PRINCIPLES OF ECONOMETRICS

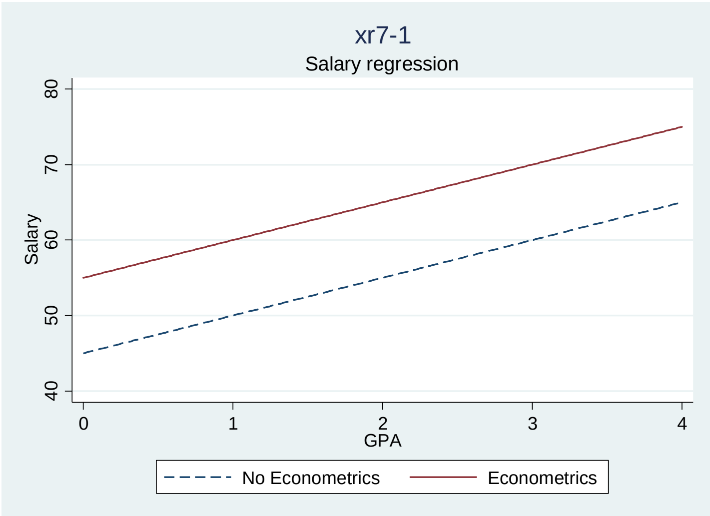
5TH EDITION

ANSWERS TO ODD-NUMBERED EXERCISES IN CHAPTER 7

EXERCISE 7.1

(a) This model should be considered predictive as the assumption of strict exogeneity is not likely to hold. The random error includes ability, perseverance, and industriousness, all of which directly contribute to a worker's success, and hence salary. These factors will also lead to students having higher grades and taking difficult courses like econometrics. The OLS coefficient estimators for *GPA* and *METRICS* will be biased upwards.

(b)



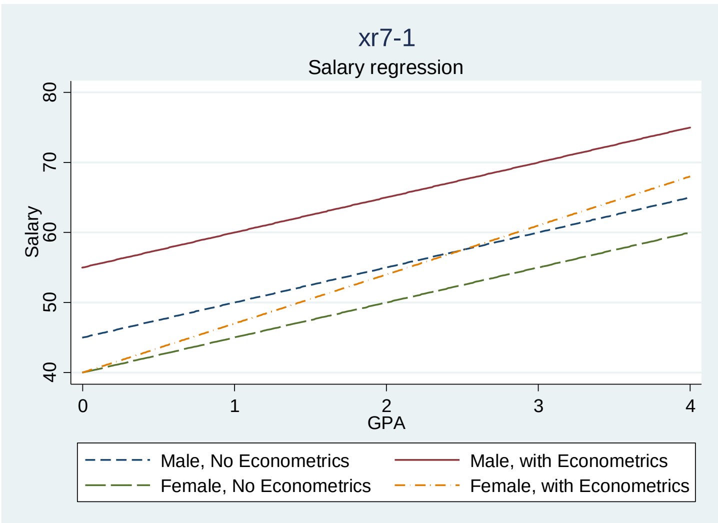
(c)

$$E(SAL \mid GPA, METRICS = 0, FEMALE = 0) = \beta_1 + \beta_2 GPA$$
$$E(SAL \mid GPA, METRICS = 1, FEMALE = 1) = (\beta_1 + \beta_3 + \delta_1) + \beta_2 GPA$$

(d)

$$E(SAL \mid GPA, METRICS = 0, FEMALE = 0) = \beta_1 + \beta_2 GPA$$
$$E(SAL \mid GPA, METRICS = 1, FEMALE = 1) = (\beta_1 + \beta_3 + \delta_1) + (\beta_2 + \delta_2) GPA$$

(e)



(f) $H_0: \beta_3 = 0, \delta_2 = 0$ and $H_1: \beta_3 \neq 0$ or $\delta_2 \neq 0$. The *F*-test statistic has the $F_{(2,295)}$-distribution. The 95th percentile, using Statistical Table 4, is 3.00. We reject the null hypothesis if the calculated *F* is greater than 3.00, and conclude that either econometrics helps predict starting salary or the interaction between female and econometrics helps, or both help. To compute the *F*-value using the restricted and unrestricted sums of squared errors, we need to estimate the model

$$SAL = \beta_1 + \beta_2 GPA + \delta_1 FEMALE + e$$

EXERCISE 7.3

(a)

$$E\left(PRICE \mid AGE = 10, SQFT = 20\right) = \begin{cases} \beta_1 + 20\beta_2 + 10\beta_3 & \text{if year} = 1991 \\ \left(\beta_1 + \delta_1\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1992 \\ \left(\beta_1 + \delta_2\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1993 \\ \left(\beta_1 + \delta_3\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1994 \\ \left(\beta_1 + \delta_4\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1995 \\ \left(\beta_1 + \delta_5\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1996 \end{cases}$$

(b)

$$E\left(PRICE \mid AGE = 10, SQFT = 20\right) = \begin{cases} \beta_1 + 20\beta_2 + 10\beta_3 & \text{if year} = 1991 \\ \left(\beta_1 + \tau\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1992 \\ \left(\beta_1 + 2\tau\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1993 \\ \left(\beta_1 + 3\tau\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1994 \\ \left(\beta_1 + 4\tau\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1995 \\ \left(\beta_1 + 5\tau\right) + 20\beta_2 + 10\beta_3 & \text{if year} = 1996 \end{cases}$$

(c) Model (xr7.3.1) has 8 parameters and model (xr7.3.2) has 4 parameters, meaning that there are 4 constraints on the first model to obtain the second. Examining the coefficients of the two models we see $\delta_1 = \tau, \delta_2 - \delta_1 = \tau, \delta_3 - \delta_2 = \tau, \delta_4 - \delta_3 = \tau, \delta_5 - \delta_4 = \tau$. Substituting δ_1 for τ, the null and alternative hypotheses are

$$H_0: \delta_2 = 2\delta_1, \delta_3 = 3\delta_1, \delta_4 = 4\delta_1, \delta_5 = 5\delta_1$$

$$H_1: \delta_2 \neq 2\delta_1, \text{ or } \delta_3 \neq 3\delta_1, \text{ or } \delta_4 \neq 4\delta_1, \text{ or } \delta_5 \neq 5\delta_1$$

The *F*-statistic has an *F*-distribution with 4 numerator and 4674 denominator degrees of freedom if the null hypothesis is true. The 95th percentile of this distribution is 2.37. We will reject the null hypothesis if the calculated *F*-statistic is greater than this value. The calculated value is

$$F = \frac{\left(SSE_R - SSE_U\right)/J}{SSE_U/\left(N-K\right)} = \frac{\left(2387476 - 2385745\right)/4}{2385745/\left(4682-8\right)} = 0.848$$

Since this value is less than the critical value we fail to reject the null hypothesis that there is a linear trend in house prices for the years 1991 to 1996 in Stockton, CA.

(d) $H_0: \delta_3 = 3\delta_1 \Rightarrow \delta_3 - 3\delta_1 = 0$, $H_1: \delta_3 \neq 3\delta_1 \Rightarrow \delta_3 - 3\delta_1 \neq 0$. The test statistic is $t = \left(\hat{\delta}_3 - 3\hat{\delta}_1\right) \big/ \text{se}\left(\hat{\delta}_3 - 3\hat{\delta}_1\right)$. The *t*-statistic has a *t*-distribution with 4674 degrees of freedom if the null hypothesis is true. The 97.5 percentile of this *t* distribution is 1.96, thus we will reject the null hypothesis if $t \geq 1.96$ or $t \leq -1.96$. The denominator of the *t*-statistic is calculated using

$$\widehat{\text{var}}\left(\hat{\delta}_3 - 3\hat{\delta}_1\right) = 1.211^2 + 9\left(1.271^2\right) - 6\left(0.87825\right) = 10.7360$$

Then the calculated value of the test statistic is $t = 0.0015$. We fail to reject the null hypothesis at the 5% level of significance.

(e) From (XR7.3.2),

$$\begin{aligned} & E\left(PRICE \mid AGE = 10, SQFT = 20, YEAR = 1994\right) \\ & \quad - E\left(PRICE \mid AGE = 10, SQFT = 20, YEAR = 1992\right) \\ & \qquad = \left(\beta_1 + 3\tau\right) + 20\beta_2 + 10\beta_3 - \left[\left(\beta_1 + \tau\right) + 20\beta_2 + 10\beta_3\right] = 2\tau \end{aligned}$$

The estimated difference is $2\hat{\tau} = 2\left(-4.12\right) = -8.24$. From (xr7.3.1) the difference is $\left(\hat{\delta}_3 - \hat{\delta}_1\right) = -13.174 - \left(-4.393\right) = -8.781$. They are very similar estimates.

EXERCISE 7.5

(a) The model specification is

$$MATHSCORE_i = \beta_1 + \beta_2 SMALL_i + \beta_3 TCHEXPER_i + e_i$$

Then, $E\left(MATHSCORE_i \mid SMALL = 0, TCHEXPER = 10\right) = \beta_1 + \beta_3\left(10\right)$

And. $E\left(MATHSCORE_i \mid SMALL = 1, TCHEXPER = 10\right) = \beta_1 + \beta_2 + \beta_3\left(10\right)$

(b) The model becomes

$$MATHSCORE_i = \beta_1 + \beta_2 SMALL_i + \beta_3 TCHEXPER_i + \theta_1 BOY_i + \theta_2\left(BOY_i \times SMALL_i\right) + e_i$$

(i)

$$E\left(MATHSCORE_i \mid SMALL = 1, BOY = 1, TCHEXPER = 10\right) = \beta_1 + \beta_2 + \beta_3\left(10\right) + \theta_1 + \theta_2$$

(ii)

$$E\left(MATHSCORE_i \mid SMALL = 0, BOY = 0, TCHEXPER = 10\right) = \beta_1 + \beta_3\left(10\right)$$

(iii) For the sex of the child to have no effect on the expected math score the null hypothesis is $H_0: \theta_1 = 0, \theta_2 = 0$. The alternative hypothesis is $H_1: \theta_1 \neq 0, \text{or } \theta_2 \neq 0$. The test statistic is

$$F = \frac{\left(SSE_R - SSE_U\right)/2}{SSE_U/1195}$$

where SSE_R comes from the model,

$$MATHSCORE_i = \beta_1 + \beta_2 SMALL_i + \beta_3 TCHEXPER_i + e_i$$

and SSE_U comes from the full model,

$$MATHSCORE_i = \beta_1 + \beta_2 SMALL_i + \beta_3 TCHEXPER_i + \theta_1 BOY_i + \theta_2 \left(BOY_i \times SMALL_i\right) + e_i$$

If the null hypothesis is true, then $F \sim F_{(2,1195)}$. The rejection region is values of F greater than or equal to $F_{(0.95,2,1195)} = 3.00$.

(iv) Using the model

$$MATHSCORE_i = \beta_1 + \beta_2 SMALL_i + \beta_3 TCHEXPER_i + \theta_1 BOY_i + \theta_2 \left(BOY_i \times SMALL_i\right) + e_i$$

The expected math score for a boy in a small class is

$$E\left(MATHSCORE_i \mid SMALL = 1, BOY = 1\right) = \beta_1 + \beta_2 + \beta_3 TCHEXPER_i + \theta_1 + \theta_2$$

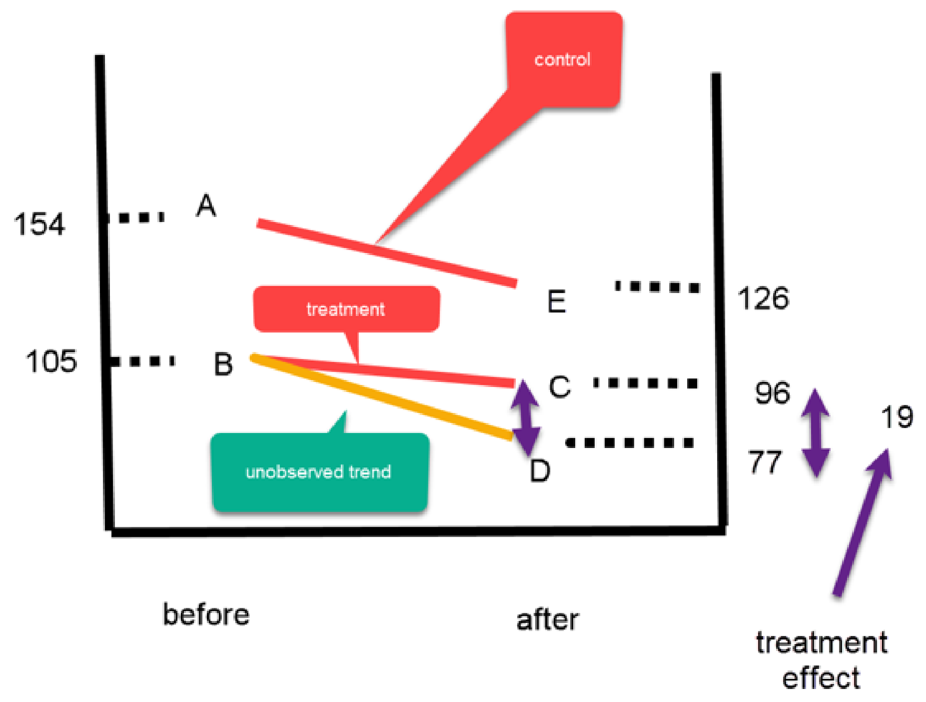
The expected math score for a girl in a small class is

$$E\left(MATHSCORE_i \mid SMALL = 1, BOY = 0\right) = \beta_1 + \beta_2 + \beta_3 TCHEXPER_i$$

If boys may benefit more than girls, we would test the null hypothesis $H_0: \theta_1 + \theta_2 \le 0$ against $H_1: \theta_1 + \theta_2 > 0$. This would be carried out using a one-tail, right tail, *t*-test. The null hypothesis would be rejected at the 5% level if the calculated *t* was greater than or equal to 1.645.

EXERCISE 7.7

(a)



(b) The sixth district (treatment) lost 9 banks, and the eighth district (control) lost 28 banks. The treatment effect is the difference (C – E) – (B – A) = (96 – 126) – (105 – 154) = 19.

(c) The estimated treatment effect is 20.5 banks using the regression. The *t*-value is 20.5/10.7 = 1.916. The 5% *t*-critical value from the $t_{(8)}$ distribution for a two-tail test is 2.306; so the estimated treatment effect is not statistically significant. However, if we formulate a one-tail test, with the alternative being that the coefficient is positive, the critical value is 1.86, so that we would conclude that the treatment had a statistically significant and positive effect on preventing bank failures.

EXERCISE 7.9

(a) *KIDS* is a quantitative variable. The coefficient δ tells us the change in the expected household alcohol expenditures for each additional child, holding income and all else constant. When the number of children increases from one to two, the change in expected alcohol expenditures is δ dollars per month. When the number of children increases from three to four, the change in expected alcohol expenditures is δ dollars per month.

(b) In this model we separate the effect of the first and second children. Once the household has three or more children, we cannot distinguish their impacts. When the number of children increases from one to two, the change in expected alcohol expenditures is δ_1 dollars per month, other factors held fixed. When the number of children increases from three to four, there is no change in expected alcohol expenditures per month, other factors held fixed.

(c) No. The constraint $\delta_1 = \delta_2 = \delta$ would mean that the effect of the first and second children on expected alcohol consumption is the same, which is the implication of (XR7.9.1). However, in the latter model we cannot separate out the difference in the expected expenditures for a third, fourth or fifth child.

EXERCISE 7.11

(a) If $E(y \mid x, D) = \exp\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)\exp\left(\sigma^2/2\right)$, then

$$\frac{\partial E(y \mid x, D)}{\partial x} = \left[\exp\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)\exp\left(\sigma^2/2\right)\right] \times \left\{\frac{\partial\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)}{\partial x}\right\}$$

$$= \exp\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)\exp\left(\sigma^2/2\right)\left(\beta_2 + \delta_2 D\right)$$

(b) Dividing both sides by $E(y \mid x, D)$, we have

$$\frac{\partial E(y \mid x, D)}{\partial x}\frac{1}{E(y \mid x, D)} = \exp\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)\exp\left(\sigma^2/2\right)\left(\beta_2 + \delta_2 D\right)\frac{1}{E(y \mid x, D)}$$

$$= \frac{\exp\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)\exp\left(\sigma^2/2\right)\left(\beta_2 + \delta_2 D\right)}{\exp\left(\beta_1 + \beta_2 x + \delta_1 D + \delta_2 (x \times D)\right)\exp\left(\sigma^2/2\right)}$$

$$= \left(\beta_2 + \delta_2 D\right)$$

(c) Multiplying by 100 gives

$$100\frac{\partial E\left(y\,|\,x,D\right)}{\partial x}\frac{1}{E\left(y\,|\,x,D\right)}=100\frac{\partial E\left(y\,|\,x,D\right)/E\left(y\,|\,x,D\right)}{\partial x}=100\left(\beta_2+\delta_2 D\right)$$

(d) For *UNTOWN* = 1,

$$\%\Delta\hat{E}\left(PRICE\,|\,SQFT, UTOWN=1\right)=100\left(0.362-0.00349\right)=35.851\%$$

For *UNTOWN* = 0,

$$\%\Delta\hat{E}\left(PRICE\,|\,SQFT, UTOWN=0\right)=100\left(0.362\right)=36.2\%.$$

(e) The standard error is

$$\text{se}\left[100\left(b_2+d_2D\right)\right]=100\sqrt{\widehat{\text{var}}\left(b_2\right)+D^2\,\widehat{\text{var}}\left(d_2\right)+2D\widehat{\text{cov}}\left(b_2,d_2\right)}$$

We should also recognize that $D^2=D$ because it is an indicator variable. This makes no difference to the computer.

(f) Obvious.

(g) The estimated elasticity is $\left(0.362-0.00349UTOWN\right)25$. When *UTOWN* = 1, this is 8.963. When *UTOWN* = 0, this is $\left(0.362\right)25=9.05$

(h) The standard error is

$$\text{se}\left[\left(b_2+d_2D\right)x\right]=x\sqrt{\widehat{\text{var}}\left(b_2\right)+D^2\,\widehat{\text{var}}\left(d_2\right)+2D\widehat{\text{cov}}\left(b_2,d_2\right)}$$

EXERCISE 7.13

(a) The table below displays the sample means of *LNPRICE* and *LNUNITS*, as well as the percentage differences using only the data for 2000.

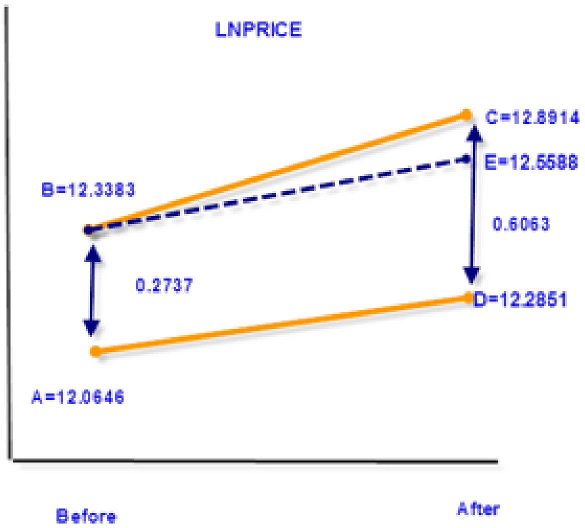
	$IZLAW=1$	$IZLAW=0$	Pct. Diff.
$\overline{LNPRICE}$	12.8914	12.2851	60.63
$\overline{LNUNITS}$	9.9950	9.5449	45.01

The approximate percentage differences in the price and units for cities with and without the law are 60.63% and 45.01% respectively. Since the average price is higher under the law, it suggests that the law failed to achieve its objective of making housing more affordable. There are, however, more units available in cities with the law.

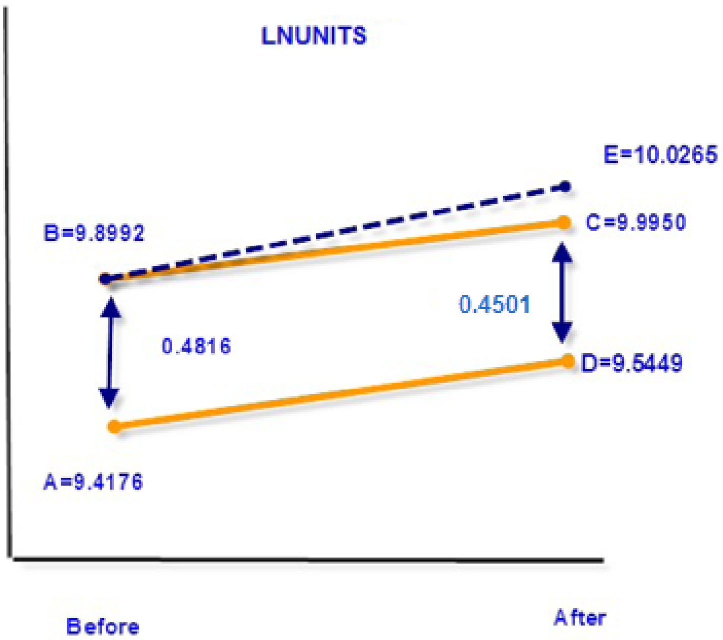
(b) The sample means of *LNPRICE* and *LNUNITS* for the year 1990 are

	$IZLAW=1$	$IZLAW=0$
$\overline{LNPRICE}$	12.3383	12.0646
$\overline{LNUNITS}$	9.8992	9.4176

For *LNPRICE* the line segment AD represents what happens in cities without the law. The line segment BC represents what happened in cities with the law. The line segment BE represents what would have happened to *LNPRICE* in the absence of the law, assuming that the common trend assumption is valid. We see that in the absence of the law, we estimate that the average price of units would have been smaller. We conclude that the policy failed.



(c) For *LNUNITS* the diagram follows. The line segment AD represents what happens in cities without the law. The line segment BC represents what happened in cities with the law. The line segment BE represents what would have happened to *LNUNITS* in the absence of the law, assuming that the common trend assumption is valid. We see that in the absence of the law, we estimate that the number of units would have actually been larger. We conclude that the policy failed.



EXERCISE 7.15

(a) The estimated coefficients are all positive, suggesting that each of the characteristics increase the probability of a missed payment. An increase in the rate of interest by 1 point increases the expected probability of a missed payment by 0.0452; an increase in the loan amount by \$100,000 increases the expected probability of a missed payment by 0.0732; and having an adjustable rate mortgage increases the expected probability of a missed payment by 0.0834. Each statement is conditional on other factors being held constant. The calculated *t*-values for *RATE*, *AMOUNT* and *ARM* are 5.37, 5.08 and 2.56 respectively. For a two-tail test at the 5% level the critical value is 1.96, and at 1% is 2.58. Thus, *RATE* and *AMOUNT* coefficients are significant at 1% and the *ARM* coefficient at 5%.

(b) The estimated probabilities are for these two borrowers are:

$$\widehat{MISSED} = -0.348 + 0.0452(8.2) + 0.0732(1.912) + 0.0834 = 0.246$$

$$\widehat{MISSED} = -0.348 + 0.0452(9.1) + 0.0732(8.6665) + 0.0834 = 0.781$$

We predict a low probability of default for the first borrower and a much higher probability of default for the second.

(c) The estimated probabilities are

$$\widehat{MISSED} = -0.348 + 0.0452(12) + 0.0732(0.71) = 0.246$$

$$\widehat{MISSED} = -0.348 + 0.0452(6.45) + 0.0732(8.5) + 0.0834 = 0.649$$

We predict a low probability of default for the first borrower and a much higher probability of default for the second.

(d)

$$AMOUNT = \frac{0.51 + 0.348 - 0.0452(6) - 0.0834}{0.0732} = 6.877$$

EXERCISE 7.17

(a) The sample size, mean and standard deviation for each group is

variable		N	mean	Std. Dev.	Std. Error
BWEIGHT	*MBSMOKE*=1	232	3136.957	586.7058	38.51912
BWEIGHT	*MBSMOKE*=0	968	3425.142	586.7901	18.86015

The test statistic, assuming equal variances, is

$$t = \frac{\left(\overline{Y}_1 - \overline{Y}_0\right)}{\sqrt{\hat{\sigma}_p^2\left(\dfrac{1}{N_1} + \dfrac{1}{N_0}\right)}} \sim t_{(232+968-2=1198)}$$

With the distribution holding if the null hypothesis is true. The pooled variance is

$$\hat{\sigma}_p^2 = (586.77385)^2$$

The value of the test statistic is $t = -6.7188$.

For the 5% level of significance of a two-tail test, the critical value is 1.96. We reject the hypothesis that the birthweights of smoking and nonsmoking mothers are the same.

(b) The regression is in the first column of Table XR7.17. It is not wise to consider this regression a basis for estimating an average treatment effect. It would be a consistent estimator only if women were randomly assigned to smoking and non-smoking groups. However, plunging ahead, the coefficient of *MBSMOKE* is negative, -288.1846, with $t = -6.71$. The one tail critical value is -1.645. We conclude that women who smoke have significantly lower birthweight babies, with the estimated reduction being 288 grams, or about 10.16 ounces.

Table XR7.17

	(1) Part (b)	(2) Part (c)	(3) *MBSMOKE*=1	(4) *MBSMOKE*=0
C	3425.1415***	3201.4784***	3143.2108***	3154.0161***
	(18.8596)	(97.4025)	(208.0885)	(107.5469)
MBSMOKE	-288.1846***	-229.9757***		
	(42.8923)	(44.8636)		
MMARRIED		132.3678**	206.9242*	96.3475
		(44.1489)	(82.3072)	(52.3232)
MAGE		2.6422	-5.5208	4.9272
		(3.6052)	(8.1695)	(4.0270)
PRENATAL1		86.2505	8.2981	119.8472*
		(46.9067)	(85.1328)	(56.2322)
FBABY		-51.5969	94.0675	-83.1670*
		(36.0350)	(85.4089)	(39.6545)
N	1200	1200	232	968
SSE	412475709	402781795	76792916.2	323057221
R^2	0.036	0.059	0.034	0.030
adj. R^2	0.036	0.055	0.017	0.026

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(c) The estimates are in column (2) of Table XR7.17. The coefficient on the indicator that the mother smokes increases in magnitude to -229.9757, with $t = -5.13$. This is a difference of 58.2089 grams, or about 2 ounces. This value does fall in the 95% interval estimate from the base regression, so the hypothesis that the coefficient is equal to this new value would not be rejected at the 5% level. Of the other variables only *MMARRIED* is significant. It has a positive sign suggesting that mothers who are married have higher birthweight babies. This is plausible. The joint *F*-test of these control variables is 7.18, with a $p = 0.0000$, so collectively we can say at least one of the coefficients helps explain the outcome.

(d) The separate estimates for mothers who smoke and who do not smoke are in columns (3) and (4) of Table XR 7.17. Examining the coefficients, we see that *MMARRIED* is positive for both groups, but larger and statistically significant for the smoking mothers. The variable *PRENATAL1* is positive but significant only for the nonsmoking mothers. *FBABY* has a negative and significant coefficient for mothers who do not smoke, but it is insignificant for mothers who smoke. The *F*-statistic is

$$F = \frac{\left(SSE_R - SSE_U\right)/J}{SSE_U/\left(N-K\right)}$$

The restricted model is in column (2) with sum of squared residuals $SSE_R = 402781795.48$. In this case $SSE_U = SSE_1 + SSE_0 = 76792916.19 + 323057220.66 = 399850136.85$. The number of hypotheses is $J = 5$, and $N-K = N_1 + N_0 - 10 = 1190$. The $F = 1.74$, and the critical value for a 5% test is 2.219. Thus, we cannot reject the null hypothesis that the coefficients of the two equations are the same.

(e) Using equation (7.37), the estimated average treatment effect is

$$\begin{aligned}\tau_{ATE} &= (3143.2108 - 3154.0161) + (206.9242 - 96.3475)\times 0.715 \\ &\quad + (-5.5208 - 4.9272)\times 26.57583 + (8.2981 - 119.8472)\times 0.815 \\ &\quad + (94.0675 + 83.167)\times 0.440833 \\ &= -222.19\end{aligned}$$

This value is similar to that in part (c), but a smaller difference than that in part (a).

EXERCISE 7.19

(a) The estimates for this model are in Table XR 7.19, column (1). The coefficient of *MSMOKE* is −97.8254 and it is statistically different from zero at the 0.001 level. This suggests as a mother moves from one level of smoking to another, starting from zero, the expected birthweight falls. However, the numerical value tells us little because the variable simply indicates a range and is not a numerical value. Also, model does not allow a differential impact of moving from one level to the next.

(b) Including indicator variables for the levels of smoking yields the results in Table XR 7.19 column (2). The coefficients of the smoking indicators increase in magnitude as the intensity of smoking increases. The calculated *t*-value for *SMOKE2* is −2.26. The *t*-critical value using the 5% level is −1.645, and for the 1% level is −2.326. Thus, we would conclude at the 5% level that smoking 1-5 cigarettes a day has a significant negative effect on the expected birth weight.

(c) In this question we test whether the difference between the coefficients of *SMOKE3* and *SMOKE4* is statistically significant. To be specific, let δ_3 and δ_4 denote their coefficients. The null hypothesis is $H_0: \delta_3 = \delta_4$, or $H_0: \delta_3 - \delta_4 = 0$. The alternative hypothesis is $H_1: \delta_3 > \delta_4$, or $H_1: \delta_3 - \delta_4 > 0$. The calculated *t*-value is 0.67, thus the difference between the coefficients of these two levels is not statistically significant.

(d) In this question we test whether the difference between the coefficients of *SMOKE2* and *SMOKE4* is statistically significant. To be specific, let δ_2 and δ_4 denote their coefficients. The null hypothesis is $H_0: \delta_2 = \delta_4$, or $H_0: \delta_2 - \delta_4 = 0$. The alternative hypothesis is

$H_1: \delta_2 > \delta_4$, or $H_1: \delta_2 - \delta_4 > 0$. The calculated *t*-value is 0.94, thus the difference between the coefficients of these two levels is not statistically significant.

Table XR7.19

	(1) Part (a)	(2) Part (b)
C	3180.4596***	3196.4293***
	(96.4905)	(97.5811)
MMARRIED	138.2313**	133.1764**
	(43.9212)	(44.1819)
MAGE	3.1173	2.8426
	(3.6031)	(3.6126)
PRENATAL1	86.8628	85.7414
	(46.9064)	(46.9319)
FBABY	-52.3384	-52.7946
	(36.0628)	(36.0891)
MSMOKE	-97.8254***	
	(19.2104)	
SMOKE2		-181.5582*
		(80.1924)
SMOKE3		-215.0420**
		(67.9824)
SMOKE4		-273.9604***
		(65.3962)
N	1200	1200

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(e) The estimated coefficients for these four models are in Table XR7.19e.

Table XR7.19e

	(1) *MSMOKE*=0	(2) *MSMOKE*=1	(3) *MSMOKE*=2	(4) *MSMOKE*=3
C	3154.0161***	3329.8137***	3710.3271***	2378.5576***
	(107.5469)	(378.5776)	(355.8671)	(372.0567)
MMARRIED	96.3475	97.3963	305.4778*	228.6593
	(52.3232)	(161.3264)	(143.6534)	(133.0409)
MAGE	4.9272	-8.4995	-28.4634*	19.3556
	(4.0270)	(15.6130)	(14.2971)	(13.7614)
PRENATAL1	119.8472*	-39.3736	71.9626	39.4500
	(56.2322)	(137.3588)	(152.7578)	(144.1350)
FBABY	-83.1670*	46.1311	-105.8220	275.7322
	(39.6545)	(141.5650)	(153.5358)	(147.7999)
N	968	58	84	90

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The estimated expected weights are 3493.39 grams (7.702 lbs.), 3175.35 grams (7.0 lbs.), 3376.182 grams (7.443 lbs.) and 3130.558 grams (6.902 lbs.), respectively. The expected birth weights of the infants with smoking mothers is estimated to be less than the expected birth weights of infants with non-smoking mothers. The trend, for what that is worth given small samples, is downward, with more smoking resulting in lower estimated expected birth weights, except for column (3).

(f) The estimated linear probability model is:

Dependent Variable: LBWEIGHT
Method: Least Squares
Sample: 1 1200
Included observations: 1200

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.083958	0.039442	2.128629	0.0335
MMARRIED	-0.038321	0.017954	-2.134455	0.0330
MAGE	0.000802	0.001473	0.544225	0.5864
PRENATAL1	-0.033180	0.019174	-1.730491	0.0838
FBABY	0.005198	0.014741	0.352587	0.7245
MSMOKE	0.018686	0.007853	2.379635	0.0175

R-squared	0.018062	Mean dependent var	0.060833
S.E. of regression	0.237450	Akaike info criterion	-0.032730

The predicted probabilities are:

MSMOKE	Probability
0	0.0325
1	0.0512
2	0.0699
3	0.0886

We observe that increasing the number of cigarettes smoked per day increases the probability of a low birthweight infant.

EXERCISE 7.21

(a) The estimates are in column (1) of Table XR7.21. The estimates suggest that an additional 1000 undergraduate students reduce expected total cost per student by 0.14%, and the estimate is not significantly different from zero. An additional 1000 graduate students are estimated to increase expected total cost per student by 3.49%, and the estimate is significantly different from zero at the 1% level.

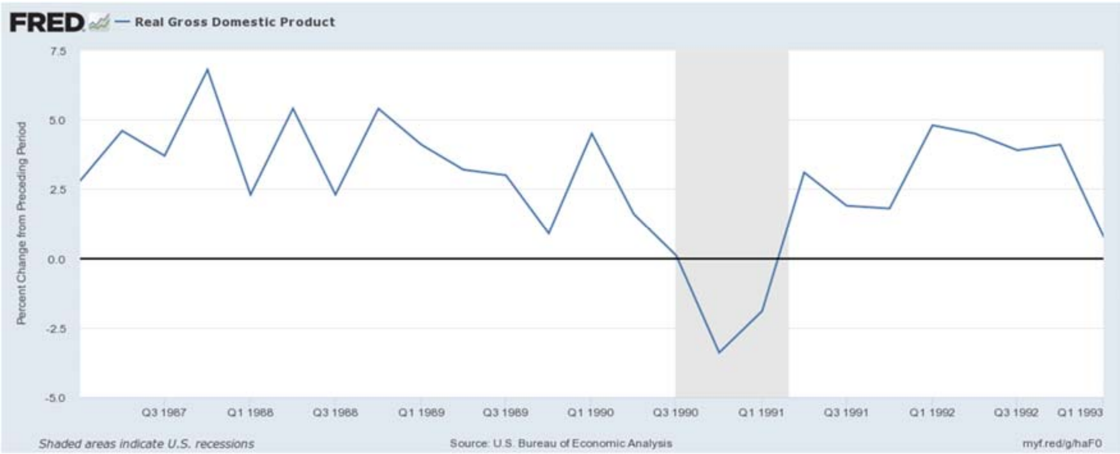
(b) We estimate that an additional full-time faculty member, per 100 students, increases expected total cost per student by about 10.29%, whereas additional contract faculty are estimated to <u>reduce</u> expected total cost per student by about 5.35%. Additional executive and professional employees are estimated to increase expected total cost per student by about 5.79%. The motivation for using contract faculty for teaching purposes is clear from these estimates. All the coefficients are significant at the 1% level.

Table XR7.21

	(1) Part (a)	(2) Part (c)	(3) Part (d)	(4) Part (e)
C	2.1974	2.2330	2.1883	2.1703
	(66.3057)	(58.8781)	(49.5599)	(46.7773)
FTUG	0.0014	-0.0006	-0.0009	0.0001
	(0.8951)	(-0.4164)	(-0.5849)	(0.0378)
FTGRAD	0.0349	0.0366	0.0383	0.0438
	(6.5731)	(6.9721)	(7.2577)	(6.3746)
CF	-0.0535	-0.0444	-0.0441	-0.0450
	(-6.6622)	(-5.4761)	(-4.5104)	(-4.5992)
FTEF	0.1029	0.0935	0.0999	0.1008
	(16.6070)	(14.8420)	(12.4875)	(12.5418)
FTENAP	0.0579	0.0562	0.0564	0.0547
	(27.6069)	(27.3584)	(22.5227)	(20.8979)
D1989		-0.0293	-0.0291	-0.0271
		(-1.0448)	(-1.0418)	(-0.9672)
D1991		-0.0611	-0.0545	-0.0575
		(-2.1596)	(-1.9069)	(-2.0134)
D1999		0.0585	0.0527	0.0521
		(2.0983)	(1.8891)	(1.8694)
D2005		0.0754	0.0692	0.0646
		(2.6611)	(2.4251)	(2.2625)
D2008		0.0820	0.1677	0.2236
		(2.8912)	(2.6663)	(2.9032)
D2010		0.1179	0.2028	0.2608
		(4.1720)	(3.3408)	(3.4832)
D2011		0.1232	0.2098	0.2678
		(4.3519)	(3.4957)	(3.5987)
CRASH_FTEF			-0.0059	-0.0122
			(-0.4500)	(-0.8976)
CRASH_CF			-0.0096	-0.0016
			(-0.5433)	(-0.0872)
CRASH_FTENAP			-0.0030	0.0025
			(-0.8214)	(0.5690)
CRASH_FTUG				-0.0022
				(-0.7232)
CRASH_FTGRAD				-0.0130
				(-1.2153)
N	1122	1122	1122	1122
R^2	0.789	0.802	0.804	0.805
adj. R^2	0.788	0.800	0.801	0.802
SSE	63.6326	59.5510	59.1162	58.7120

t statistics in parentheses

(c) The estimates including the year indicators are in column (2) of Table XR7.21. The coefficient of *D1989* is negative but it is not significant. The coefficient of *D1991* is negative and significant, suggesting that total cost per student fell relative to 1987, holding all else constant. The coefficients of all the remaining indicators are positive and significant, and increasing in magnitude. This suggests that costs were rising during 1999 to 2011, holding all else fixed. The *F*-statistic value is 10.86. The number of hypotheses is $J = 7$ and the number of denominator degrees of freedom is 1109. The *F*-critical value for a test at the 1% level is 2.64. Thus, the coefficients are jointly significant as well. A graph using the FRED data is below. Note that there was declining real GDP from 1990 Q3 to 1991 Q1. This is reflected in the negative and significant coefficient for 1991.



(d) The interaction variables are added in column (3) of Table XR 7.21. They are labeled *CRASH_FTEF*, etc. The coefficients of the interaction terms are negative, but insignificant. The *F*-statistic is 2.71. The number of hypotheses is $J = 3$ and the number of denominator degrees of freedom is 1106. The *F*-critical value for a test at the 1% level is 3.78, and for the 5% level it is 2.60. Thus, the coefficients are jointly significant at the 5% level, but not the 1% level. Thus, there is some evidence that during the period when $CRASH = 1$, there are some slight changes in these slope coefficients, but the individual changes have not been estimated precisely.

(e) The interaction variables are added in column (4) of Table XR7.21. They are labeled *CRASH_FTEF*, etc. The coefficients of the interaction terms are negative, but insignificant. The *F*-statistic is 3.16. The number of hypotheses is $J = 5$ and the number of denominator degrees of freedom is 1104. The *F*-critical value for a test at the 1% level is 3.02. Thus, the coefficients are jointly significant at the 1% level. Thus, there is some evidence that during the period when $CRASH = 1$, there are some slight changes in these slope coefficients, but the individual changes have not been estimated precisely.

EXERCISE 7.23

(a) The average math score for students in regular sized classes is 482.32 ($N = 431$), for students in a regular sized class with a teacher aide the average is 483.86 ($N = 404$), and for students in small classes the average is 496.47 ($N = 365$). The average in small classes is larger by 13-14 points than the averages in other classes, which are similar.

(b) The estimates are in Table XR7.23 column (1). The constant term is the average in the regular sized classes, which is the reference group because its indicator variable is not included. The coefficient of *SMALL* is the difference between the base group average and the average in *SMALL* classes. The coefficient of *AIDE* is the difference between the base group average and the average in regular sized classes with an aide.

Table XR7.23

	(1) Part (b)	(2) Part (c)	(3) Part (d)	(4) Part (e)
C	482.3179	475.4253	489.1310	482.5663
	(213.2874)	(151.9259)	(146.3098)	(108.7128)
SMALL	14.1534	13.9050	13.4593	15.0376
	(4.2382)	(4.1784)	(4.1932)	(3.4242)
AIDE	1.5410	0.9991	1.3183	5.1930
	(0.4740)	(0.3081)	(0.4214)	(1.1979)
TCHEXPER		0.7637	0.5668	1.0542
		(3.1735)	(2.4327)	(3.1123)
FREELUNCH			-24.9585	-12.8759
			(-9.5309)	(-2.1247)
SMALL_FREE				-3.2987
				(-0.5132)
AIDE_FREE				-7.7122
				(-1.2326)
TCHEXPER_FREE				-0.9048
				(-1.9395)
N	1200	1200	1200	1200
SSE	2638199	2616170	2431353	2420073

t statistics in parentheses

(c) The estimates are in Table XR7.23 column (2). The estimated coefficient is 0.7637 means that each additional year of teaching experience is estimated to increase expected math score by 0.7637 points, other things held constant. The *t*-value is 3.1735 which is larger than 2.58, the critical value for two-tail test at the 1% level of significance. The coefficients of the other variables change very little, the reason being that teachers, and students, were randomly assigned.

Let β_4 be the coefficient of *TCHEXPER*. The estimated expected score of a student in a small class and a teacher with 10 years experience is

$$\hat{E}\left(MATHSCORE \mid SMALL = 1, TCHEXPER = 10\right) = 496.9671$$

The standard error is 2.4530 and the 95% interval estimate is [492.1544, 501.7798].

The estimated expected score of a student in a regular sized class with a teacher aide and a teacher with 10 years experience is

$$\hat{E}\left(MATHSCORE \mid AIDE = 1, TCHEXPER = 10\right) = 484.0612$$

The standard error is 2.3278 and the 95% interval estimate is [479.4942, 488.6281]. Observe that the intervals do not overlap, with the interval estimate for expected math scores in small classes being higher than that the interval for the classes with an aide.

(d) The estimates are in column (3) of Table XR7.23. The estimated coefficient of *FREELUNCH* is −24.96 with a $t = -9.53$, so it is significant at all the usual levels. That is, after controlling for class size and teacher experience the students receiving a free lunch have an expected test score that is almost 25 points lower than students not receiving a free lunch. Using the residuals from the model in part (c), we find that the average of the residuals for students receiving a free lunch is −13.0141, meaning that the predicted scores are on average too high. The average of the residuals for students not receiving a free lunch is 11.7354, meaning that the predicted scores are on average too low. It is clear that not accounting for the income status of households leads to systematic errors in predictions that are reflected in the sign and significance of the *FREELUNCH* coefficient.

(e) The estimates are in column (4) of Table XR7.23. The coefficients of the interactions between *FREELUNCH* and the class variables *SMALL* and *AIDE* are statistically insignificant. The interaction between *FREELUNCH* and *TCHEXPER* is significant at the 10% level (critical value 1.645). The *F*-statistic is 1.85. There are $J = 3$ hypotheses and 1192 denominator degrees of freedom. The 5% critical value is 2.60, so we fail to reject the null hypothesis that the coefficients of the interaction variables are zero.

(f) The Chow test is based on the unrestricted model in column (4), and the restricted model in column (2). The value of the *F*-statistic is $F = 24.15$. The 5% critical value is 2.37, so we conclude that there are significant differences between the parameters of the model between those students receiving a free lunch and those not receiving a free lunch. The result in part (e) shows no significant differences in 3 of the coefficients, but the Chow test includes the effect of *FREELUNCH*, whose coefficient is significant.

EXERCISE 7.25

(a) *VOTE* is the percentage vote in favor of the democratic candidate. The indicator variable *DPER* = 1 if a democratic president is running, and *DPER* = -1 if a republican president is running. If the democratic president is popular we expect the parameter estimate for the dummy variable *DPER* to be positive because of reputation and knowledge of the incumbent. If a republican president is popular a positive coefficient would mean an estimated smaller expected vote in favor of the democrats, and hence an estimated larger expected vote for the republican.

(b) The expected vote equation given a democratic incumbent is

$$E(VOTE \mid X, INCUMB = 1) = \begin{array}{l}(\beta_1 + \beta_7) + \beta_2 GROWTH + \beta_3 INFLAT + \beta_4 GOODNEWS \\ + \beta_5 DPER + \beta_6 DUR + \beta_8 WAR\end{array}$$

For a republican incumbent it is

$$E(VOTE \mid X, INCUMB = -1) = \begin{array}{l}(\beta_1 - \beta_7) + \beta_2 GROWTH + \beta_3 INFLAT + \beta_4 GOODNEWS \\ + \beta_5 DPER + \beta_6 DUR + \beta_8 WAR\end{array}$$

The intercept when there is a Democrat incumbent is $\beta_1 + \beta_7$. When there is a Republican incumbent it is $\beta_1 - \beta_7$. Thus, the effect of *INCUMB* on the vote is $2\beta_7$. If $(\beta_7 > 0)$ then having a democratic incumbent tends to increase the expected vote in favor of a democrat and reduce the expected vote in favor of the republican party. If $(\beta_7 < 0)$ then having a democratic incumbent reduces the expected vote in favor of a democrat and increases the expected vote in favor of the republican party.

(c) Using the data from 1916-2012 the estimates are in the table below:

The signs are as expected. We expect the coefficient of *GROWTH* to be positive. Recall that this variable is positive for democratic incumbents and negative for republican incumbents. Thus, a positive coefficient means that when a democrat is the incumbent growth has a positive influence on the expected vote in favor of the democratic party. If the incumbent is a republican, then positive growth has a negative impact on the expected vote in favor of the democratic party.

For the same reason we expect the coefficient of *GOODNEWS* to be positive.

We expect a negative sign for the coefficient of *INFLATION* because increased prices impact negatively on society. If a democrat is the incumbent increased inflation would reduce the expected vote in favor of the democratic candidate.

We expect the coefficient for *DPER* to be positive for reasons discussed in part (b).

We expect the coefficient of *DUR* to be negative. If either party has been in power only one term the effect of this variable is zero. However, if a party has been in power more than one term, we expect that for each subsequent term it is more likely that the presidency will change hands; therefore, we expect the parameter for *DUR* to be negative. Furthermore, the more terms the party is in power the greater the sentiment to vote that party out of power.

The variable *INCUMB* = 1 if there is democratic incumbent and -1 if there is a republican incumbent. This variable is not statistically significant. We expect the parameter for *WAR* to be positive. During the years covered by the data WAR = 1 in 1920, 1944 and 1948. During these years the president was a democrat, and during these popular wars the country's sentiment was to keep with the democratic administration.

All the estimates are statistically significant at a 1% level of significance except for *INFLATION*, *DPER*, *INCUMB* and *WAR*. As noted above *INCUMB* is insignificant. The coefficients of *INFLATION*, *DURATION* and *PERSON* are statistically significant at a 5% level of significance, however. The coefficient of *WAR* is statistically significant at a level of 10%. Lastly, an R^2 of 0.8967 suggests that the model fits the data very well.

Table XR7.25

C	47.7540^{***}	(0.6033)
GROWTH	0.6670^{***}	(0.1152)
INFLAT	-0.6903^{**}	(0.2953)
GOODNEWS	0.9676^{***}	(0.2401)
DPER	3.0079^{**}	(1.4075)
DUR	-3.8047^{***}	(1.2269)
INCUMB	-1.5627	(2.2153)
WAR	4.8917^{*}	(2.5441)
N	25	
R^2	0.897	
SSE	117.0702	

Standard errors in parentheses
$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

(d) Using the actual data on the variables in 2016 the predicted vote in favor of the democratic candidate, Clinton, was 43.988%. The actual vote in favor of Clinton was 50.819%.

(e) The standard error of the forecast is 3.035, and the 0.975 percentile of the $t_{(17)}$ distribution is 2.1098. The 95% prediction interval is 37.585% to 50.392%. The actual vote was outside this interval.

(f) Using these values, the predicted vote in favor the democratic candidate was 45.78%.

(g) Using these values, the predicted vote in favor the democratic candidate was 46.73%.

(h) Using these values, the predicted vote in favor the democratic candidate was 47.96%.

EXERCISE 7.27

(a) The estimated model is in column (1) of Table XR7.27. The estimated elasticity of expected price with respect to *SQFT* is 1.0378. That is, we estimate expected price to increase by 1.0378% given a 1% increase in house area. We estimate that houses close to the university have an expected price of roughly 19.50% higher than those elsewhere. Using the exact calculation this is 21.5297%. The calculated *t*-value for *CLOSE* is 6.00. For a two-tail test the 5% critical value is close to 1.96, thus the coefficient of *CLOSE* is statistically significant at the 5% level.

Table XR7.27

	(1) part(a)	(2) part(b)	(3) part(c)	(4) part(e)	(5) part(f)
C	1.9337^{***}	2.0102^{***}	1.2714^{***}	1.5913^{***}	1.6772^{***}
	(0.1539)	(0.1540)	(0.1864)	(0.1971)	(0.2122)
LSQFT	1.0378^{***}	1.0168^{***}	1.2410^{***}	1.0983^{***}	1.0557^{***}
	(0.0468)	(0.0471)	(0.0569)	(0.0625)	(0.0686)
FIREPLACE				0.0909^{***}	0.1619^{***}
				(0.0326)	(0.0407)
TWOSTORY				0.1015^{**}	0.0819
				(0.0469)	(0.0685)
OCCUPIED				0.1608^{***}	0.1952^{***}
				(0.0300)	(0.0378)
CLOSE	0.1950^{***}		1.9957^{***}	1.8603^{***}	1.6271^{***}
	(0.0325)		(0.3063)	(0.2962)	(0.3271)
CLOSE_LSQFT		0.0537^{***}	-0.5560^{***}	-0.5222^{***}	-0.3995^{***}
		(0.0101)	(0.0941)	(0.0909)	(0.1063)
CLOSE_FIREPLACE					-0.2025^{***}
					(0.0671)
CLOSE_TWOSTORY					0.0510
					(0.0933)
CLOSE_OCCUPIED					-0.0992
					(0.0612)
N	500	500	500	500	500
R^2	0.509	0.502	0.542	0.578	0.589
BIC	390.9249	397.9575	363.1192	340.1094	345.9728
SSE	61.6389	62.5120	57.5845	52.9816	51.6445

Standard errors in parentheses
$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

(b) The estimates are in the second column of Table XR7.27. The coefficient of $\ln(SQFT)$ is the elasticity of expected house price with respect to house area for a house that is not close to the university (*CLOSE* = 0). The estimate, 1.0168, is very close to the estimate in part (a). When *CLOSE* equals 1, the coefficient of $\ln(SQFT)$ is 1.0705; it is the estimated price elasticity of expected house price with respect to house area for a house that is close to the university. The interaction variable $\left[CLOSE \times \ln(SQFT)\right]$ has a coefficient with *t*-value 5.34, which is significant at the 5% level.

(c) The estimates are in the third column of Table XR7.27. The *t*-value for *CLOSE* is 6.51 and for the interaction $\left[CLOSE \times \ln(SQFT)\right]$ the *t*-value is −5.91. Thus, both variables have statistically significant coefficients at the 5% level. The *F*-value for the joint test of the null hypothesis $H_0: \delta_1 = 0, \delta_2 = 0$ is 36.67. The 95th percentile of the *F*-distribution with 2 numerator degrees of freedom and 496 denominator degrees of freedom is 3.0139 (using software). The *F*-value is greater than this critical value, so we reject the null hypothesis that both coefficients are zero and conclude that the coefficient of *CLOSE* and/or $\left[CLOSE \times \ln(SQFT)\right]$ is not zero.

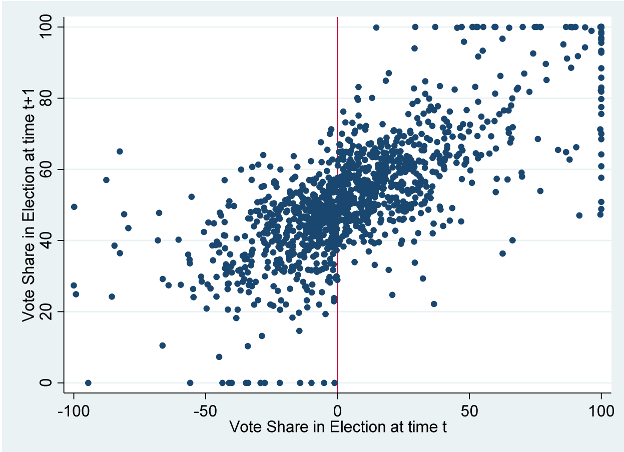
(d) The estimated value of the error variance for the model in (c) is $\hat{\sigma}^2 = 0.11609769$ and thus the correction factor is $\exp\left(\hat{\sigma}^2/2\right) = 1.0597668$. Using $\ln(25) = 3.218876$, the natural predictor of a house not close the university (*CLOSE* = 0) is \$193,678.40 and the corrected predictor is \$205,253.90. For houses close to the university the natural predictor is \$237,987.90 and corrected predictor is \$252,211.70. Thus, the predicted house price is \$46,957.80 higher for houses with 2500 square feet of living area that are close to the university.

(e) Adding these three variables we obtain the results in the fourth column of Table XR7.27. We estimate that a fireplace adds approximately 9.09% to the expected price of a home holding other factors constant. A two-story house is estimated to increase expected price by about 10.15%, and if the home is occupied at the time of sale that is expected to increase the expected price by about 16.08%, holding all else constant. The *t*-values for the variables are 2.79, 2.17 and 5.36, respectively. Thus, they are all significant at the 5% level.

(f) The estimates of the fully interacted model are in the fifth column of Table XR7.27. The value of the *F*-statistic for the null hypothesis that the coefficients of *CLOSE*, ln(*SQFT*) × *CLOSE*, *FIREPLACE* × *CLOSE*, *TWOSTORY* × *CLOSE*, and *OCCUPIED* × *CLOSE* is 15.28. The *p*-value is 0.0000. We conclude that there is a significant difference between the houses close to the university and those not close even at the .001 level of significance.

EXERCISE 7.29

(a) The scatter plot below shows a positive association between *MARGIN* and *VOTE*.



(b) The estimates are shown in column (1) of Table XR7.29b. The treatment effect is the coefficient of *D*. That is, we estimate the advantage having a democratic incumbent is 6% in the next Senate election. The coefficient *t*-value is 6.15, so the coefficient is significantly different from zero at all usual test significance levels.

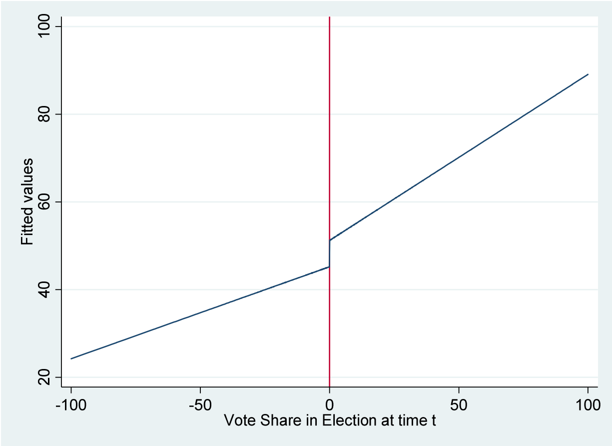
Table XR7.29b

	(1) part(b)	(2) $D=0$	(3) $D=1$
C	45.2151***	45.2151***	51.2168***
	(0.7280)	(0.7207)	(0.6545)
MARGIN	0.2098***	0.2098***	0.3786***
	(0.0282)	(0.0280)	(0.0159)
D	6.0017***		
	(0.9755)		
D_MARGIN	0.1689***		
	(0.0323)		
N	1198	540	658
R^2	0.577	0.095	0.464
BIC	9289.1542	4175.8569	5110.3033
SSE	159651.6000	70506.3636	89145.2364

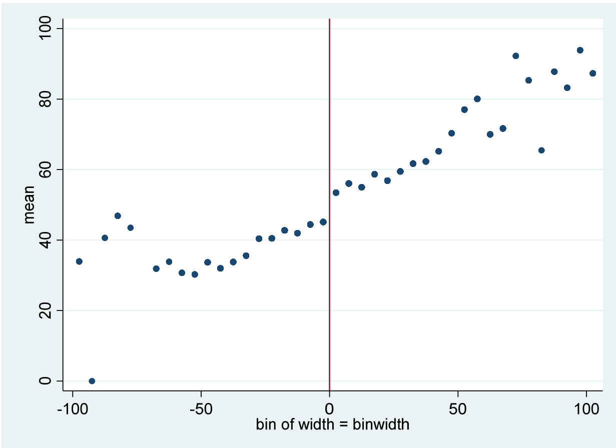
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The graph of the fitted line follows. It is the "jump" at *MARGIN* that estimates the treatment effect. The estimated model intercept term is 45.215 is where the fitted line intersects the vertical line at *MARGIN* = 0. The coefficient of *MARGIN* is the slope of the fitted line to the left of the vertical rule and the change in slope to the right of the rule is 0.1689. All these estimated coefficients are statistically different from zero.

In Table XR7.29b the estimation results are shown for *D* = 0 and *D* = 1. The different between the two estimated intercepts is the estimated treatment effect.



(c) Graphically we are testing the difference between the average election margin in the bins just to the left and just to the right of "0". This jump is another estimate of the treatment effect.



(d) The bin to the left of 0 contains 115 observations with mean 45.12953 and standard deviation 10.00895. To the right of 0 the first bin has 110 observations with mean 53.45991 and standard deviation 7.726179. The pooled variance is $\hat{\sigma}_p^2 = 80.390343$. The difference in the means is 8.33 and its standard error $= 1.1957708$. The *t*-statistic is 6.9665332 and the 5% critical value is 1.97. Therefore, we reject the hypothesis that the two population means are equal, and conclude that they are not equal at the 5% level.

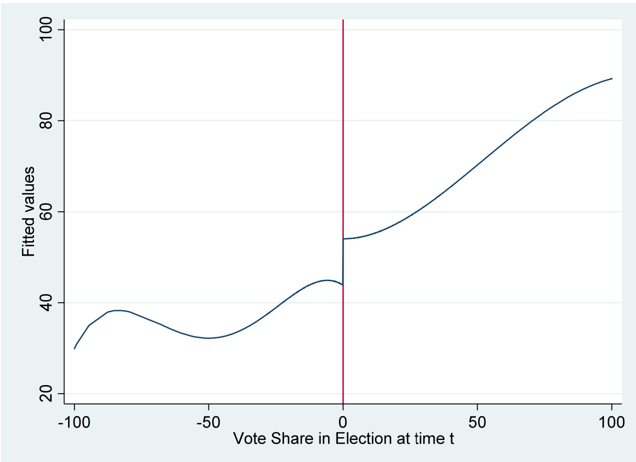
(e) The model estimates are in column (1) of Table XR7.29e. The coefficients of *MARGIN*, *MARGIN2*, *MARGIN3* and *MARGIN4* are coefficients of the 4th order polynomial fitted to the data for which $D = 0$, as in Equation (7.47). The coefficients of the *MARGIN* variables interacted with D show the changes in the polynomial coefficients estimated when $D = 1$ as compared to $D = 0$. The *MARGIN* variable coefficients and their powers are significant individually and jointly. The interactions between D and *MARGIN*, *MARGIN2*, *MARGIN3* and *MARGIN4* are jointly significant and individually significant, except for $D \times MARGIN$. The treatment effect is estimated by the estimated coefficient of D, 10.194, which is statistically significant.

Table XR7.29e

	(1) part(e)	(2) $D = 0$	(3) $D = 1$
C	43.8589***	43.8589***	54.0529***
	(1.4244)	(1.4028)	(1.4006)
MARGIN	-0.3865	-0.3865	-0.0040
	(0.2736)	(0.2694)	(0.2444)
MARGIN2	-0.0393***	-0.0393***	0.0100
	(0.0141)	(0.0139)	(0.0117)
MARGIN3	-0.0007***	-0.0007***	-0.0001
	(0.0003)	(0.0003)	(0.0002)
MARGIN4	-0.0000***	-0.0000***	0.0000
	(0.0000)	(0.0000)	(0.0000)
D	10.1941***		
	(1.9858)		
D_MARGIN	0.3826		
	(0.3649)		
D_MARGIN2	0.0493***		
	(0.0182)		
D_MARGIN3	0.0007**		
	(0.0003)		
D_MARGIN4	0.0000**		
	(0.0000)		
N	1198	540	658
R^2	0.586	0.124	0.471
BIC	9305.7812	4177.1237	5121.2045
SSE	156236.6271	68244.4333	87992.1938

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(f) The graph of the fitted values from the regression in part (d) is below. The nonlinearity, especially to the left of 0 is quite pronounced.



(g) The separate models for $D = 0$ and $D = 1$ are given in Table XR7.29e. The difference in the estimated intercepts is the estimated treatment effect.