
Contents

| | | |
|--|------|------|
| <i>Preface to the Second Edition</i> | page | xiii |
| <i>Preface to the First Edition</i> | | xv |
| Chapter 1. Introduction | | 1 |
| 1.1 Advantages of Panel Data | | 1 |
| 1.2 Issues Involved in Utilizing Panel Data | | 8 |
| 1.2.1 Heterogeneity Bias | | 8 |
| 1.2.2 Selectivity Bias | | 9 |
| 1.3 Outline of the Monograph | | 11 |
| Chapter 2. Analysis of Covariance | | 14 |
| 2.1 Introduction | | 14 |
| 2.2 Analysis of Covariance | | 15 |
| 2.3 An Example | | 21 |
| Chapter 3. Simple Regression with Variable Intercepts | | 27 |
| 3.1 Introduction | | 27 |
| 3.2 Fixed-Effects Models: Least-Squares Dummy-Variable Approach | | 30 |
| 3.3 Random-Effects Models: Estimation of Variance-Components Models | | 34 |
| 3.3.1 Covariance Estimation | | 35 |
| 3.3.2 Generalized-Least-Squares Estimation | | 35 |
| 3.3.3 Maximum Likelihood Estimation | | 39 |
| 3.4 Fixed Effects or Random Effects | | 41 |
| 3.4.1 An Example | | 41 |
| 3.4.2 Conditional Inference or Unconditional (Marginal) Inference | | 43 |
| 3.4.2.a Mundlak's Formulation | | 44 |
| 3.4.2.b Conditional and Unconditional Inferences in the Presence or Absence of Correlation between Individual Effects and Attributes | | 46 |

| | |
|--|-----------|
| 3.5 Tests for Misspecification | 49 |
| 3.6 Models with Specific Variables and Both Individual- and Time-Specific Effects | 51 |
| 3.6.1 Estimation of Models with Individual-Specific Variables | 51 |
| 3.6.2 Estimation of Models with Both Individual and Time Effects | 53 |
| 3.7 Heteroscedasticity | 55 |
| 3.8 Models with Serially Correlated Errors | 57 |
| 3.9 Models with Arbitrary Error Structure – Chamberlain π Approach | 60 |
| Appendix 3A: Consistency and Asymptotic Normality of the Minimum-Distance Estimator | 65 |
| Appendix 3B: Characteristic Vectors and the Inverse of the Variance–Covariance Matrix of a Three-Component Model | 67 |
| Chapter 4. Dynamic Models with Variable Intercepts | 69 |
| 4.1 Introduction | 69 |
| 4.2 The Covariance Estimator | 71 |
| 4.3 Random-Effects Models | 73 |
| 4.3.1 Bias in the OLS Estimator | 73 |
| 4.3.2 Model Formulation | 75 |
| 4.3.3 Estimation of Random-Effects Models | 78 |
| 4.3.3.a Maximum Likelihood Estimator | 78 |
| 4.3.3.b Generalized-Least-Squares Estimator | 84 |
| 4.3.3.c Instrumental-Variable Estimator | 85 |
| 4.3.3.d Generalized Method of Moments Estimator | 86 |
| 4.3.4 Testing Some Maintained Hypotheses on Initial Conditions | 90 |
| 4.3.5 Simulation Evidence | 91 |
| 4.4 An Example | 92 |
| 4.5 Fixed-Effects Models | 95 |
| 4.5.1 Transformed Likelihood Approach | 96 |
| 4.5.2 Minimum-Distance Estimator | 98 |
| 4.5.3 Relations between the Likelihood-Based Estimator and the Generalized Method of Moments Estimator (GMM) | 99 |
| 4.5.4 Random- versus Fixed-Effects Specification | 101 |
| 4.6 Estimation of Dynamic Models with Arbitrary Correlations in the Residuals | 103 |
| 4.7 Fixed-Effects Vector Autoregressive Models | 105 |
| 4.7.1 Model Formulation | 105 |
| 4.7.2 Generalized Method of Moments (GMM) Estimation | 107 |

| | |
|--|-----|
| 4.7.3 (Transformed) Maximum Likelihood Estimator | 109 |
| 4.7.4 Minimum-Distance Estimator | 109 |
| Appendix 4A: Derivation of the Asymptotic Covariance Matrix of the Feasible MDE | 111 |
| Chapter 5. Simultaneous-Equations Models | 113 |
| 5.1 Introduction | 113 |
| 5.2 Joint Generalized-Least-Squares Estimation Technique | 116 |
| 5.3 Estimation of Structural Equations | 119 |
| 5.3.1 Estimation of a Single Equation in the Structural Model | 119 |
| 5.3.2 Estimation of the Complete Structural System | 124 |
| 5.4 Triangular System | 127 |
| 5.4.1 Identification | 127 |
| 5.4.2 Estimation | 129 |
| 5.4.2.a Instrumental-Variable Method | 130 |
| 5.4.2.b Maximum-Likelihood Method | 133 |
| 5.4.3 An Example | 136 |
| Appendix 5A | 138 |
| Chapter 6. Variable-Coefficient Models | 141 |
| 6.1 Introduction | 141 |
| 6.2 Coefficients That Vary over Cross-Sectional Units | 143 |
| 6.2.1 Fixed-Coefficient Model | 144 |
| 6.2.2 Random-Coefficient Model | 144 |
| 6.2.2.a The Model | 144 |
| 6.2.2.b Estimation | 145 |
| 6.2.2.c Predicting Individual Coefficients | 147 |
| 6.2.2.d Testing for Coefficient Variation | 147 |
| 6.2.2.e Fixed or Random Coefficients | 149 |
| 6.2.2.f An Example | 150 |
| 6.3 Coefficients That Vary over Time and Cross-Sectional Units | 151 |
| 6.3.1 The Model | 151 |
| 6.3.2 Fixed-Coefficient Model | 153 |
| 6.3.3 Random-Coefficient Model | 153 |
| 6.4 Coefficients That Evolve over Time | 156 |
| 6.4.1 The Model | 156 |
| 6.4.2 Predicting β_t by the Kalman Filter | 158 |
| 6.4.3 Maximum Likelihood Estimation | 161 |
| 6.4.4 Tests for Parameter Constancy | 162 |
| 6.5 Coefficients That Are Functions of Other Exogenous Variables | 163 |
| 6.6 A Mixed Fixed- and Random-Coefficients Model | 165 |
| 6.6.1 Model Formulation | 165 |
| 6.6.2 A Bayes Solution | 168 |
| 6.6.3 An Example | 170 |

| | |
|---|-----|
| 6.6.4 Random or Fixed Parameters | 172 |
| 6.6.4.a An Example | 172 |
| 6.6.4.b Model Selection | 173 |
| 6.7 Dynamic Random-Coefficient Models | 175 |
| 6.8 An Example – Liquidity Constraints and Firm Investment Expenditure | 180 |
| Appendix 6A: Combination of Two Normal Distributions | 185 |
| | |
| Chapter 7. Discrete Data | 188 |
| 7.1 Introduction | 188 |
| 7.2 Some Discrete-Response Models | 188 |
| 7.3 Parametric Approach to Static Models with Heterogeneity | 193 |
| 7.3.1 Fixed-Effects Models | 194 |
| 7.3.1.a Maximum Likelihood Estimator | 194 |
| 7.3.1.b Conditions for the Existence of a Consistent Estimator | 195 |
| 7.3.1.c Some Monte Carlo Evidence | 198 |
| 7.3.2 Random-Effects Models | 199 |
| 7.4 Semiparametric Approach to Static Models | 202 |
| 7.4.1 Maximum Score Estimator | 203 |
| 7.4.2 A Root- N Consistent Semiparametric Estimator | 205 |
| 7.5 Dynamic Models | 206 |
| 7.5.1 The General Model | 206 |
| 7.5.2 Initial Conditions | 208 |
| 7.5.3 A Conditional Approach | 211 |
| 7.5.4 State Dependence versus Heterogeneity | 216 |
| 7.5.5 Two Examples | 218 |
| 7.5.5.a Female Employment | 218 |
| 7.5.5.b Household Brand Choices | 221 |
| | |
| Chapter 8. Truncated and Censored Data | 225 |
| 8.1 Introduction | 225 |
| 8.2 An Example – Nonrandomly Missing Data | 234 |
| 8.2.1 Introduction | 234 |
| 8.2.2 A Probability Model of Attrition and Selection Bias | 235 |
| 8.2.3 Attrition in the Gary Income-Maintenance Experiment | 238 |
| 8.3 Tobit Models with Random Individual Effects | 240 |
| 8.4 Fixed-Effects Estimator | 243 |
| 8.4.1 Pairwise Trimmed Least-Squares and Least-Absolute-Deviation Estimators for Truncated and Censored Regressions | 243 |
| 8.4.1.a Truncated Regression | 243 |
| 8.4.1.b Censored Regressions | 249 |
| 8.4.2 A Semiparametric Two-Step Estimator for the Endogenously Determined Sample Selection Model | 253 |

| | |
|--|-----|
| 8.5 An Example: Housing Expenditure | 255 |
| 8.6 Dynamic Tobit Models | 259 |
| 8.6.1 Dynamic Censored Models | 259 |
| 8.6.2 Dynamic Sample Selection Models | 265 |
| Chapter 9. Incomplete Panel Data | 268 |
| 9.1 Estimating Distributed Lags in Short Panels | 268 |
| 9.1.1 Introduction | 268 |
| 9.1.2 Common Assumptions | 270 |
| 9.1.3 Identification Using Prior Structure of the Process of the Exogenous Variable | 271 |
| 9.1.4 Identification Using Prior Structure of the Lag Coefficients | 275 |
| 9.1.5 Estimation and Testing | 277 |
| 9.2 Rotating or Randomly Missing Data | 279 |
| 9.3 Pseudopanel (or Repeated Cross-Sectional Data) | 283 |
| 9.4 Pooling of a Single Cross-Sectional and a Single Time-Series Data Set | 285 |
| 9.4.1 Introduction | 285 |
| 9.4.2 The Likelihood Approach to Pooling Cross-Sectional and Time-Series Data | 287 |
| 9.4.3 An Example | 288 |
| Chapter 10. Miscellaneous Topics | 291 |
| 10.1 Simulation Methods | 291 |
| 10.2 Panels with Large N and T | 295 |
| 10.3 Unit-Root Tests | 298 |
| 10.4 Data with Multilevel Structures | 302 |
| 10.5 Errors of Measurement | 304 |
| 10.6 Modeling Cross-Sectional Dependence | 309 |
| Chapter 11. A Summary View | 311 |
| 11.1 Introduction | 311 |
| 11.2 Benefits and Limitations of Panel Data | 311 |
| 11.2.1 Increasing Degrees of Freedom and Lessening the Problem of Multicollinearity | 311 |
| 11.2.2 Identification and Discrimination between Competing Hypotheses | 312 |
| 11.2.3 Reducing Estimation Bias | 313 |
| 11.2.3.a Omitted-Variable Bias | 313 |
| 11.2.3.b Bias Induced by the Dynamic Structure of a Model | 315 |
| 11.2.3.c Simultaneity Bias | 316 |
| 11.2.3.d Bias Induced by Measurement Errors | 316 |

| | |
|---|-----|
| 11.2.4 Providing Micro Foundations for Aggregate Data Analysis | 316 |
| 11.3 Efficiency of the Estimates | 317 |
| <i>Notes</i> | 319 |
| <i>References</i> | 331 |
| <i>Author Index</i> | 353 |
| <i>Subject Index</i> | 359 |