

SUBJECT INDEX

'Note: Page numbers followed by "f" indicate figures, "t" indicate tables.'

A

Adaptive (sequential) sampling
 designs, 23
Admissible Estimators, 37–41, 55
Admissible strategies, 47–48
Almost unbiased ratio estimator,
 273–274
Altham's model, 664–667
Analytic inference, 687
Anderson's measure, 545–546
Area Level Model, 573, 577–579
Arnab modification, 436–437
Arnab allocation, 227
Arnab and Singh method, 488–491
Arnab's model, 516–518
Autocorrelated population, 99–103
 CSS, 103–106
 efficiency, 93–103
 circular, 104–106
 linear, 89–93, 103
 population with linear trend, 96–99
 periodic variation, 99
 random arrangement of units, 95
 two dimensional, 112–113
 variance estimation, 106–112
Auxiliary information, 257
Auxiliary variable, 117, 325, 480

B

Bailey's binomial model, 846
Balance Repeated Replication method
 (BRR method), 587, 614–629,
 649, 677
Balanced Incomplete Block Design
 (BIBD), 148, 776–777
Balanced sample, 198
Balanced sampling design, 196–197
Balanced sampling plan, 780–783
Balanced sampling plan excluding con-
 tiguous units (BSEC), 780–783
Balanced systematic sampling, 98–99

Bandwidth, 754–755
Bayes Estimator, 202–203
Bayesian imputation, 485–487
Bayesian inference, 167–168, 200–203
Bernoulli sampling, 147
Best linear unbiased estimator
 (BLUE), 680
Best linear unbiased Prediction (BLUP),
 186, 575
Biased estimator, 24, 845
BIBD, 148, 776–777
Binomial population, 18–19
Bird-Banding, 851
Bonferroni test, 662
Bootstrap, 649
 mirror match, 635–636
 rescaling, 633–634
Bootstrap confidence interval, 630
Bootstrap for finite population, 630–636
Bootstrap for SRSWR sampling,
 631–633
Bootstrap t-method, 630
Bootstrap without replacement (BWO),
 635
Borrowing Strength, 567–573
Breidt and Opsomer estimator, 755–756
Brewer's sampling scheme, 137–138
Brier model, 667

C

Calibration estimator, 313–319
Calibration methods, 757–759
Capture probability, 854
Capture-recapture methods, 844–856
Categorical data analysis, 645–671
CC Method, 561
Central limit theorem, 220
Chaudhuri's RR technique, 520
Chebyshev Inequality, 78–80, 80t
Chi-square distance function, 314, 803
Chi-square test goodness of fit, 645–646

Chi-square test of homogeneity,
663–664

Chi-square test of independence,
661–663

Christofide's model, 518

Circular Systematic sampling (CSS),
103–106

Closed population, 844–850

Cluster sampling, 409, 423–424,
823–824
estimation of mean per unit, 417–420
optimum choice of cluster size,
414–416

Coefficient of variation, 77, 453,
591–592

Cold deck imputation, 479

Combinatorics, 147–150

Combined ratio estimator, 276–280

Combined regression estimator,
276–280

Complete enumeration, 3–4

Complete sufficient statistic, 46

Complex survey designs, 587, 640, 645,
650, 661, 664, 677

Composite estimator, 568–573

Composite Method, 562

Concomitant Variables, 703–708

Conditions of unbiasedness, 26–27

Confidence interval, 737–742, 848
for distribution function and
quantiles, 818
for mean and proportion, 74–76
large sample size, 74–75
small sample size, 75
stratified sampling, 739–741
survey parameter, 737–738

Construction of strata, 233–240

Continuous population, 1–2

Controlled sampling, 773–774
experimental design configuration,
776–783
of linear programming, 783–784
nearest proportional to size design,
784–785
of non-linear programming, 785–786

Co-ordination of Samples over time,
786–791

Cost function, 220, 329, 331, 441–442

Cumulative distribution function (CDF),
485–486, 691, 797

Cumulative total method, 7–8,
118–119, 118t–119t

D

Dalenious and Hodge's approximation,
237–239

Data (D), 17, 23–24, 42

Deductive imputation, 479

Design effect ($Deff$), 638, 651, 684–685

Design-unbiased estimator, 168

Design-based estimators, 749–750

Determination of sample size, 76–80

Deterministic imputation, 480

Difference Correlation Method,
563–564

Difference estimator, 29, 287–289

Difference method of estimation,
326–331

Direct Estimation, 564

Disproportionate sampling, 824–825

DISTANCE balanced sampling plan
(DBSP), 783

Distance function, 314, 316

Distribution function, 795
calibration method, 757–759
confidence interval estimation,
767–768, 818
design based estimation, 748–749

Domain estimation, 558–560

Donor, 479–480

Double sampling, 325

Doubly balanced incomplete block
design (DBIBD), 149

Dual to ratio estimator, 311–313

Bias of dual estimator, 312

Durbin's sampling scheme, 138–139

E

Effective sample size, 4, 6

Eichhorn and Hayre's model, 518–519

Empirical Bayes, 581–582

Empirical Best Linear Unbiased
Prediction (EBLUP), 580–581

Empirical likelihood (EL), 795, 797

Empirical likelihood ratio confidence intervals, 813–818
 End corrections, 97–98
 Equicorrelated model, 176–179
 Ericson's technique, 182, 200, 515–516
 Estimating Equations, 723–727
 Estimating function for a survey population, 731–736
 Estimating Functions (EF), 723
 interval estimation, 736–742
 Estimation of change, 394–396
 Estimation of domain, 62–67
 Estimation of mean of means, 396–402
 Estimation of median, 762–767
 Estimation of proportion, 350, 506–507, 509–511, 514–515
 Estimation of Quantiles, 761–762
 Estimator, 23–24, 41
 Exchangeable model, 182–183
 Exponential Distribution, 695–696

F

Fay's Method, 628–629
 Fay-Harriet Model, 579–581
 F-corrected Wald Statistics, 658
 Fellegi correction, 653
 Finite population, 2, 680
 Fish-tagging studies, 851
 Fixed effective size (FES) design, 733
 Fixed sample size design (FESD), 6, 217, 266–267, 307–308
 Fractional interval, 103
 Franklin's RR technique, 519
 Full optional RR technique (FORT), 533

G

Gain due to Stratification, 240–247
 General Linear Mixed Model, 573–575
 Generalized difference, 29
 Generalized difference Estimator, 29
 Generalized difference predictor, 173
 Generalized Jackknife Estimator, 605–606
 Generalized least square estimator (GLS estimator), 680

Generalized Pearsonian chi-square statistics, 650–651
 Generalized Regression Estimator (GREG), 316, 568, 802–804
 Generalized Variance Functions (GVF), 587, 637–640
 applicability of GVF model, 640
 justification of GVF model, 638–639
 Gini coefficient, 747
 GLS estimator, 680
 Goodness of fit, 646–661
 Greg estimator vs. MPEL estimator, 803–804
 Grouped balanced half-sample method (GBHS method), 625–626
 GVF method for variance estimation, 639–640

H

Hadamart matrix, 618, 622
 Half-samples, 592
 Hansen-Hurwitz Estimator, 28, 120–122, 195, 460–461, 596, 797
 Hansen-Hurwitz strategy, 206
 Hanurav's Algorithm, 11–16
 Hanurav's sampling scheme, 139–140
 Harmonic mean, 716, 718
 Hartley-Ross estimator, 275, 464–465
 HH estimator. *See* Hansen-Hurwitz estimator
 Hidioglou modifications, 435–436
 Hierarchical Bayes (HB), 582–583
 Higher order JK Estimator, 604–605
 Homogeneity, tests of, 663–664
 Homogeneous quadratic estimator, 435
 Horvitz-Thomson Estimator, 27, 54, 90, 124, 136, 142, 144–145, 161–162, 169, 228, 444, 459–460, 523–524, 595, 803, 837
 Horvitz-Thomson Predictor, 171
 Hot deck imputation, 479–480
 Housing unit, 561
 Hypergeometric model, 845

I

- Ignorable nonresponse, 475
- Imputations, 479–483
- Inclusion probabilities, 5
 - consistency conditions, 5–6
- Inclusion probability proportional to
 - aggregate size (PPAS), 136–151
- Inclusion probability proportional to
 - measure of size sampling (IPPS), 136–151, 228–233, 257, 596, 608–610, 621
- Bernoulli sampling, 147
- Brewer's sampling scheme, 137–138
- Durbin's sampling scheme, 138–139
- Hanurav's sampling scheme, 139–140
- LMS sampling design, 140–141
- nearest proportional to size sampling, 150–151
- PPS systematic Sampling, 141–143, 143t
- Sampford's sampling, 143–145
- use of combinatorics, 147–150
- Indirect estimators, 573
- Infinite population, 2
- Interpenetrating network of subsampling (IPNS), 106, 496–502, 592
- Intersection Probabilities, 841–842
- Interval estimation, 74–76, 220, 270–272, 673, 736–742, 848–849
- Intraclass correlation, 93, 108, 414, 658
- Intraclass correlation coefficient, 412–414, 638
- Inverse sampling, 81–84

J

- Jackknife Method, 587, 599–611, 649, 677
- Jackknife variance estimation, 807
- Jolly–Seber model, 851–856
- Judgment Ranking, 700–701

K

- Kernel function, 754–755
- Keyfitz method, 787–789
- Kuo Estimator, 756–757

Kuk's model, 511–512, 517

Kuo Estimator, 756

L

- Lahiri–Midzuno–Sensampling scheme (LMS sampling scheme), 10–11, 13, 117, 149–150, 204, 207–209
- Lahiri's Method, 119–120
- Lanke method, 789–791
- Lehman–Scheffe approach, 723
- Leysieffer and Warner's measure, 539–544
- Likelihood, 41–44
- Lincoln method, 844–845
- Linear homogeneous unbiased estimator, 444, 453
- Linear Programming, 774, 783–784
- Linear systematic sampling, 89–93
- Linear trend, 96–99
- Linear unbiased estimators, 23, 25–29, 453–455
- Linearization Method, 587–592
- Linearly optimal, 728–730
- Liu and Chow's technique, 513–515
- Location sampling, 838–839
- Logistic regression, 480, 679–680
- Log-linear model, 855–856
- Lund estimator, 833

M

- Mail Questionnaire, 822
- Mangat and Singh model, 512–513, 518
- MAR. *See* Missing at random
- Margin of permissible error, 77–78
- Match sample, 404
- Maximum empirical likelihood (MEL), 798
- Maximum likelihood estimator (MLE), 508, 835
- Maximum pseudo empirical likelihood (MPEL), 800
 - estimator for population distribution function, 801
 - estimator under linear constraints, 801–802

MCAR. *See* missing completely at random

Mean for recent occasion, 368–394

Mean imputation, 480, 482–483

Mean square error, 24–25, 259, 291, 418, 440, 456, 469, 494, 559, 761

Mean square estimation, 456–465

Measure of Protection of Privacy, 539–547

Measure of size, 117, 133

Measurement bias, 493–496

Measurement errors, 470, 493–502

Minimal sufficient statistic, 44

Minimax strategy, 48

Mirror-Match BT method, 635–636

Missing at random (MAR), 475

Missing completely at random(MCAR), 475

Model-assisted estimators, 752–755

Model-assisted inference, 169–184

Model-based estimators, 750–752, 754–755

Mobile population, 821

Model pseudo empirical likelihood (MPEL), 801

Model design-unbiased estimator, 168–169

Model unbiased estimators, 681, 684, 752

Model-based inference, 167–169, 184–194

Model-design based (model assisted) inferences, 210

Modified chi-square, 662–663

More than two-stage sampling, 437–439

MPEL estimator asymptotic behaviour, 802–804

MSE of dual estimator, 312

Multiframe sampling, 826–837

Multiphase sampling, 325

Multiple imputation, 479, 483–484

Multiple Marking, 849–850

Multiple regression model, 735

Multiplicity or network sampling, 825–826

Multiplier, 444

Multistage sampling, 423–424, 596–598, 808

Multivariate regression estimator, 304–305

Murthy's estimator, 129–136, 133t–136t, 461–462

N

Nandarama-Watson estimator, 755

Nearest hot deck imputation, 479–480, 483

Nearest Proportional to Size, 150–151, 784–785

Neighbourhood relationship, 840

Nested Error Regression Model, 575–577

Network sampling, 825–826

Newton-Raphson iterative procedure, 679–680

Neyman statistic (X^2_N), 650

Neyman's optimum allocation, 698

NMAR. *See* Not missing at random

Nonexistence theorems, 23, 32–37

Nonignorable nonresponse, 476

Noninformative sampling designs, 23, 168

Nonlinear estimators, 587

Non-Linear Programming, 587

Nonnegative homogeneous quadratic unbiased estimator, 458

Nonnegative variance estimation, 456–465

Non-parametric regression method, 754–757

Nonresponse, 742–744

Nonresponse errors, 470–471

Nonsampling errors, 469–504

Nonsequential sampling, 168

Normed size measure, 9

Not missing at random (NMAR), 476

O

Open population, 844

Optimal estimator, 170, 734

Optimal model-unbiased prediction, 180–182

Optimal RR technique, 533–538
 Optimal sampling strategies, 167–168
 Optimality
 of balanced sampling, 199–200
 of HTE, 35–36
 of ratio estimator, 266
 of regression estimator, 294–295
 Optimum allocation, 236–237,
 342–344, 343t, 441–444,
 698–700
 Optimum cluster size, 414–416
 Optimum Estimating Functions, 727
 Optimum points of stratification,
 233–237
 Optional randomized response technique
 (ORT), 533–538
 Order Statistics, 699
 Ordered data, 17, 71
 Ordered sample, 16–17

P

Parameter space, 2–3
 Parameter, 2–3
 Partial ORT (PORT), 533, 537–538
 Pearsonian chi-square, 655
 Percentile method, 630
 Periodic variation, 99
 Peterson method, 844–845
 Point estimation, 673
 Poisson (or Bernoulli) Sampling, 147
 Politz and Simmons method,
 476–478
 Polygonal designs, 783
 Polynomial regression model, 197–198
 Population, 1–2
 Position estimator, 762–764
 Post stratification, 247–249,
 759–760
 PPS Systematic sampling scheme,
 161–162
 Prediction approach, 184
 Primary sampling unit, 423–424
 Probability proportional to aggregate size
 sampling (PPAS sampling),
 527–528, 789–791

Probability proportional to size, 9–10,
 118–136, 416–417
 Probability proportional to size with
 replacement sampling (PPSWR
 sampling), 9–10, 28, 118–124,
 195, 218, 224, 226–228, 243
 –247, 257, 268–269, 330–331,
 354–356, 378–380, 387–392,
 409, 416–417, 430, 528–530,
 531t–532t, 537, 596, 606–607,
 787, 797
 Probability proportional to size without
 replacement sampling (PPSWOR
 sampling), 10, 13, 124–136,
 125t, 257, 627
 Probability sampling, 1–21
 Product estimator, 313
 Productmeasure model, 170–176,
 186–190, 549–550
 Proportional allocation, 225, 232–236,
 349–350
 Pseudoempirical likelihood (PEL), 795
 Purposive sampling design, 188–189
 Purposive sampling, 4

Q

Quadratic unbiased estimator, 50,
 456–458, 460, 522–523
 Quantiles, 741–742
 confidence interval, 767–768
 estimation, 747, 761–762

R

Raj's estimator, 432–434
 Raj's regression estimator, 305–306
 Random arrangements of units, 95
 Random Group Method (RG method),
 587, 592–599, 677
 Random imputation, 480, 483
 Random number, 66, 66t, 118
 Random permutation models (MRP),
 183–184
 Random start, 89–90, 90t
 Randomized response techniques
 (RR techniques), 505

Ranked set estimator, 709
 Ranked Set Sampling (RSS), 691
 Rao-Blackwell technique, 51, 723
 Rao-Blackwellization, 45–46, 71–74
 Rao-Hartley-Cochran sampling (RCH sampling), 117, 155–161, 159t–161t, 356–358, 525–527, 536
 Rao-Scott first order corrections, 652
 Rao-Scott second order corrections, 653
 Rare populations, 824, 837–838
 Ratio Correlation Method, 562–563
 Ratio Estimator, 313, 316, 440, 589–591
 approximate expression of bias and mean square errors, 261–264
 combined ratio estimator, 277
 dual to, 311–313
 exact expression of bias and mean square error r , 258–261
 optimality of ratio estimator, 266
 separate ratio estimator, 277–280
 for stratified sampling, 275–280
 Ratio estimator for several auxiliary variables, 281–283
 Ratio imputation, 480–481
 Ratio method of estimation, 257, 331–337, 846
 Ratio-type estimators, 274–275
 Regression analysis, 673
 Regression coefficient, 673–674
 Regression estimator, 289–306, 610–611
 approximate expression of bias and mean square errors, 337–338
 combined regression estimator, 301–303
 separate regression estimator, 298–299
 for stratified sampling, 297–303
 Regression imputations, 480, 483
 Regression method of estimation, 337–344
 Regression model, 192–194, 197–198, 575–577, 580–581

Repetitive sampling, 367
 Rescaling Bootstrap, 633–634
 Residual analysis, 658–661
 Response probabilities, 475–476
 Respondent unit, 479–480
 Restricted ML method (RML method), 580
 Revealing density, 546
 Right-Tail Allocation, 699–700
 Robustness, 167–168, 195–200
 Rotation sampling, 367–368

S

Sampford's Sampling scheme, 143–145
 Sample, 4
 Sample space, 17
 Sample survey, 3
 Sampling design, 4–5, 410, 587
 Sampling errors, 3–4, 469
 Sampling frame, 2, 469–470
 Sampling from a binomial population, 18–19
 Sampling from a normal population, 18
 Sampling from a uniform population, 18
 Sampling on two occasions, 368–387
 Sampling rare population, 821–857
 Sampling scheme, 8, 367–368, 409, 497, 799–800
 Sampling strategies, 47–48, 168
 Sampling Strategy, 168
 Scale load estimator, 796–797
 Schenker and Welsh method, 487
 Schnabel census, 849
 Screening, 822–824
 Self-weighting design, 444–448, 445t, 447t–448t
 Separate ratio estimator, 276–280
 Separate regression estimator, 298–299
 Sequential Sampling, 23, 839–840
 Simple random sampling without replacement (SRSWOR), 9, 12, 27, 51–67, 93, 95, 97, 169, 214, 282–283, 288, 293–294, 308,

310–311, 322–324, 328–329,
 335–336, 340–341, 395–396,
 409, 412–413, 428, 495–496,
 708–716, 738, 748, 773–774
 Singh and Singh method, 491–492
 Single imputation, 479
 Sized-Based Probability Selection,
 716–718
 Small area estimation, 557–558,
 560–583
 area-level model, 573, 577–579
 borrowing strength, 567–573
 composite estimator, 568–573
 direct estimation, 564
 EBLUP, 580–581
 empirical Bayes, 581–582
 Fay-Herriot model, 579–580
 generalized regression estimator, 568
 HB approach, 582–583
 nested error regression model,
 575–577
 synthetic estimator, 564–565
 Snowball sampling, 837–838
 Srinath and Hiriroglou modification,
 435–436
 Statistic, 649
 Stratification estimator, 762–764
 Stratified multi-stage sampling,
 627–628
 Stratified sampling, 213, 614–619,
 654–655, 739–741, 817–818
 Study variable, 2–3
 Sub-sampling method, 488–492
 Substitution, 479
 Sudman-Waksberg method, 823–824
 Sufficiency, 41–46, 105
 Sufficient statistic, 41, 46
 Superpopulation model, 99–100, 167,
 229–230, 680, 727–731, 737,
 809
 Survey Parameter, 737–738
 Symptomatic Accounting Technique,
 561–564
 Synthetic Estimation,
 564–565
 Systematic sampling, 89, 839

T

Test of independence, 661–663
 Tests of Homogeneity, 663–664
 Three-stage sampling, 423–424,
 438–439
 Transformation model, 179–180,
 190–192
 Two auxiliary variables, 305
 Two-dimensional Systematic sampling,
 112–113, 113f, 113t
 Two-phase sampling, 325, 824
 Two-stage sampling, 424, 655–658

U

Ultimate unit, 409–410, 423–424
 Unbiased estimator, 24, 32, 63–64, 103,
 105–106, 410, 417–418, 424,
 438–439, 828, 845
 Unbiased Predictors, 170–180
 Unbiased product type estimators,
 308–311
 Unbiased ratio estimator, 28–29,
 273–275, 462–463
 Unbiased regression estimator,
 296–297
 Unbiased strategy, 47
 Unequal (or varying) probability
 sampling, 117
 Uncluster sampling design, 33
 Unified Sampling Theory, 23–50
 Uniform Distribution, 695
 Uniformly minimum variance unbiased
 estimator (UMVUE), 25, 33
 Unit, 1–2
 Unlabelled data, 17
 Unordered data, 17, 41–44, 124, 200
 Unordered sample, 16–17
 Unrelated question method, 509–511

V

Variance, 24–25, 76–77, 453, 795
 Variance estimation, 106–112,
 345–349, 587, 681–682, 806
 BRR method, 614–629
 GVF method
 JK method, 599–611

- Linear estimator, 453
- LR method, 587–592
- RG method, 592–599
- Vital rates method (VR Method), 561

W

- Wald Statistics
 - for goodness of fit, 649–650
 - tests of independence, 661
 - tests of homogeneity, 663
- Wang et al. method, 485–487

- Warners's technique, 506–509, 517
- Welsh method, 487
- With replacement sampling
 - (WR sampling), 8
- Without replacement sampling
 - (WOR sampling), 8

Y

- Yates-Grundy variance estimator, 32
- Yates-Grundy's estimator, 460