

Contents

| | |
|--|-----------|
| Preface | ix |
| 1 Introduction to Regression Modeling of Survival Data | 1 |
| 1.1 Introduction, 1 | |
| 1.2 Typical Censoring Mechanisms, 17 | |
| 1.3 Example Data Sets, 22 | |
| Exercises, 25 | |
| 2 Descriptive Methods for Survival Data | 27 |
| 2.1 Introduction, 27 | |
| 2.2 Estimation of the Survivorship Function, 28 | |
| 2.3 Using the Estimated Survivorship Function, 40 | |
| 2.4 Comparison of Survivorship Functions, 57 | |
| 2.5 Other Functions of Survival Time and Their Estimators, 73 | |
| Exercises, 84 | |
| 3 Regression Models for Survival Data | 87 |
| 3.1 Introduction, 87 | |
| 3.2 Semiparametric Regression Models, 90 | |
| 3.3 Fitting the Proportional Hazards Regression Model, 93 | |
| 3.4 Fitting the Proportional Hazards Model with Tied Survival Times, 106 | |
| 3.5 Estimating the Survivorship Function of the Proportional Hazards Regression Model, 108 | |
| Exercises, 111 | |

| | | |
|----------|---|------------|
| 4 | Interpretation of a Fitted Proportional Hazards Regression Model | 113 |
| 4.1 | Introduction, 113 | |
| 4.2 | Nominal Scale Covariate, 115 | |
| 4.3 | Continuous Scale Covariate, 127 | |
| 4.4 | Multiple-Covariate Models, 129 | |
| 4.5 | Interpretation and Use of the Covariate-Adjusted Survivorship Function, 137 | |
| 4.6 | Confidence Interval Estimation of the Covariate-Adjusted Survivorship Function, 152 | |
| | Exercises, 156 | |
| 5 | Model Development | 158 |
| 5.1 | Introduction, 158 | |
| 5.2 | Purposeful Selection of Covariates, 159 | |
| 5.3 | Stepwise Selection of Covariates, 180 | |
| 5.4 | Best Subsets Selection of Covariates, 187 | |
| 5.5 | Numerical Problems, 193 | |
| | Exercises, 195 | |
| 6 | Assessment of Model Adequacy | 196 |
| 6.1 | Introduction, 196 | |
| 6.2 | Residuals, 197 | |
| 6.3 | Methods for Assessing the Proportional Hazards Assumption, 205 | |
| 6.4 | Identification of Influential and Poorly Fit Subjects, 216 | |
| 6.5 | Overall Goodness-of-Fit Tests and Measures, 225 | |
| 6.6 | Interpretation and Presentation of the Final Model, 230 | |
| | Exercises, 239 | |
| 7 | Extensions of the Proportional Hazards Model | 241 |
| 7.1 | Introduction, 241 | |
| 7.2 | The Stratified Proportional Hazards Model, 243 | |
| 7.3 | Time-Varying Covariates, 248 | |
| 7.4 | Truncated, Left Censored, and Interval Censored Data, 253 | |
| | Exercises, 269 | |
| 8 | Parametric Regression Models | 271 |
| 8.1 | Introduction, 271 | |
| 8.2 | The Exponential Regression Model, 273 | |

| | | |
|------------|--|------------|
| 8.3 | The Weibull Regression Model, 289 | |
| 8.4 | The Log-Logistic Regression Model, 299 | |
| 8.5 | Other Parametric Regression Models, 304 | |
| | Exercises, 305 | |
| 9 | Other Models and Topics | 307 |
| 9.1 | Introduction, 307 | |
| 9.2 | Recurrent Event Models, 308 | |
| 9.3 | Frailty Models, 317 | |
| 9.4 | Nested Case-Control Studies, 326 | |
| 9.5 | Additive Models, 333 | |
| | Exercises, 350 | |
| Appendix 1 | The Delta Method | 354 |
| Appendix 2 | An Introduction to the Counting Process Approach to Survival Analysis | 358 |
| Appendix 3 | Percentiles for Computation of the Hall and Wellner Confidence Bands | 365 |
| References | | 365 |
| Index | | 379 |