

# Contents

<i>List of figures and tables</i>	xii
<i>Preface</i>	xiii
<b>1 Multivariate analysis and the linear regression model</b>	<b>1</b>
1.1 <i>Introduction</i>	1
1.2 <i>Existence of a solution to the normal equation</i>	7
1.3 <i>The concept of wide-sense conditional expectation</i>	10
1.4 <i>Conditional expectation with normal variables</i>	14
1.5 <i>The relation between wide-sense and strict-sense conditional expectation</i>	15
1.6 <i>Conditional means and minimum mean-square error</i>	17
1.7 <i>Bayes estimation</i>	20
1.8 <i>The relation between Bayes and Gauss–Markov estimation in the case of a single independent variable</i>	23
1.9 <i>Exercises</i>	27
<b>2 Least-squares and Gauss–Markov theory</b>	<b>30</b>
2.1 <i>Least-squares theory</i>	30
2.2 <i>Principles of estimation</i>	31
2.3 <i>The concept of a generalized inverse of a matrix</i>	33
2.4 <i>The matrix Cauchy–Schwarz inequality and an extension</i>	35
2.5 <i>Gauss–Markov theory</i>	37
2.6 <i>The relation between Gauss–Markov and least-squares estimators</i>	41
2.7 <i>Minimum-bias estimation</i>	49
2.8 <i>Multicollinearity and the imposition of dummy linear restrictions</i>	51
2.9 <i>Specification error</i>	55
2.10 <i>Exercises</i>	60

<b>3</b>	<b>Multicollinearity and reduced-rank estimation</b>	<b>65</b>
3.1	<i>Introduction</i>	65
3.2	<i>Singular-value decomposition of a matrix</i>	65
3.3	<i>The condition number of a matrix</i>	68
3.4	<i>The Eckart–Young theorem</i>	70
3.5	<i>Reduced-rank estimation</i>	81
3.6	<i>Exercises</i>	86
<b>4</b>	<b>The treatment of linear restrictions</b>	<b>88</b>
4.1	<i>Estimation subject to linear restrictions</i>	88
4.2	<i>Linear aggregation and duality</i>	92
4.3	<i>Testing linear restrictions</i>	101
4.4	<i>Reduction of mean-square error by imposition of linear restrictions</i>	106
4.5	<i>Uncertain linear restrictions</i>	108
4.6	<i>Properties of the generalized ridge estimator</i>	109
4.7	<i>Comparison of restricted and generalized ridge estimators</i>	112
4A	<i>Appendix (to Section 4.4): Guide to the computation of percentage points of the noncentral <math>F</math> distribution</i>	115
4.8	<i>Exercises</i>	122
<b>5</b>	<b>Stein estimation</b>	<b>126</b>
5.1	<i>Stein's theorem and the regression model</i>	126
5.2	<i>Lemmas underlying the James–Stein theorem</i>	132
5.3	<i>Some further developments of Stein estimation</i>	138
5.4	<i>Exercises</i>	141
<b>6</b>	<b>Autocorrelation of residuals – 1</b>	<b>143</b>
6.1	<i>The first-order autoregressive model</i>	143
6.2	<i>Efficiency of trend estimation: the ordinary least-squares estimator</i>	147
6.3	<i>Efficiency of trend estimation: the Cochrane–Orcutt estimator</i>	154
6.4	<i>Efficiency of trend estimation: the Prais–Winsten weighted-difference estimator</i>	157
6.5	<i>Efficiency of trend estimation: the Prais–Winsten first-difference estimator</i>	161
6.6	<i>Discussion of the literature</i>	162
6.7	<i>Exercises</i>	165
<b>7</b>	<b>Autocorrelation of residuals – 2</b>	<b>167</b>
7.1	<i>Anderson models</i>	167

7.2	<i>Testing for autocorrelation: Anderson's theorem and the Durbin–Watson test</i>	177
7.3	<i>Distribution and beta approximation of the Durbin–Watson statistic</i>	189
7.4	<i>Bias in estimation of sampling variances</i>	196
7.5	<i>Exercises</i>	200
<b>8</b>	<b>Simultaneous-equations estimation</b>	<b>202</b>
8.1	<i>The identification problem</i>	202
8.2	<i>Anderson and Rubin's "limited-information maximum-likelihood" (LIML) method, 1: the handling of linear restrictions</i>	210
8.3	<i>Anderson and Rubin's "limited-information maximum-likelihood" method, 2: constrained maximization of the likelihood function</i>	215
8.4	<i>The contributions of Basman and Theil</i>	223
8.5	<i>Exact properties of simultaneous-equations estimators</i>	238
8.6	<i>Approximations to finite-sample distributions</i>	251
8.7	<i>Recursive models</i>	268
8.8	<i>Exercises</i>	283
<b>9</b>	<b>Solutions to the exercises</b>	<b>287</b>
9.1	<i>Chapter 1</i>	287
9.2	<i>Chapter 2</i>	294
9.3	<i>Chapter 3</i>	304
9.4	<i>Chapter 4</i>	309
9.5	<i>Chapter 5</i>	318
9.6	<i>Chapter 6</i>	323
9.7	<i>Chapter 7</i>	329
9.8	<i>Chapter 8</i>	334
	<i>Notes</i>	349
	<i>Bibliography</i>	357
	<i>Index</i>	385