

Contents

1	Introduction	1
	References	5
2	Why Cohort Analysis?	7
2.1	Introduction	7
2.2	The Conceptualization of Cohort Effects	7
2.3	Distinguishing Age, Period, and Cohort.....	9
2.4	Summary	12
	References	13
3	APC Analysis of Data from Three Common Research Designs	15
3.1	Introduction	15
3.2	Repeated Cross-Sectional Data Designs.....	15
3.3	Research Design I: Age-by-Time Period Tabular Array of Rates/Proportions.....	19
3.3.1	Understanding Cancer Incidence and Mortality Using APC Analysis: Biodemography, Social Disparities, and Forecasting.....	19
3.3.2	Cancer Incidence Rates from Surveillance, Epidemiology, and End Results (SEER): 1973–2008.....	21
3.3.3	Cancer Mortality Rates from the National Center for Health Statistics (NCHS): 1969–2007	21
3.4	Research Design II: Repeated Cross-Sectional Sample Surveys ...	26
3.4.1	General Social Survey (GSS) 1972–2006: Verbal Test Score and Subjective Well-Being	26
3.4.2	National Health and Nutrition Examination Surveys (NHANES) 1971–2008: The Obesity Epidemic	32
3.4.3	National Health Interview Surveys (NHIS) 1984–2007: Health Disparities	34
3.4.4	Birth Cohort and Time Period Covariates Related to Cancer Trends.....	37
3.5	Research Design III: Prospective Cohort Panels and the Accelerated Longitudinal Design.....	39
3.5.1	Americans' Changing Lives (ACL) Study 1986–2002: Depression, Physical Disability, and Self-Rated Health... 41	41
3.5.2	Health and Retirement Survey (HRS) 1992–2008: Frailty Index.....	48
	References	50

4 Formalities of the Age-Period-Cohort Analysis Conundrum and a Generalized Linear Mixed Models (GLMM) Framework.....	55
4.1 Introduction	55
4.2 Descriptive APC Analysis	56
4.3 Algebra of the APC Model Identification Problem	61
4.4 Conventional Approaches to the APC Identification Problem....	63
4.4.1 Reduced Two-Factor Models	64
4.4.2 Constrained Generalized Linear Models (CGLIMs).....	65
4.4.3 Nonlinear Parametric Transformation	66
4.4.4 Proxy Variables.....	66
4.4.5 Other Approaches in Biostatistics	67
4.5 Generalized Linear Mixed Models (GLMM) Framework.....	68
References	71
5 APC Accounting/Multiple Classification Model, Part I: Model Identification and Estimation Using the Intrinsic Estimator	75
5.1 Introduction	75
5.2 Algebraic, Geometric, and Verbal Definitions of the Intrinsic Estimator	76
5.2.1 Algebraic Definition	77
5.2.2 Geometric Representation.....	80
5.2.3 Verbal Description	82
5.2.4 Computational Tools	83
5.3 Statistical Properties	84
5.3.1 Estimability, Unbiasedness, and Relative Efficiency	84
5.3.2 Asymptotic Properties	86
5.3.3 Implications	87
5.4 Model Validation: Empirical Example	89
5.5 Model Validation: Monte Carlo Simulation Analyses	92
5.5.1 Results for APC Models: True Effects of A, P, and C All Present.....	94
5.5.1.1 Property of Estimable Constraints	98
5.5.2 Misuse of APC Models: Revisiting a Numerical Example.....	104
5.6 Interpretation and Use of the Intrinsic Estimator	109
Appendix 5.1: Proof of Unbiasedness of the IE as an Estimator of the $b_0 = P_{proj}b$ Constrained APC Coefficient Vector	115
Appendix 5.2: Proof of Relative Efficiency of the IE as an Estimator of the $b_0 = P_{proj}b$ Constrained APC Coefficient Vector.....	116
Appendix 5.3: IE as a Minimum Norm Quadratic Unbiased Estimator of the $b_0 = P_{proj}b$ Constrained APC Coefficient Vector... 117	117
Appendix 5.4: Interpreting the Intrinsic Estimator, Its Relationship to Other Constrained Estimators in APC Accounting Models, and Limits on Its Empirical Applicability	118
References	120

6 APC Accounting/Multiple Classification Model, Part II: Empirical Applications.....	125
6.1 Introduction	125
6.2 Recent U.S. Cancer Incidence and Mortality Trends by Sex and Race: A Three-Step Procedure.....	125
6.2.1 Step 1: Descriptive Analysis Using Graphics.....	126
6.2.2 Step 2: Model Fit Comparisons	146
6.2.3 Step 3: IE Analysis	152
6.2.3.1 All Cancer Sites Combined	153
6.2.3.2 Age Effects by Site	156
6.2.3.3 Period Effects by Site	161
6.2.3.4 Cohort Effects on Cancer Incidence	165
6.2.3.5 Cohort Effects on Cancer Mortality.....	166
6.2.4 Summary and Discussion of Findings	167
6.3 APC Model-Based Demographic Projection and Forecasting....	169
6.3.1 Two-Dimensional versus Three-Dimensional View	170
6.3.2 Forecasting of the U.S. Cancer Mortality Trends for Leading Causes of Death.....	171
6.3.2.1 Methods of Extrapolation.....	171
6.3.2.2 Prediction Intervals.....	172
6.3.2.3 Internal Validation	173
6.3.2.4 Forecasting Results	181
Appendix 6.1: The Bootstrap Method Using a Residual Resampling Scheme for Prediction Intervals	188
References	189
7 Mixed Effects Models: Hierarchical APC-Cross-Classified Random Effects Models (HAPC-CCREM), Part I: The Basics	191
7.1 Introduction	191
7.2 Beyond the Identification Problem	192
7.3 Basic Model Specification.....	195
7.4 Fixed versus Random Effects HAPC Specifications	199
7.5 Interpretation of Model Estimates.....	205
7.6 Assessing the Significance of Random Period and Cohort Effects.....	208
7.6.1 HAPC Linear Mixed Models	209
7.6.1.1 Step 1: Study the Patterns and Statistical Significance of the Individual Estimated Coefficients for Time Periods and Birth Cohorts.....	209
7.6.1.2 Step 2: Test for the Statistical Significance of the Period and Cohort Effects Taken as a Group	212
7.6.2 HAPC Generalized Linear Mixed Models.....	215
7.7 Random Coefficients HAPC-CCREM	222

Appendix 7.1: Matrix Algebra Representations of Linear Mixed Models and Generalized Linear Mixed Models	227
References	229
8 Mixed Effects Models: Hierarchical APC-Cross-Classified Random Effects Models (HAPC-CCREM), Part II: Advanced Analyses.....	231
8.1 Introduction	231
8.2 Level 2 Covariates: Age and Temporal Changes in Social Inequalities in Happiness	231
8.3 HAPC-CCREM Analysis of Aggregate Rate Data on Cancer Incidence and Mortality	243
8.3.1 Trends in Age, Period, and Cohort Variations: Comparison with the IE Analysis	243
8.3.2 Sex and Race Differentials.....	244
8.3.3 Cohort and Period Mechanisms: Cigarette Smoking, Obesity, Hormone Replacement Therapy, and Mammography.....	257
8.4 Full Bayesian Estimation.....	261
8.4.1 REML-EB Estimation.....	261
8.4.2 Gibbs Sampling and MCMC Estimation.....	264
8.4.3 Discussion and Summary	268
8.5 HAPC-Variance Function Regression	269
8.5.1 Variance Function Regression: A Brief Overview	270
8.5.2 Research Topic: Changing Health Disparities.....	271
8.5.3 Intersecting the HAPC and VFR Models	272
8.5.4 Results: Variations in Health and Health Disparities by Age, Period, and Cohort, 1984–2007	275
8.5.5 Summary.....	280
References	282
9 Mixed Effects Models: Hierarchical APC-Growth Curve Analysis of Prospective Cohort Data	285
9.1 Introduction	285
9.2 Intercohort Variations in Age Trajectories.....	287
9.2.1 Hypothesis	287
9.2.2 Model Specification	288
9.2.3 Results	291
9.3 Intracohort Heterogeneity in Age Trajectories	294
9.3.1 Hypothesis	294
9.3.2 Results	296
9.4 Intercohort Variations in Intracohort Heterogeneity Patterns	300
9.4.1 Hypothesis	300
9.4.2 Model Specification	301
9.4.3 Results	302

9.5 Summary	307
References	309
10 Directions for Future Research and Conclusion	313
10.1 Introduction	313
10.2 Additional Models	315
10.2.1 The Smoothing Cohort Model and Nonparametric Methods.....	315
10.2.2 The Continuously Evolving Cohort Effects Model	316
10.3 Longitudinal Cohort Analysis of Balanced Cohort Designs of Age Trajectories.....	317
10.4 Conclusion.....	319
References	320
Index	323