797.66/35) = 0.8647783$, $F(.99; 9, 35) = 2.96301$. If $F^* \leq 2.96301$ conclude H_0, otherwise H_a. Conclude H_0. P-value $= 0.564$

Chapter 5

MATRIX APPROACH TO SIMPLE LINEAR REGRESSION ANALYSIS

5.4. (1) 503.77 (2) $\begin{bmatrix} 5 & 0 \\ 0 & 160 \end{bmatrix}$ (3) $\begin{bmatrix} 49.7 \\ -39.2 \end{bmatrix}$

5.6. (1) 2,194 (2) $\begin{bmatrix} 10 & 10 \\ 10 & 20 \end{bmatrix}$ (3) $\begin{bmatrix} 142 \\ 182 \end{bmatrix}$

5.12. $\begin{bmatrix} .2 & 0 \\ 0 & .00625 \end{bmatrix}$

5.14. a. $\begin{bmatrix} 4 & 7 \\ 2 & 3 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 25 \\ 12 \end{bmatrix}$

b. $\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 4.5 \\ 1 \end{bmatrix}$

5.18. a. $\begin{bmatrix} W_1 \\ W_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \end{bmatrix}$

b. $\mathbf{E}\left\{\begin{bmatrix} W_1 \\ W_2 \end{bmatrix}\right\} = \begin{bmatrix} \frac{1}{4}[E\{Y_1\} + E\{Y_2\} + E\{Y_3\} + E\{Y_4\}] \\ \frac{1}{2}[E\{Y_1\} + E\{Y_2\} - E\{Y_3\} - E\{Y_4\}] \end{bmatrix}$

c. $$\boldsymbol{\sigma}^2\{\mathbf{W}\} = \begin{bmatrix} \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} \sigma^2\{Y_1\} & \sigma\{Y_1, Y_2\} & \sigma\{Y_1, Y_3\} & \sigma\{Y_1, Y_4\} \\ \sigma\{Y_2, Y_1\} & \sigma^2\{Y_2\} & \sigma\{Y_2, Y_3\} & \sigma\{Y_2, Y_4\} \\ \sigma\{Y_3, Y_1\} & \sigma\{Y_3, Y_2\} & \sigma^2\{Y_3\} & \sigma\{Y_3, Y_4\} \\ \sigma\{Y_4, Y_1\} & \sigma\{Y_4, Y_2\} & \sigma\{Y_4, Y_3\} & \sigma^2\{Y_4\} \end{bmatrix}$$

$$\times \begin{bmatrix} \frac{1}{4} & \frac{1}{2} \\ \frac{1}{4} & \frac{1}{2} \\ \frac{1}{4} & -\frac{1}{2} \\ \frac{1}{4} & -\frac{1}{2} \end{bmatrix}$$

Using the notation σ_1^2 for $\sigma^2\{Y_1\}, \sigma_{12}$ for $\sigma\{Y_1, Y_2\}$, etc., we obtain:

$\sigma^2\{W_1\} = \frac{1}{16}(\sigma_1^2 + +\sigma_2^2 + \sigma_3^2 + \sigma_4^2 + 2\sigma_{12} + 2\sigma_{13} + 2\sigma_{14} + 2\sigma_{23} + 2\sigma_{24} + 2\sigma_{34})$

$$\sigma^2\{W_2\} = \frac{1}{4}(\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \sigma_4^2 + 2\sigma_{12} - 2\sigma_{13} - 2\sigma_{14} - 2\sigma_{23} - 2\sigma_{24} + 2\sigma_{34})$$

$$\sigma\{W_1, W_2\} = \frac{1}{8}(\sigma_1^2 + \sigma_2^2 - \sigma_3^2 - \sigma_4^2 + 2\sigma_{12} - 2\sigma_{34})$$

5.19. $\begin{bmatrix} 3 & 5 \\ 5 & 17 \end{bmatrix}$

5.21. $5Y_1^2 + 4Y_1Y_2 + Y_2^2$

5.23. a. (1) $\begin{bmatrix} 9.940 \\ -.245 \end{bmatrix}$ (2) $\begin{bmatrix} -.18 \\ .04 \\ .26 \\ .08 \\ -.20 \end{bmatrix}$ (3) 9.604 (4) .148

(5) $\begin{bmatrix} .00987 & 0 \\ 0 & .000308 \end{bmatrix}$ (6) 11.41 (7) .02097

c. $\begin{bmatrix} .6 & .4 & .2 & 0 & -.2 \\ .4 & .3 & .2 & .1 & 0 \\ .2 & .2 & .2 & .2 & .2 \\ 0 & .1 & .2 & .3 & .4 \\ -.2 & 0 & .2 & .4 & .6 \end{bmatrix}$

d. $\begin{bmatrix} .01973 & -.01973 & -.00987 & .00000 & .00987 \\ -.01973 & .03453 & -.00987 & -.00493 & .00000 \\ -.00987 & -.00987 & .03947 & -.00987 & -.00987 \\ .00000 & -.00493 & -.00987 & .03453 & -.01973 \\ .00987 & .00000 & -.00987 & -.01973 & .01973 \end{bmatrix}$

5.25. a. (1) $\begin{bmatrix} .2 & -.1 \\ -.1 & .1 \end{bmatrix}$ (2) $\begin{bmatrix} 10.2 \\ 4.0 \end{bmatrix}$ (3) $\begin{bmatrix} 1.8 \\ -1.2 \\ -1.2 \\ 1.8 \\ -.2 \\ -1.2 \\ -2.2 \\ .8 \\ .8 \\ .8 \end{bmatrix}$

(4) $\begin{bmatrix} .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 \\ .1 & .2 & 0 & .2 & -.1 & .1 & .2 & .1 & 0 & .2 \\ .1 & 0 & .2 & 0 & .3 & .1 & 0 & .1 & .2 & 0 \\ .1 & .2 & 0 & .2 & -.1 & .1 & .2 & .1 & 0 & .2 \\ .1 & -.1 & .3 & -.1 & .5 & .1 & -.1 & .1 & .3 & -.1 \\ .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 \\ .1 & .2 & 0 & .2 & -.1 & .1 & .2 & .1 & 0 & .2 \\ .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 & .1 \\ .1 & .0 & .2 & 0 & .3 & .1 & 0 & .1 & .2 & 0 \\ .1 & .2 & 0 & .2 & -.1 & .1 & .2 & .1 & .0 & .2 \end{bmatrix}$

(5) 17.60 (6) $\begin{bmatrix} .44 & -.22 \\ -.22 & .22 \end{bmatrix}$ (7) 18.2 (8) .44

b. (1) .22 (2) $-.22$ (3) .663

c.
$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & .1 & -.1 & .1 & -.2 & 0 & .1 & 0 & -.1 & .1 \\ 0 & -.1 & .1 & -.1 & .2 & 0 & -.1 & 0 & .1 & -.1 \\ 0 & .1 & -.1 & .1 & -.2 & 0 & .1 & 0 & -.1 & .1 \\ 0 & -.2 & .2 & -.2 & .4 & 0 & -.2 & 0 & .2 & -.2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & .1 & -.1 & .1 & -.2 & 0 & .1 & 0 & -.1 & .1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -.1 & .1 & -.1 & .2 & 0 & -.1 & 0 & .1 & -.1 \\ 0 & .1 & -.1 & .1 & -.2 & 0 & .1 & 0 & -.1 & .1 \end{bmatrix}$$

Chapter 6

MULTIPLE REGRESSION – I

6.9. c.

$$\begin{array}{c} Y \\ X_1 \\ X_2 \\ X_3 \end{array} \begin{bmatrix} 1.0000 & .2077 & .0600 & .8106 \\ & 1.0000 & .0849 & .0457 \\ & & 1.0000 & .1134 \\ & & & 1.0000 \end{bmatrix}$$

6.10. a. $\hat{Y} = 4149.89 + 0.000787X_1 - 13.166X_2 + 623.554X_3$

b&c.

i:	1	2	...	51	52
e_i:	−32.0635	169.2051	...	−184.8776	64.5168
Expected Val.:	−24.1737	151.0325	...	−212.1315	75.5358

e. $n_1 = 26$, $\bar{d}_1 = 145.0$, $n_2 = 26$, $\bar{d}_2 = 77.4$, $s = 81.7$, $t^*_{BF} = (145.0 - 77.4)/[81.7\sqrt{(1/26) + (1/26)}] = 2.99$, $t(.995; 50) = 2.67779$. If $|t^*_{BF}| \leq 2.67779$ conclude error variance constant, otherwise error variance not constant. Conclude error variance not constant.

6.11. a. H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: not all $\beta_k = 0$ (k = 1, 2,3). $MSR = 725,535$, $MSE = 20,531.9$, $F^* = 725,535/20,531.9 = 35.337$, $F(.95; 3, 48) = 2.79806$. If $F^* \leq 2.79806$ conclude H_0, otherwise H_a. Conclude H_a. P-value = 0+.

b. $s\{b_1\} = .000365$, $s\{b_3\} = 62.6409$, $B = t(.9875; 48) = 2.3139$

$$0.000787 \pm 2.3139(.000365) \qquad -.000058 \leq \beta_1 \leq 0.00163$$

$$623.554 \pm 2.3139(62.6409) \qquad 478.6092 \leq \beta_3 \leq 768.4988$$

c. $SSR = 2,176,606$, $SSTO = 3,162,136$, $R^2 = .6883$

6.12. a. $F(.95; 4, 48) = 2.56524$, $W = 3.2033$; $B = t(.995; 48) = 2.6822$

X_{h1}	X_{h2}	X_{h3}		
302,000	7.2	0:	$4292.79 \pm 2.6822(21.3567)$	$4235.507 \leq E\{Y_h\} \leq 4350.073$
245,000	7.4	0:	$4245.29 \pm 2.6822(29.7021)$	$4165.623 \leq E\{Y_h\} \leq 4324.957$
280,000	6.9	0:	$4279.42 \pm 2.6822(24.4444)$	$4213.855 \leq E\{Y_h\} \leq 4344.985$
350,000	7.0	0:	$4333.20 \pm 2.6822(28.9293)$	$4255.606 \leq E\{Y_h\} \leq 4410.794$
295,000	6.7	1:	$4917.42 \pm 2.6822(62.4998)$	$4749.783 \leq E\{Y_h\} \leq 5085.057$

b.Yes, no

6.13. $F(.95;4,48) = 2.5652$, $S = 3.2033$; $B = t(.99375;48) = 2.5953$

X_{h1}	X_{h2}	X_{h3}		
230,000	7.5	0:	$4232.17 \pm 2.5953(147.288)$	$3849.913 \leq Y_{h(\text{new})} \leq 4614.427$
250,000	7.3	0:	$4250.55 \pm 2.5953(146.058)$	$3871.486 \leq Y_{h(\text{new})} \leq 4629.614$
280,000	7.1	0:	$4276.79 \pm 2.5953(145.134)$	$3900.124 \leq Y_{h(\text{new})} \leq 4653.456$
340,000	6.9	0:	$4326.65 \pm 2.5953(145.930)$	$3947.918 \leq Y_{h(\text{new})} \leq 4705.382$

6.14. a. $\hat{Y}_h = 4278.37$, $s\{\text{predmean}\} = 85.82262$, $t(.975;48) = 2.01063$,

$4278.37 \pm 2.01063(85.82262)$, $4105.812 \leq \bar{Y}_{h(\text{new})} \leq 4450.928$

b. $12317.44 \leq$ Total labor hours≤ 13352.78

6.15. b.

$$
\begin{array}{c}
Y \\ X_1 \\ X_2 \\ X_3
\end{array}
\begin{bmatrix}
1.000 & -.7868 & -.6029 & -.6446 \\
 & 1.000 & .5680 & .5697 \\
 & & 1.000 & .6705 \\
 & & & 1.000
\end{bmatrix}
$$

c. $\hat{Y} = 158.491 - 1.1416X_1 - 0.4420X_2 - 13.4702X_3$

d&e.

i:	1	2	...	45	46
e_i:	.1129	-9.0797	...	-5.5380	10.0524
Expected Val.:	-0.8186	-8.1772	...	-5.4314	8.1772

f. No

g. $SSR^* = 21,355.5$, $SSE = 4,248.8$, $X^2_{BP} = (21,355.5/2) \div (4,248.8\ /46)^2 = 1.2516$, $\chi^2(.99;3) = 11.3449$. If $X^2_{BP} \leq 11.3449$ conclude error variance constant, otherwise error variance not constant. Conclude error variance constant.

6.16. a. H_0: $\beta_1 = \beta_2 = \beta_3 = 0$, H_a: not all $\beta_k = 0$ $(k = 1,2,3)$.

$MSR = 3,040.2$, $MSE = 101.2$, $F^* = 3,040.2/101.2 = 30.05$, $F(.90;3,42) = 2.2191$. If $F^* \leq 2.2191$ conclude H_0, otherwise H_a. Conclude H_a. P-value $= 0.4878$

b. $s\{b_1\} = .2148$, $s\{b_2\} = .4920$, $s\{b_3\} = 7.0997$, $B = t(.9833;42) = 2.1995$

$-1.1416 \pm 2.1995(.2148)$ $\quad -1.6141 \leq \beta_1 \leq -0.6691$

$-.4420 \pm 2.1995(.4920)$ $\quad -1.5242 \leq \beta_2 \leq 0.6402$

$-13.4702 \pm 2.1995(7.0997)$ $\quad -29.0860 \leq \beta_3 \leq 2.1456$

c. $SSR = 9,120.46$, $SSTO = 13,369.3$, $R = .8260$

6.17. a. $\hat{Y}_h = 69.0103$, $s\{\hat{Y}_h\} = 2.6646$, $t(.95;42) = 1.6820$, $69.0103 \pm 1.6820(2.6646)$, $64.5284 \leq E\{Y_h\} \leq 73.4922$

b. $s\{\text{pred}\} = 10.405$, $69.0103 \pm 1.6820(10.405)$, $51.5091 \leq Y_{h(\text{new})} \leq 86.5115$

Chapter 7

MULTIPLE REGRESSION – II

7.4. a. $SSR(X_1) = 136,366$, $SSR(X_3|X_1) = 2,033,566$, $SSR(X_2|X_1, X_3) = 6,674$, $SSE(X_1, X_2, X_3) = 985,530$, df: 1, 1, 1,48.

b. H_0: $\beta_2 = 0$, H_a: $\beta_2 \neq 0$. $SSR(X_2|X_1, X_3) = 6,674$, $SSE(X_1, X_2, X_3) = 985,530$, $F^* = (6,674/1) \div (985,530/48) = 0.32491$, $F(.95; 1, 17) = 4.04265$. If $F^* \leq 4.04265$ conclude H_0, otherwise H_a. Conclude H_0. P-value = 0.5713.

c. Yes, $SSR(X_1)+SSR(X_2|X_1) = 136,366+5,726 = 142,092$, $SSR(X_2)+SSR(X_1|X_2) = 11,394.9 + 130,697.1 = 142,092$.

Yes.

7.5. a. $SSR(X_2) = 4,860.26$, $SSR(X_1|X_2) = 3,896.04$, $SSR(X_3|X_2, X_1) = 364.16$, $SSE(X_1, X_2, X_3) = 4,248.84$, df: 1, 1, 1, 42

b. H_0: $\beta_3 = 0$, H_a: $\beta_3 \neq 0$. $SSR(X_3|X_1, X_2) = 364.16$, $SSE(X_1, X_2, X_3) =4,248.84$, $F^* = (364.16/1)\div(4,248.84/42) = 3.5997$, $F(.975; 1, 42) = 5.4039$. If $F^* \leq 5.4039$ conclude H_0, otherwise H_a . Conclude H_0. P-value = 0.065.

7.6. H_0: $\beta_2 = \beta_3 = 0$, H_a: not both β_2 and $\beta_3 = 0$. $SSR(X_2, X_3|X_1) = 845.07$, $SSE(X_1, X_2, X_3) = 4,248.84$, $F^* = (845.07/2)\div(4,248.84/42) = 4.1768$, $F(.975; 2, 42) = 4.0327$. If $F^* \leq 4.0327$ conclude H_0, otherwise H_a. Conclude H_a. P-value = 0.022.

7.9. H_0: $\beta_1 = -1.0$, $\beta_2 = 0$; H_a: not both equalities hold. Full model: $Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \varepsilon_i$, reduced model: $Y_i + X_{i1} = \beta_0 + \beta_3 X_{i3} + \varepsilon_i$. $SSE(F) = 4,248.84$, $df_F = 42$, $SSE(R) = 4,427.7$, $df_R = 44$, $F^* = [(4427.7-4248.84)/2]\div(4,248.84/42) = .8840$, $F(.975; 2, 42) = 4.0327$. If $F^* \leq 4.0327$ conclude H_0, otherwise H_a. Conclude H_0.

7.13. $R^2_{Y1} = .0431$, $R^2_{Y2} = .0036$, $R^2_{12} = .0072$, $R^2_{Y1|2} = 0.0415$, $R^2_{Y2|1} = 0.0019$, $R^2_{Y2|13} = .0067$ $R^2 = .6883$

7.14. a. $R^2_{Y1} = .6190$, $R^2_{Y1|2} = .4579$, $R^2_{Y1|23} = .4021$

b. $R^2_{Y2} = .3635$, $R^2_{Y2|1} = .0944$, $R^2_{Y2|13} = .0189$

7.17. a. $\hat{Y}^* = .17472X_1^* - .04639X_2^* + .80786X_3^*$

b. $R^2_{12} = .0072$, $R^2_{13} = .0021$,$R^2_{23} = .0129$

c. $s_Y = 249.003,\ s_1 = 55274.6,\ s_2 = .87738,\ s_3 = .32260\ b_1 = \frac{249.003}{55274.6}(.17472) = .00079,\ b_2 = \frac{249.003}{.87738}(-.04639) = -13.16562,\ b_3 = \frac{249.003}{5.32260}(.80786) = 623.5572,$
$b_0 = 4363.04 - .00079(302,693) + 13.16562(7.37058) - 623.5572(0.115385) = 4149.002.$

7.18. a. $\hat{Y}^* = -.59067X_1^* - .11062X_2^* - .23393X_3^*$

b. $R_{12}^2 = .32262,\ R_{13}^2 = .32456,\ R_{23}^2 = .44957$

c. $s_Y = 17.2365,\ s_1 = 8.91809,\ s_2 = 4.31356,\ s_3 = .29934,\ b_1 = \frac{17.2365}{8.91809}(-.59067) = -1.14162,\ b_2 = \frac{17.2365}{4.31356}(-.11062) = -.44203,\ b_3 = \frac{17.2365}{.29934}(-.23393) = -13.47008,$
$b_0 = 61.5652 + 1.14162(38.3913) + .44203(50.4348) + 13.47008(2.28696) = 158.4927$

7.25. a. $\hat{Y} = 4079.87 + 0.000935X_2$

c. No, $SSR(X_1) = 136,366,\ SSR(X_1|X_2) = 130,697$

d. $r_{12} = .0849$

7.26. a. $\hat{Y} = 156.672 - 1.26765X_1 - 0.920788X_2$

c. No, $SSR(X_1) = 8,275.3,\ SSR(X_1|X_3) = 3,483.89$

No, $SSR(X_2) = 4,860.26,\ SSR(X_2|X_3) = 708$

d. $r_{12} = .5680,\ r_{13} = .5697,\ r_{23} = .6705$

Chapter 8

MODELS FOR QUANTITATIVE AND QUALITATIVE PREDICTORS

8.4. a. $\hat{Y} = 82.9357 - 1.18396x + .0148405x^2$, $R^2 = .76317$

b. H_0: $\beta_1 = \beta_{11} = 0$, H_a: not both β_1 and $\beta_{11} = 0$. $MSR = 5915.31$, $MSE = 64.409$, $F^* = 5915.31/64.409 = 91.8398$, $F(.95; 2, 57) = 3.15884$. If $F^* \leq 3.15884$ conclude H_0, otherwise H_a. Conclude H_a.

c. $\hat{Y}_h = 99.2546$, $s\{\hat{Y}_h\} = 1.4833$, $t(.975; 57) = 2.00247$, $99.2546 \pm 2.00247(1.4833)$, $96.2843 \leq E\{Y_h\} \leq 102.2249$

d. $s\{\text{pred}\} = 8.16144$, $99.2546 \pm 2.00247(8.16144)$, $82.91156 \leq Y_{h(\text{new})} \leq 115.5976$

e. H_0: $\beta_{11} = 0$, H_a: $\beta_{11} \neq 0$. $s\{b_{11}\} = .00836$, $t^* = .0148405/.00836 = 1.7759$, $t(.975; 57) = 2.00247$. If $|t^*| \leq 2.00247$ conclude H_0, otherwise H_a. Conclude H_0. Alternatively, $SSR(x^2|x) = 203.1$, $SSE(x, x^2) = 3671.31$, $F^* = (203.1/1) \div (3671.31/57) = 3.15329$, $F(.95; 1, 57) = 4.00987$. If $F^* \leq 4.00987$ conclude H_0, otherwise H_a. Conclude H_0.

f. $\hat{Y} = 207.350 - 2.96432X + .0148405X^2$

g. $r_{X,X^2} = .9961$, $r_{x,x^2} = -.0384$

8.5. a.

i:	1	2	3	...	58	59	60
e_i:	-1.3238	-4.7592	-3.8091	...	-11.7798	-.8515	6.22023

b. H_0: $E\{Y\} = \beta_0 + \beta_1 x + \beta_{11}x^2$, H_a: $E\{Y\} \neq \beta_0 + \beta_1 x + \beta_{11}x^2$. $MSLF = 62.8154$, $MSPE = 66.0595$, $F^* = 62.8154/66.0595 = 0.95$, $F(.95; 29, 28) = 1.87519$. If $F^* \leq 1.87519$ conclude H_0, otherwise H_a. Conclude H_0.

c. $\hat{Y} = 82.92730 - 1.26789x + .01504x^2 + .000337x^3$

H_0: $\beta_{111} = 0$, H_a: $\beta_{111} \neq 0$. $s\{b_{111}\} = .000933$, $t^* = .000337/.000933 = .3612$, $t(.975; 56) = 2.00324$. If $|t^*| \leq 2.00324$ conclude H_0, otherwise H_a. Conclude H_0. Yes. Alternatively, $SSR(x^3|x, x^2) = 8.6$, $SSE(x, x^2, x^3) = 3662.78$, $F^* = (8.6/1) \div (3662.78/56) = .13148$, $F(.95; 1, 56) = 4.01297$. If $F^* \leq 4.01297$ conclude H_0, otherwise H_a. Conclude H_0. Yes.

8.19. a. $\hat{Y} = 2.81311 + 14.3394X_1 - 8.14120X_2 + 1.77739X_1X_2$

b. $H_0 : \beta_3 = 0$, $H_a : \beta_3 \neq 0$. $s\{b_3\} = .97459$, $t^* = 1.77739/.97459 = 1.8237$, $t(.95; 41) = 1.68288$. If $|t^*| \leq 1.68288$ conclude H_0, otherwise H_a. Conclude H_a. Alternatively, $SSR(X_1X_2|X_1, X_2) = 255.9$, $SSE(X_1, X_2, X_1X_2) = 3154.44$, $F^* = (255.9/1) \div (3154.44/\ 41) = 3.32607$, $F(.90; 1, 41) = 2.83208$. If $F^* \leq 2.83208$ conclude H_0, otherwise H_a. Conclude H_a.

Chapter 9

BUILDING THE REGRESSION MODEL I: MODEL SELECTION AND VALIDATION

9.9.

Variables in Model	R_p^2	AIC_p	C_p	$PRESS_p$
None	0	262.916	88.16	13,970.10
X_1	.6190	220.529	8.35	5,569.56
X_2	.3635	244.131	42.11	9,254.49
X_3	.4155	240.214	35.25	8,451.43
X_1, X_2	.6550	217.968	5.60	5,235.19
X_1, X_3	.6761	215.061	2.81	4,902.75
X_2, X_3	.4685	237.845	30.25	8,115.91
X_1, X_2, X_3	.6822	216.185	4.00	5,057.886

9.10. b.

$$\begin{array}{c} X_1 \\ X_2 \\ X_3 \\ X_4 \end{array} \begin{bmatrix} 1 & .102 & .181 & .327 \\ & 1 & .519 & .397 \\ & & 1 & .782 \\ & & & 1 \end{bmatrix}$$

c. $\hat{Y} = -124.3820 + .2957X_1 + .0483X_2 + 1.3060X_3 + .5198X_4$

9.11. a.

Subset	$R_{a,p}^2$
X_1, X_3, X_4	.9560
X_1, X_2, X_3, X_4	.9555
X_1, X_3	.9269
X_1, X_2, X_3	.9247

9.17. a. X_1, X_3

b. .10

c. X_1, X_3

d. X_1, X_3

9.18. a. X_1, X_3, X_4

9.21. $PRESS = 760.974$, $SSE = 660.657$

9.22. a.

$$\begin{array}{c} X_1 \\ X_2 \\ X_3 \\ X_4 \end{array} \begin{bmatrix} 1 & .011 & .177 & .320 \\ & 1 & .344 & .221 \\ & & 1 & .871 \\ & & & 1 \end{bmatrix}$$

b.

	Model-building data set	Validation data set
b_0:	-127.596	-130.652
$s\{b_0\}$:	12.685	12.189
b_1:	.348	.347
$s\{b_1\}$:	.054	.048
b_3:	1.823	1.848
$s\{b_3\}$:	.123	.122
MSE:	27.575	21.446
R^2:	.933	.937

c. $MSPR = 486.519/25 = 19.461$

d. $\hat{Y} = -129.664 + .349X_1 + 1.840X_3$, $s\{b_0\} = 8.445$, $s\{b_1\} = .035$, $s\{b_3\} = .084$

Chapter 10

BUILDING THE REGRESSION MODEL II: DIAGNOSTICS

10.10.a&f.

i:	1	2	...	51	52
t_i:	$-.224$	1.225	...	-1.375	.453
D_i:	.0003	.0245	...	.0531	.0015

$t(.9995192; 47) = 3.523$. If $|t_i| \leq 3.523$ conclude no outliers, otherwise outliers. Conclude no outliers.

b. $2p/n = 2(4)/52 = .15385$. Cases 3, 5, 16, 21, 22, 43, 44, and 48.

c. $\mathbf{X}'_{\text{new}} = [\ 1 \quad 300,000 \quad 7.2 \quad 0\ ]$

$$(\mathbf{X}'\mathbf{X})^{-1} = \begin{bmatrix} 1.8628 & -.0000 & -.1806 & .0473 \\ & .0000 & -.0000 & -.0000 \\ & & .0260 & -.0078 \\ & & & .1911 \end{bmatrix}$$

$h_{\text{new, new}} = .01829$, no extrapolation

d.

	$DFFITS$	$DFBETAS$ b_0	b_1	b_2	b_3	D
Case 16:	$-.554$	$-.2477$	$-.0598$	.3248	$-.4521$	.0769
Case 22:	.055	.0304	$-.0253$	$-.0107$	.0446	.0008
Case 43:	.562	$-.3578$	.1338	.3262	.3566	.0792
Case 48:	$-.147$	.0450	$-.0938$	.0090	$-.1022$	.0055
Case 10:	.459	.3641	$-.1044$	$-.3142$	$-.0633$	.0494
Case 32:	$-.651$	.4095	.0913	$-.5708$	.1652	.0998
Case 38:	.386	$-.0996$	$-.0827$	.2084	$-.1270$	.0346
Case 40:	.397	.0738	$-.2121$	.0933	$-.1110$	.0365

e. Case 16: .161%, case 22: .015%, case 43: .164%, case 48: .042%, case 10: .167%, case 32: .227%, case 38: .152%, case 40: .157%.

10.11.a&f.

i:	1	2	...	45	46
t_i:	.0116	$-.9332$	...	$-.5671$	1.0449
D_i:	.000003	.015699	...	.006400	.024702

$t(.998913; 41) = 3.27$. If $|t_i| \leq 3.27$ conclude no outliers, otherwise outliers. Conclude no outliers.

b. $2p/n = 2(4)/46 = .1739$. Cases 9, 28, and 39.

c. $\mathbf{X}'_{\text{new}} = [\ 1 \quad 30 \quad 58 \quad 2.0\ ]$

$$(\mathbf{X}'\mathbf{X})^{-1} = \begin{bmatrix} 3.24771 & .00922 & -.06793 & -.06730 \\ & .00046 & -.00032 & -.00466 \\ & & .00239 & -.01771 \\ & & & .49826 \end{bmatrix}$$

$h_{\text{new, new}} = .3267$, extrapolation

d.

	$DFFITS$	$DFBETAS$ b_0	b_1	b_2	b_3	D
Case 11:	.5688	.0991	$-.3631$	$-.1900$	.3900	.0766
Case 17:	.6657	$-.4491$	$-.4711$	.4432	.0893	.1051
Case 27:	$-.6087$	$-.0172$	.4172	$-.2499$	.1614	.0867

e. Case 11: 1.10%, case 17: 1.32% , case 27: 1.12%.

10.16.b. $(VIF)_1 = 1.0086$, $(VIF)_2 = 1.0196$, $(VIF)_3 = 1.0144$.

10.17.b. $(VIF)_1 = 1.6323$, $(VIF)_2 = 2.0032$, $(VIF)_3 = 2.0091$

10.21.a. $(VIF)_1 = 1.305$, $(VIF)_2 = 1.300$, $(VIF)_3 = 1.024$

b&c.

i:	1	2	3	$\cdots$	32	33
e_i:	13.181	-4.042	3.060	$\cdots$	14.335	1.396
$e(Y \mid X_2, X_3)$:	26.368	-2.038	-31.111	$\cdots$	6.310	5.845
$e(X_1 \mid X_2, X_3)$:	$-.330$	$-.050$	.856	$\cdots$	.201	.111
$e(Y \mid X_1, X_3)$:	18.734	-17.470	8.212	$\cdots$	12.566	-8.099
$e(X_2 \mid X_1, X_3)$:	-7.537	18.226	-6.993	$\cdots$	2.401	12.888
$e(Y \mid X_1, X_2)$:	11.542	-7.756	15.022	$\cdots$	6.732	-15.100
$e(X_3 \mid X_1, X_2)$:	-2.111	-4.784	15.406	$\cdots$	-9.793	-21.247
Exp. value:	11.926	-4.812	1.886	$\cdots$	17.591	$-.940$

10.22.a. $\hat{Y}' = -2.0427 - .7120X'_1 + .7474X'_2 + .7574X'_3$, where $Y' = \log_e Y$, $X'_1 = \log_e X_1$, $X'_2 = \log_e(140 - X_2)$, $X'_3 = \log_e X_3$

b.

i:	1	2	3	$\cdots$	31	32	33
e_i:	$-.0036$	.0005	$-.0316$	$\cdots$	$-.1487$	.2863	.1208
Exp. value:	.0238	.0358	$-.0481$	$\cdots$	$-.1703$	.2601	.1164

c. $(VIF)_1 = 1.339$, $(VIF)_2 = 1.330$, $(VIF)_3 = 1.016$

d&e.

i:	1	2	3	$\cdots$	31	32	33
h_{ii}:	.101	.092	.176	$\cdots$	.058	.069	.149
t_i:	$-.024$	.003	$-.218$	$\cdots$	$-.975$	1.983	.829

$t(.9985; 28) = 3.25$. If $|t_i| \leq 3.25$ conclude no outliers, otherwise outliers. Conclude no outliers.

f.

		DFBETAS				
Case	*DFFITS*	b_0	b_1	b_2	b_3	D
28	.739	.530	$-.151$	$-.577$	$-.187$	.120
29	$-.719$	$-.197$	$-.310$	$-.133$	.420	.109

Chapter 11

BUILDING THE REGRESSION MODEL III: REMEDIAL MEASURES

11.7. a. $\hat{Y} = -5.750 + .1875X$

i:	1	2	3	4	5	6
e_i:	-3.75	5.75	-13.50	-16.25	-9.75	7.50

i:	7	8	9	10	11	12
e_i:	-10.50	26.75	14.25	-17.25	-1.75	18.50

b. $SSR^* = 123,753.125$, $SSE = 2,316.500$,

$X^2_{BP} = (123,753.125/2)/(2,316.500/12)^2 = 1.66$, $\chi^2(.90;1) = 2.71$. If $X^2_{BP} \leq$ 2.71 conclude error variance constant, otherwise error variance not constant. Conclude error variance constant.

d. $\hat{v} = -180.1 + 1.2437X$

i:	1	2	3	4	5	6
weight:	.01456	.00315	.00518	.00315	.01456	.00518

i:	7	8	9	10	11	12
weight:	.00518	.00315	.01456	.00315	.01456	.00518

e. $\hat{Y} = -6.2332 + .1891X$

f.

	Unweighted	Weighted
$s\{b_0\}$:	16.7305	13.1672
$s\{b_1\}$:	.0538	.0506

g. $\hat{Y} = -6.2335 + .1891X$

11.10. a. $\hat{Y} = 3.32429 + 3.76811X_1 + 5.07959X_2$

d. $c = .07$

e. $\hat{Y} = 6.06599 + 3.84335X_1 + 4.68044X_2$

11.11. a. $\hat{Y} = 1.88602 + 15.1094X$ (47 cases)

$\hat{Y} = -.58016 + 15.0352X$ (45 cases)

b.

i:	1	2	...	46	47
u_i:	-1.4123	-.2711	...	4.6045	10.3331

smallest weights: .13016 (case 47), .29217 (case 46)

c. $\hat{Y} = -.9235 + 15.13552X$

d. 2nd iteration: $\hat{Y} = -1.535 + 15.425X$

3rd iteration: $\hat{Y} = -1.678 + 15.444X$

smallest weights: .12629 (case 47), .27858 (case 46)

Chapter 12

AUTOCORRELATION IN TIME SERIES DATA

12.6. $H_0 : \rho = 0$, $H_a : \rho > 0$. $D = 2.4015$, $d_L = 1.29$, $d_U = 1.38$. If $D > 1.38$ conclude H_0, if $D < 1.29$ conclude H_a, otherwise the test is inconclusive. Conclude H_0.

12.9. a. $\hat{Y} = -7.7385 + 53.9533X$, $s\{b_0\} = 7.1746$, $s\{b_1\} = 3.5197$

t:	1	2	3	4	5	6	7	8
e_t:	$-.0737$	$-.0709$	.5240	.5835	.2612	$-.5714$	-1.9127	$-.8276$

t:	9	10	11	12	13	14	15	16
e_t:	$-.6714$	.9352	1.803	.4947	.9435	.3156	$-.6714$	-1.0611

c. $H_0 : \rho = 0$, $H_a : \rho > 0$. $D = .857$, $d_L = 1.10$, $d_U = 1.37$. If $D > 1.37$ conclude H_0, if $D < 1.10$ conclude H_a, otherwise the test is inconclusive. Conclude H_a.

12.10. a. $r = .5784$, $2(1 - .5784) = .8432$, $D = .857$

b. $b_0' = -.69434$, $b_1' = 50.93322$

$\hat{Y}' = -.69434 + 50.93322X'$

$s\{b_0'\} = 3.75590$, $s\{b_1'\} = 4.34890$

c. $H_0 : \rho = 0$, $H_a : \rho > 0$. $D = 1.476$, $d_L = 1.08$, $d_U = 1.36$. If $D > 1.36$ conclude H_0, if $D < 1.08$ conclude H_a, otherwise the test is inconclusive. Conclude H_0.

d. $\hat{Y} = -1.64692 + 50.93322X$

$s\{b_0\} = 8.90868$, $s\{b_1\} = 4.34890$

f. $F_{17} = -1.64692 + 50.93322(2.210) + .5784(-.6595) = 110.534$, $s\{\text{pred}\} = .9508$, $t(.975; 13) = 2.160$, $110.534 \pm 2.160(.9508)$, $108.48 \leq Y_{17(\text{new})} \leq 112.59$

g. $t(.975; 13) = 2.160$, $50.93322 \pm 2.160(4.349)$, $41.539 \leq \beta_1 \leq 60.327$.

12.11. a.

ρ:	.1	.2	.3	.4	.5
SSE:	11.5073	10.4819	9.6665	9.0616	8.6710

ρ:	.6	.7	.8	.9	1.0
SSE:	8.5032	8.5718	8.8932	9.4811	10.3408

$\rho = .6$

b. $\hat{Y}' = -.5574 + 50.8065X'$, $s\{b_0'\} = 3.5967$, $s\{b_1'\} = 4.3871$

c. $H_0 : \rho = 0$, $H_a : \rho > 0$. $D = 1.499$, $d_L = 1.08$, $d_U = 1.36$. If $D > 1.36$ conclude H_0, if $D < 1.08$ conclude H_a, otherwise test is inconclusive. Conclude H_0.

d. $\hat{Y} = -1.3935 + 50.8065X$, $s\{b_0\} = 8.9918$, $s\{b_1\} = 4.3871$

f. $F_{17} = -1.3935 + 50.8065(2.210) + .6(-.6405) = 110.505$, $s\{\text{pred}\} = .9467$, $t(.975; 13) = 2.160$, $110.505 \pm 2.160(.9467)$, $108.46 \leq Y_{17(\text{new})} \leq 112.55$

12.12. a. $b_1 = 49.80564$, $s\{b_1\} = 4.77891$

b. $H_0 : \rho = 0$, $H_a : \rho \neq 0$. $D = 1.75$ (based on regression with intercept term), $d_L = 1.08$, $d_U = 1.36$. If $D > 1.36$ and $4 - D > 1.36$ conclude H_0, if $D < 1.08$ or $4 - D < 1.08$ conclude H_a, otherwise the test is inconclusive. Conclude H_0.

c. $\hat{Y} = .71172 + 49.80564X$, $s\{b_1\} = 4.77891$

e. $F_{17} = .71172 + 49.80564(2.210) - .5938 = 110.188$, $s\{\text{pred}\} = .9078$, $t(.975; 14) = 2.145$, $110.188 \pm 2.145(.9078)$, $108.24 \leq Y_{17(\text{new})} \leq 112.14$

f. $t(.975; 14) = 2.145$, $49.80564 \pm 2.145(4.77891)$, $39.555 \leq \beta_1 \leq 60.056$

Chapter 13

INTRODUCTION TO NONLINEAR REGRESSION AND NEURAL NETWORKS

13.1. a. Intrinsically linear

$\log_e f(\mathbf{X}, \boldsymbol{\gamma}) = \gamma_0 + \gamma_1 X$

b. Nonlinear

c. Nonlinear

13.3. b. 300, 3.7323

13.5. a. $b_0 = -.5072512$, $b_1 = -0.0006934571$, $g_0^{(0)} = 0$, $g_1^{(0)} = .0006934571$, $g_2^{(0)} = .6021485$

b. $g_0 = .04823$, $g_1 = .00112$, $g_2 = .71341$

13.6. a. $\hat{Y} = .04823 + .71341\exp(-.00112X)$

City A

i:	1	2	3	4	5
$\hat{Y}_i$:	.61877	.50451	.34006	.23488	.16760
e_i:	.03123	$-.04451$	$-.00006$	.02512	.00240
Exp. value:	.04125	$-.04125$	$-.00180$	.02304	.00180

i:	6	7	8
$\hat{Y}_i$:	.12458	.07320	.05640
e_i:	.02542	$-.01320$	$-.01640$
Exp. value:	.02989	$-.01777$	$-.02304$

City B

i:	9	10	11	12	13
$\hat{Y}_i$:	.61877	.50451	.34006	.23488	.16760
e_i:	.01123	$-.00451$	$-.04006$	.00512	.02240
Exp. value:	.01327	$-.00545$	$-.02989$	.00545	.01777

i:	14	15	16
$\hat{Y}_i$:	.12458	.07320	.05640
e_i:	$-.00458$	.00680	$-.00640$
Exp. value:	$-.00923$	.00923	$-.01327$

13.7. $H_0 : E\{Y\} = \gamma_0 + \gamma_2 \exp(-\gamma_1 X)$, $H_a : E\{Y\} \neq \gamma_0 + \gamma_2 \exp(-\gamma_1 X)$.

$SSPE = .00290$, $SSE = .00707$, $MSPE = .00290/8 = .0003625$,

$MSLF = (.00707 - .00290)/5 = .000834$, $F^* = .000834/.0003625 = 2.30069$, $F(.99; 5, 8) = 6.6318$. If $F^* \leq 6.6318$ conclude H_0, otherwise H_a. Conclude H_0.

13.8. $s\{g_0\} = .01456$, $s\{g_1\} = .000092$, $s\{g_2\} = .02277$, $z(.9833) = 2.128$

$.04823 \pm 2.128(.01456)$	$.01725 \leq \gamma_0 \leq .07921$
$.00112 \pm 2.128(.000092)$	$.00092 \leq \gamma_1 \leq .00132$
$.71341 \pm 2.128(.02277)$	$.66496 \leq \gamma_2 \leq .76186$

13.9. a. $g_0 = .04948$, $g_1 = .00112$, $g_2 = .71341$, $g_3 = -.00250$

b. $z(.975) = 1.96$, $s\{g_3\} = .01211$, $-.00250 \pm 1.96(.01211)$, $-.02624 \leq \gamma_3 \leq .02124$, yes, no.

13.13. $g_0 = 100.3401$, $g_1 = 6.4802$, $g_2 = 4.8155$

13.14. a. $\hat{Y} = 100.3401 - 100.3401/[1 + (X/4.8155)^{6.4802}]$

b.

i:	1	2	3	4	5	6	7
$\hat{Y}_i$:	.0038	.3366	4.4654	11.2653	11.2653	23.1829	23.1829
e_i:	.4962	1.9634	-1.0654	.2347	$-.3653$	.8171	2.1171
Expected Val.:	.3928	1.6354	-1.0519	$-.1947$	$-.5981$	.8155	2.0516

i:	8	9	10	11	12	13	14
$\hat{Y}_i$:	39.3272	39.3272	56.2506	56.2506	70.5308	70.5308	80.8876
e_i:	.2728	-1.4272	-1.5506	.5494	.2692	-2.1308	1.2124
Expected Val.:	.1947	-1.3183	-1.6354	.5981	.0000	-2.0516	1.0519

i:	15	16	17	18	19
$\hat{Y}_i$:	80.8876	87.7742	92.1765	96.7340	98.6263
e_i:	$-.2876$	1.4258	2.6235	$-.5340$	-2.2263
Expected Val.:	$-.3928$	1.3183	2.7520	$-.8155$	-2.7520

13.15. $H_0 : E\{Y\} = \gamma_0 - \gamma_0/[1 + (X/\gamma_2)^{\gamma_1}]$, $H_a : E\{Y\} \neq \gamma_0 - \gamma_0/[1 + (X/\gamma_2)^{\gamma_1}]$.

$SSPE = 8.67999$, $SSE = 35.71488$, $MSPE = 8.67999/6 = 1.4467$, $MSLF = (35.71488 - 8.67999)/10 = 2.7035$, $F^* = 2.7035/1.4467 = 1.869$,$F(.99; 10, 6) = 7.87$. If $F^* \leq 7.87$ conclude H_0, otherwise H_a. Conclude H_0.

13.16. $s\{g_0\} = 1.1741$, $s\{g_1\} = .1943$, $s\{g_2\} = .02802$, $z(.985) = 2.17$

$100.3401 \pm 2.17(1.1741)$	$97.7923 \leq \gamma_0 \leq 102.8879$

$$6.4802 \pm 2.17(.1943) \qquad 6.0586 \le \gamma_1 \le 6.9018$$

$$4.8155 \pm 2.17(.02802) \qquad 4.7547 \le \gamma_2 \le 4.8763$$

Chapter 14

LOGISTIC REGRESSION, POISSON REGRESSION,AND GENERALIZED LINEAR MODELS

14.5. a. $E\{Y\} = [1 + \exp(-20 + .2X)]^{-1}$

b. 100

c. $X = 125: \quad \pi = .006692851,\ \pi/(1-\pi) = .006737947$

$X = 126: \quad \pi = .005486299,\ \pi/(1-\pi) = .005516565$

$005516565/.006737947 = .81873 = \exp(-.2)$

14.7. a. $b_0 = -4.80751$, $b_1 = .12508$, $\hat{\pi} = [1 + \exp(4.80751 - .12508X)]^{-1}$

c. 1.133

d. .5487

e. 47.22

14.11.a.

j:	1	2	3	4	5	6
p_j:	.144	.206	.340	.592	.812	.898

b. $b_0 = -2.07656$, $b_1 = .13585$

$\hat{\pi} = [1 + \exp(2.07656 - .13585X)]^{-1}$

d. 1.1455

e. .4903

f. 23.3726

14.14.a. $b_0 = -1.17717$, $b_1 = .07279$, $b_2 = -.09899$, $b_3 = .43397$

$\hat{\pi} = [1 + \exp(1.17717 - .07279X_1 + .09899X_2 - .43397X_3)]^{-1}$

b. $\exp(b_1) = 1.0755$, $\exp(b_2) = .9058$, $\exp(b_3) = 1.5434$

c. .0642

14.15.a. $z(.95) = 1.645$, $s\{b_1\} = .06676$, $\exp[.12508 \pm 1.645(.06676)]$,

$1.015 \leq \exp(\beta_1) \leq 1.265$

b. $H_0: \beta_1 = 0$, $H_a: \beta_1 \neq 0$. $b_1 = .12508$, $s\{b_1\} = .06676$, $z^* = .12508/.06676 = 1.8736$. $z(.95) = 1.645$, $|z^*| \leq 1.645$, conclude H_0, otherwise conclude H_a. Conclude H_a. P-value=.0609.

c. $H_0: \beta_1 = 0$, $H_a: \beta_1 \neq 0$. $G^2 = 3.99$, $\chi^2(.90; 1) = 2.7055$. If $G^2 \leq 2.7055$, conclude H_0, otherwise conclude H_a. Conclude H_a. P-value=.046

14.17.a. $z(.975) = 1.960$, $s\{b_1\} = .004772$, $.13585 \pm 1.960(.004772)$,

$$.1265 \leq \beta_1 \leq .1452, \qquad 1.1348 \leq \exp(\beta_1) \leq 1.1563.$$

b. $H_0: \beta_1 = 0$, $H_a: \beta_1 \neq 0$. $b_1 = .13585$, $s\{b_1\} = .004772$, $z^* = .13585/.004772 = 28.468$. $z(.975) = 1.960$, $|z^*| \leq 1.960$, conclude H_0, otherwise conclude H_a. Conclude H_a. P-value= 0+.

c. $H_0: \beta_1 = 0$, $H_a: \beta_1 \neq 0$. $G^2 = 1095.99$, $\chi^2(.95; 1) = 3.8415$. If $G^2 \leq 3.8415$, conclude H_0, otherwise conclude H_a. Conclude H_a. P-value= 0+.

14.20.a. $z(1-.1/[2(2)]) = z(.975) = 1.960$, $s\{b_1\} = .03036$, $s\{b_2\} = .03343$, $\exp\{30[.07279 \pm 1.960(.03036)]\}$, $1.49 \leq \exp(30\beta_1) \leq 52.92$, $\exp\{25[-.09899 \pm 1.960(.03343)]\}$, $.016 \leq \exp(2\beta_2) \leq .433$.

b. $H_0: \beta_3 = 0$, $H_a: \beta_3 \neq 0$. $b_3 = .43397$, $s\{b_3\} = .52132$, $z^* = .43397/.52132 = .8324$. $z(.975) = 1.96$, $|z^*| \leq 1.96$, conclude H_0, otherwise conclude H_a. Conclude H_0. P-value= .405.

c. $H_0: \beta_3 = 0$, $H_a: \beta_3 \neq 0$. $G^2 = .702$, $\chi^2(.95; 1) = 3.8415$. If $G^2 \leq 3.8415$, conclude H_0, otherwise conclude H_a. Conclude H_0.

d. $H_0: \beta_3 = \beta_4 = \beta_5 = 0$, H_a: not all $\beta_k = 0$, for $k = 3, 4, 5$. $G^2 = 1.534$, $\chi^2(.95; 3) = 7.81$. If $G^2 \leq 7.81$, conclude H_0, otherwise conclude H_a. Conclude H_0.

14.22.a. X_1 enters in step 1; X_2 enters in step 2;

no variables satisfy criterion for entry in step 3.

b. X_{11} is deleted in step 1; X_{12} is deleted in step 2; X_3 is deleted in step 3; X_{22} is deleted in step 4; X_1 and X_2 are retained in the model.

c. The best model according to the AIC_p criterion is based on X_1 and X_2. $AIC_3 = 111.795$.

d. The best model according to the SBC_p criterion is based on X_1 and X_2. $SBC_3 = 121.002$.

14.23.

j:	1	2	3	4	5	6
O_{j1}:	72	103	170	296	406	449
E_{j1}:	71.0	99.5	164.1	327.2	394.2	440.0
O_{j0}:	428	397	330	204	94	51
E_{j0}:	429.0	400.5	335.9	172.9	105.8	60.0

$H_0: E\{Y\} = [1 + \exp(-\beta_0 - \beta_1 X)]^{-1}$,

$H_a: E\{Y\} \neq [1 + \exp(-\beta_0 - \beta_1 X)]^{-1}$.

$X^2 = 12.284$, $\chi^2(.99; 4) = 13.28$. If $X^2 \leq 13.28$ conclude H_0, otherwise H_a. Conclude H_0.

14.25 a.

Class j	$\hat{\pi}'$ Interval	Midpoint	n_j	p_j
1	-1.1 - under $-.4$	$-.75$	10	.3
2	$-.4$ - under .6	.10	10	.6
3	.6 - under 1.5	1.05	10	.7

b.

i:	1	2	3	$\cdots$	28	29	30
r_{SP_i}:	$-.6233$	1.7905	$-.6233$	$\cdots$	.6099	.5754	-2.0347

14.28 a.

j:	1	2	3	4	5	6	7	8
O_{j1}:	0	1	0	2	1	8	2	10
E_{j1}:	.2	.5	1.0	1.5	2.4	3.4	4.7	10.3
O_{j0}:	19	19	20	18	19	12	18	10
E_{j0}:	18.8	19.5	19.0	18.5	17.6	16.6	15.3	9.7

b. $H_0: E\{Y\} = [1 + \exp(-\beta_0 - \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3)]^{-1}$,

$H_a: E\{Y\} \neq [1 + \exp(-\beta_0 - \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3)]^{-1}$.

$X^2 = 12.116$, $\chi^2(.95; 6) = 12.59$. If $X^2 \leq 12.59$, conclude H_0, otherwise conclude H_a. Conclude H_0. P-value = .0594.

c.

i:	1	2	3	$\cdots$	157	158	159
dev_i:	$-.5460$	$-.5137$	1.1526	$\cdots$	.4248	.8679	1.6745

14.29 a.

i:	1	2	3	$\cdots$	28	29	30
h_{ii}:	.1040	.1040	.1040	$\cdots$	.0946	.1017	.1017

b.

i:	1	2	3	$\cdots$	28	29	30
ΔX_i^2:	.3885	3.2058	.3885	$\cdots$	4.1399	.2621	.2621
Δdev_i:	.6379	3.0411	.6379	$\cdots$	3.5071	.4495	.4495
D_i:	.0225	.1860	.0225	$\cdots$	.2162	.0148	.0148

14.32 a.

i:	1	2	3	$\cdots$	157	158	159
h_{ii}:	.0197	.0186	.0992	$\cdots$	.0760	.1364	.0273

b.

i:	1	2	3	$\cdots$	157	158	159
ΔX_i^2:	.1340	.1775	1.4352	$\cdots$	.0795	.6324	2.7200
Δdev_i:	.2495	.3245	1.8020	$\cdots$	.1478	.9578	2.6614
D_i:	.0007	.0008	.0395	$\cdots$	.0016	.0250	.0191

14.33 a. $z(.95) = 1.645$, $\hat{\pi}'_h = .19561$, $s^2\{b_0\} = 7.05306$, $s^2\{b_1\} = .004457$, $s\{b_0, b_1\} = -.175353$, $s\{\hat{\pi}'_h\} = .39428$, $.389 \leq \pi_h \leq .699$

b.

Cutoff	Renewers	Nonrenewers	Total
.40	18.8	50.0	33.3
.45	25.0	50.0	36.7
.50	25.0	35.7	30.0
.55	43.8	28.6	36.7
.60	43.8	21.4	33.3

c. Cutoff = .50. Area = .70089.

14.36 a. $\hat{\pi}'_h = -1.3953$, $s^2\{\hat{\pi}'_h\} = .1613$, $s\{\hat{\pi}'_h\} = .4016$, $z(.95) = 1.645$. $L = -1.3953 - 1.645(.4016) = -2.05597$, $U = -1.3953 + 1.645(.4016) = -.73463$.
$L^* = [1 + \exp(2.05597)]^{-1} = .11345$, $U^* = [1 + \exp(.73463)]^{-1} = .32418$.

b.

Cutoff	Received	Not receive	Total
.05	4.35	62.20	66.55
.10	13.04	39.37	52.41
.15	17.39	26.77	44.16
.20	39.13	15.75	54.88

c. Cutoff = .15. Area = .82222.

14.38 a. $b_0 = 2.3529$, $b_1 = .2638$, $s\{b_0\} = .1317$, $s\{b_1\} = .0792$, $\hat{\mu} = \exp(2.3529 + .2638X)$.

b.

i:	1	2	3	$\cdots$	8	9	10
dev_i:	.6074	$-.4796$	$-.1971$	$\cdots$	.3482	.2752	.1480

c.

X_h:	0	1	2	3
Poisson:	10.5	13.7	17.8	23.2
Linear:	10.2	14.2	18.2	22.2

e. $\hat{\mu}_h = \exp(2.3529) = 10.516$

$$P(Y \leq 10 \mid X_h = 0) = \sum_{Y=0}^{10} \frac{(10.516)^Y \exp(-10.516)}{Y!}$$
$$= 2.7 \times 10^{-5} + \cdots + .1235 = .5187$$

f. $z(.975) = 1.96$, $.2638 \pm 1.96(.0792)$, $.1086 \leq \beta_1 \leq .4190$