

	Exercises	51
<b>3</b>	Qualitative explanatory variables regression models	53
3.1	Wage function revisited	53
3.2	Refinement of the wage function	55
3.3	Another refinement of the wage function	56
3.4	Functional form of the wage regression	59
3.5	Use of dummy variables in structural change	61
3.6	Use of dummy variables in seasonal data	64
3.7	Expanded sales function	66
3.8	Piecewise linear regression	69
3.9	Summary and conclusions	73
	Exercises	74
<b>Part II: Regression diagnostics</b>		
<b>4</b>	Regression diagnostic I: multicollinearity	80
4.1	Consequences of imperfect collinearity	81
4.2	An example: married women's hours of work in the labor market	84
4.3	Detection of multicollinearity	85
4.4	Remedial measures	87
4.5	The method of principal components (PC)	89
4.6	Summary and conclusions	92
	Exercises	93
<b>5</b>	Regression diagnostic II: heteroscedasticity	96
5.1	Consequences of heteroscedasticity	96
5.2	Abortion rates in the USA	97
5.3	Detection of heteroscedasticity	100
5.4	Remedial measures	103
5.5	Summary and conclusions	110
	Exercises	110
<b>6</b>	Regression diagnostic III: autocorrelation	113
6.1	US consumption function, 1947–2000	113
6.2	Tests of autocorrelation	115
6.3	Remedial measures	121
6.4	Model evaluation	126
6.5	Summary and conclusions	129
	Exercises	129
<b>7</b>	Regression diagnostic IV: model specification errors	131
7.1	Omission of relevant variables	131
7.2	Tests of omitted variables	135
7.3	Inclusion of irrelevant or unnecessary variables	138
7.4	Misspecification of the functional form of a regression model	139
7.5	Errors of measurement	141
7.6	Outliers, leverage and influence data	142
7.7	Probability distribution of the error term	145
7.8	Random or stochastic regressors	147

7.9	The simultaneity problem	147
7.10	Dynamic regression models	153
7.11	Summary and conclusions	162
	Exercises	163
	Appendix: Inconsistency of the OLS estimators of the consumption function	167
<b>Part III: Topics in cross-section data</b>		
8	The logit and probit models	170
8.1	An illustrative example: to smoke or not to smoke	170
8.2	The linear probability model (LPM)	171
8.3	The logit model	172
8.4	The language of the odds ratio (OR)	180
8.5	The probit model	181
8.6	Summary and conclusions	184
	Exercises	185
9	Multinomial regression models	190
9.1	The nature of multinomial regression models	190
9.2	Multinomial logit model (MLM): school choice	192
9.3	Conditional logit model (CLM)	198
9.4	Mixed logit (MXL)	201
9.5	Summary and conclusions	201
	Exercises	203
10	Ordinal regression models	206
10.1	Ordered multinomial models (OMM)	207
10.2	Estimation of ordered logit model (OLM)	207
10.3	An illustrative example: attitudes toward working mothers	209
10.4	Limitation of the proportional odds model	212
10.5	Summary and conclusions	215
	Exercises	216
	Appendix: Derivation of Eq. (10.4)	218
11	Limited dependent variable regression models	219
11.1	Censored regression models	220
11.2	Maximum likelihood (ML) estimation of the censored regression model: the Tobit model	223
11.3	Truncated sample regression models	227
11.4	A concluding example	229
11.5	Summary and conclusions	232
	Exercises	233
	Appendix: Heckman's (Heckit) selection-bias model	234
12	Modeling count data: the Poisson and negative binomial regression models	236
12.1	An illustrative example	236
12.2	The Poisson regression model (PRM)	238
12.3	Limitation of the Poisson regression model	242
12.4	The Negative Binomial Regression Model (NBRM)	244

12.5	Summary and conclusions	244
	Exercises	245
<b>Part IV: Time series econometrics</b>		
13	Stationary and nonstationary time series	250
13.1	Are exchange rates stationary?	250
13.2	The importance of stationary time series	251
13.3	Tests of stationarity	251
13.4	The unit root test of stationarity	255
13.5	Trend stationary vs. difference stationary time series	258
13.6	The random walk model (RWM)	262
13.7	Summary and conclusions	266
	Exercises	267
14	Cointegration and error correction models	269
14.1	The phenomenon of spurious regression	269
14.2	Simulation of spurious regression	270
14.3	Is the regression of consumption expenditure on disposable income spurious?	271
14.4	When a spurious regression may not be spurious	274
14.5	Tests of cointegration	275
14.6	Cointegration and error correction mechanism (ECM)	276
14.7	Are 3-month and 6-month Treasury Bill rates cointegrated?	278
14.8	Summary and conclusions	280
	Exercises	281
15	Asset price volatility: the ARCH and GARCH models	283
15.1	The ARCH model	284
15.2	The GARCH model	290
15.3	Further extensions of the ARCH model	292
15.4	Summary and conclusions	294
	Exercises	295
16	Economic forecasting	296
16.1	Forecasting with regression models	296
16.2	The Box–Jenkins methodology: ARIMA modeling	302
16.3	An ARMA model of IBM daily closing prices, 3 January 2000 to 31 October 2002	304
16.4	Vector autoregression (VAR)	310
16.5	Testing causality using VAR: the Granger causality test	315
16.6	Summary and conclusions	319
	Exercises	320
	Appendix: Measures of forecast accuracy	323
<b>Part V: Selected topics in econometrics</b>		
17	Panel data regression models	326
17.1	The importance of panel data	326
17.2	An illustrative example: charitable giving	327

12.5	Summary and conclusions	244
	Exercises	245
<b>Part IV: Time series econometrics</b>		
13	Stationary and nonstationary time series	250
13.1	Are exchange rates stationary?	250
13.2	The importance of stationary time series	251
13.3	Tests of stationarity	251
13.4	The unit root test of stationarity	255
13.5	Trend stationary vs. difference stationary time series	258
13.6	The random walk model (RWM)	262
13.7	Summary and conclusions	266
	Exercises	267
14	Cointegration and error correction models	269
14.1	The phenomenon of spurious regression	269
14.2	Simulation of spurious regression	270
14.3	Is the regression of consumption expenditure on disposable income spurious?	271
14.4	When a spurious regression may not be spurious	274
14.5	Tests of cointegration	275
14.6	Cointegration and error correction mechanism (ECM)	276
14.7	Are 3-month and 6-month Treasury Bill rates cointegrated?	278
14.8	Summary and conclusions	280
	Exercises	281
15	Asset price volatility: the ARCH and GARCH models	283
15.1	The ARCH model	284
15.2	The GARCH model	290
15.3	Further extensions of the ARCH model	292
15.4	Summary and conclusions	294
	Exercises	295
16	Economic forecasting	296
16.1	Forecasting with regression models	296
16.2	The Box–Jenkins methodology: ARIMA modeling	302
16.3	An ARMA model of IBM daily closing prices, 3 January 2000 to 31 October 2002	304
16.4	Vector autoregression (VAR)	310
16.5	Testing causality using VAR: the Granger causality test	315
16.6	Summary and conclusions	319
	Exercises	320
	Appendix: Measures of forecast accuracy	323
<b>Part V: Selected topics in econometrics</b>		
17	Panel data regression models	326
17.1	The importance of panel data	326
17.2	An illustrative example: charitable giving	327

17.3	Pooled OLS regression of charity function	328
17.4	The fixed effects least squares dummy variable (LSDV) model	330
17.5	Limitations of the fixed effects LSDV model	332
17.6	The fixed effect within group (WG) estimator	333
17.7	The random effects model (REM) or error components model (ECM)	335
17.8	Fixed effects model vs. random effects model	336
17.9	Properties of various estimators	339
17.10	Panel data regressions: some concluding comments	339
17.11	Summary and conclusions	340
	Exercises	341
<b>18</b>	<b>Survival analysis</b>	<b>344</b>
18.1	An illustrative example: modeling recidivism duration	344
18.2	Terminology of survival analysis	345
18.3	Modeling recidivism duration	348
18.4	Exponential probability distribution	348
18.5	Weibull probability distribution	351
18.6	The proportional hazard model	353
18.7	Summary and conclusions	355
	Exercises	356
<b>19</b>	<b>Stochastic regressors and the method of instrumental variables</b>	<b>358</b>
19.1	The problem of endogeneity	359
19.2	The problem with stochastic regressors	360
19.3	Reasons for correlation between regressors and the error term	363
19.4	The method of instrumental variables	367
19.5	Monte Carlo simulation of IV	369
19.6	Some illustrative examples	370
19.7	A numerical example: earnings and educational attainment of youth in the USA	373
19.8	Hypothesis testing under IV estimation	378
19.9	Test of endogeneity of a regressor	379
19.10	How to find whether an instrument is weak or strong	381
19.11	The case of multiple instruments	381
19.12	Regression involving more than one endogenous regressor	384
19.13	Summary and conclusions	385
	Exercises	387
<b>20</b>	<b>Beyond OLS: quantile regression</b>	<b>390</b>
20.1	Quantiles	391
20.2	The quantile regression model (QRM)	392
20.3	The quantile wage regression model	392
20.4	Median wage regression	396
20.5	Wage regressions for 25%, 50% and 75% quantiles	397
20.6	Test of coefficient equality of different quantiles	400
20.7	Summary of OLS and 25th, 50th (median) and 75th quantile regressions	401
20.8	Quantile regressions in <i>Eviews 8</i>	402
20.9	Summary and conclusions	403

	Exercises	404
	Appendix: The mechanics of quantile regression	405
<b>21</b>	<b>Multivariate regression models</b>	<b>407</b>
21.1	Some examples of MRMs	407
21.2	Advantages of joint estimation	408
21.3	An illustrative example of MRM estimation with the same explanatory variables	409
21.4	Estimation of MRM	410
21.5	Other advantages of MRM	413
21.6	Some technical aspects of MRM	414
21.7	Seemingly Unrelated Regression Equations (SURE)	417
21.8	Summary and conclusions	419
	Exercises	422
	Appendix	424
<b>Appendices</b>		
<b>1</b>	<b>Data sets used in the text</b>	<b>425</b>
<b>2</b>	<b>Statistical appendix</b>	<b>436</b>
A.1	Summation notation	436
A.2	Experiments	437
A.3	Empirical definition of probability	438
A.4	Probabilities: properties, rules, and definitions	439
A.5	Probability distributions of random variables	439
A.6	Expected value and variance	442
A.7	Covariance and correlation coefficient	444
A.8	Normal distribution	445
A.9	Student's <i>t</i> distribution	446
A.10	Chi-square ( $\chi^2$ ) distribution	447
A.11	<i>F</i> distribution	447
A.12	Statistical inference	448
	Exercises	451
	Exponential and logarithmic functions	455
<b>Index</b>		<b>460</b>