

Contents

1	<i>Random Variables, Sampling and Estimation</i>	1
1.1	Introduction	1
1.2	Probabilities	1
1.2.1	Events	1
1.2.2	Probability postulates	2
1.3	Discrete random variables and expectations	3
1.3.1	Discrete random variables	3
1.3.2	Expected value of random variables	4
1.3.3	Expected value rules	5
1.3.4	Variance of a discrete random variable	5
1.3.5	Probability density	6
1.4	Continuous random variables	7
1.4.1	Probability density	7
1.4.2	Normal distribution	8
1.4.3	Expected value and variance of a continuous random variable	9
1.5	Covariance and correlation	9
1.5.1	Covariance	9
1.5.2	Correlation	9
1.6	Sampling and estimators	10
1.6.1	Sampling	10
1.6.2	Estimators	11
1.7	Unbiasedness and efficiency	11
1.7.1	Unbiasedness	11
1.7.2	Efficiency	12
1.7.3	Unbiasedness versus efficiency	13
1.8	Estimators for the variance, covariance, and correlation	13
1.9	Asymptotic properties of estimators	14
1.9.1	Consistency	15
1.9.2	Central limit theorem	15

2	<i>Simple Linear Regression</i>	17
2.1	Simple linear model	17
2.2	Least squares regression	17
2.3	Interpretation of the regression coefficients	19
2.4	Goodness of fit	20
3	<i>Properties and Hypothesis Testing</i>	23
3.1	Types of data	23
3.2	Assumptions of the model	23
3.3	Unbiasedness of the coefficients	25
3.4	Precision of the coefficients	25
3.5	The Gauss-Markov theorem	26
3.6	Hypotheses testing	26
3.6.1	Formulation of the null hypothesis	26
3.6.2	t -tests	27
3.6.3	Confidence intervals	28
3.6.4	F test	29
3.7	Computer output	31
4	<i>Multiple Regression Analysis</i>	33
4.1	Interpretation of the coefficients	33
4.2	Ordinary Least Squares	34
4.3	Assumptions	34
4.4	Properties of the coefficients	35
4.4.1	Unbiasedness	35
4.4.2	Efficiency	35
4.4.3	Precision of the coefficient, t tests, and confidence intervals	35
4.5	Regression output in Gretl	36
4.6	Multicollinearity	37
4.7	Goodness of fit: R^2 and \bar{R}^2	38
4.8	F tests	38
4.9	Adjusted R^2 , \bar{R}^2	39
5	<i>Transformations of Variables and Interactions</i>	41
5.1	Basic idea	41
5.2	Logarithmic transformations	42
5.3	Quadratic terms	43
5.4	Interaction terms	45
6	<i>Analysis with Qualitative Information: Dummy Variables</i>	47
6.1	Describing qualitative information	47
6.2	A single dummy independent variable	48
6.3	Dummy variables for multiple categories	50
6.4	Incorporating ordinal information	51
6.5	Interactions involving dummy variables	52
6.5.1	Allowing for different slopes	53

Contents	vii
6.5.2 Testing for differences in regression functions across groups	54
6.6 The dummy variable trap	56
7 Specification of Regression Variables	57
7.1 Model specification	57
7.2 Omitting a variable	57
7.2.1 The bias problem	57
7.2.2 Invalid statistical tests	58
7.2.3 Example	58
7.3 Including a variable that should not be included	61
7.3.1 Example	62
7.4 Testing a linear restriction	63
8 Heteroscedasticity	67
8.1 Heteroscedasticity and its implications	67
8.2 Testing for heteroscedasticity	67
8.2.1 Breusch-Pagan test	67
8.2.2 Breusch-Pagan test in Gretl	69
8.2.3 White test	70
8.2.4 White test in Gretl	70
8.3 What to do with heteroscedasticity?	70
8.3.1 Simple transformation of the variables	71
8.3.2 Weighted Least Squares	71
8.3.3 Weighted Least Squares in Gretl	72
8.3.4 White's heteroscedasticity-consistent standard errors	74
9 Binary Choice Models	75
9.1 The linear probability model	75
9.1.1 The model	75
9.1.2 The linear probability model in Gretl	76
9.2 Logit analysis	77
9.2.1 The logit transformation	77
9.2.2 Logit regression in Gretl	78
9.3 Probit analysis	79
9.3.1 The probit transformation	79
9.3.2 Probit regression in Gretl	79