

SUBJECT INDEX



A

accelerated failure time models, 796
 acceptance region, 892
 ACF. *See* autocorrelation function (ACF)
 addition, 804–805, 809, 823
 ADF-GLS procedure, 645
 adjusted R -squared, 34–36, 40, 159.
 See also coefficient of determination (R^2)
 adjustment equation, 568
 admissible, 389, 395
 age
 correlation with
 education/income, 9
 labor force participation model, 681
 probit model example, 669
 regression approach, 665
 as socioeconomic variable, 54
 aggregation bias, 341
 Ahn-Schmidt estimator, 313
 Aitken's Theorem, 207–208
 Akaike information criterion, 36,
 159–160, 565, 589, 644
 algorithms
 BFGS algorithm, 170
 BHHH algorithm, 242, 795
 EM algorithm, 774
 iterative algorithm, 935, 943
 Metropolis–Hastings algorithm,
 445–446
 Oberhofer-Kmenta
 algorithm, 299
 variable metric algorithm, 939
 Almon lag, 566
 almost sure convergence,
 900–901, 905
 alternative estimators, 180–189
 alternative hypothesis, 95–98, 681
 analog estimation, 536
 analysis of behavior, 7
 analysis of covariance, 118–120
 analysis of variance, 33–38, 867
 analytic function, 926
 APC (average propensity to
 consume), 2
 AR(1) model
 alternatives to, 609
 autocorrelation and, 581–583

disturbance processes, 257–259
 Ergodic Theorem, 260
 gross correlation and, 617
 Grunfeld investment model, 332
 linear least squares, 622
 panel data model, 317
 restrictions and, 584–585
 serial correlation, 273–274
 spectral density function, 626–627
 stability condition, 573
 testing unit roots, 636–637
 AR(2) model
 ACF and PACF example,
 622–623
 restrictions and, 584–585
 serial correlation, 272, 274
 stationarity requirement, 613
 testing common factor
 restrictions, 586
 ARCH-in-mean model, 240–242
 ARCH model, 216, 238–242, 244
 ARDL. *See* autoregressive
 distributed lag (ARDL)
 model
 Arellano, Bond, and Bover
 estimator, 308
 ARFIMA model, 647–649
 ARIMA model, 632
 ARMA model. *See* autoregressive-
 moving average (ARMA)
 model
 associative law, 806
 assumption 1, 163
 asymptotic covariance matrix
 BHHH algorithm, 795
 BHHH estimator, 507n22, 512,
 741, 773, 797
 CES production function, 129
 defined, 915
 estimating, 71, 77–78
 GLS estimator and, 212, 321, 342
 GMM estimator, 140, 204,
 409–410
 Hausman test, 302
 instrumental variable
 estimator, 79
 Lagrange multiplier test, 489, 492
 MLE, 347, 498, 500, 672–673, 688
 MPC example, 110
 MSL estimation, 514

OLS estimation, 216–217, 323
 parameter estimator and, 169
 Phillips curve example, 569
 production function example, 499
 QMLE, 673–674
 robust estimation of, 198–201
 stochastic frontier model, 504
 theorem, 184
 Wald statistic, 550
 weighting matrix and, 312
 asymptotic distribution
 delta method, 70
 of empirical moments, 542
 of GMM estimator, 543
 in GR model, 196–197
 with independent
 observations, 68
 large sample distribution theory,
 914–918
 least squares estimator and, 105
 nonlinear instrumental variables
 estimator, 183
 theorem, 77
 asymptotic efficiency
 defined, 70–71, 916
 MLE property, 473, 479–480
 as statistical property, 460
 asymptotic expectations, 917–918
 asymptotic moments, 918
 asymptotic negligibility, 264
 asymptotic normality
 consistency, 72
 definition, 916
 GMM estimator, 543
 of least squares, 195, 260
 least squares estimator, 69
 M estimators theorem, 464
 MLE property, 473, 478–479
 nonlinear least squares estimator,
 167–169
 regression estimation, 621
 Slutsky Theorem, 184
 as statistical property, 460
 stochastic regressors, 74
 asymptotic properties
 assumptions, 461–463
 defined, 885
 of estimators, 464–465
 of instrumental variables
 estimator, 196–197

Subject Index 1001

- least squares, 65–74, 194–196, 265–267
 - MCSE, 688
 - method of moments estimator, 531–533
 - MLE, 476–482, 493, 689
 - of parameter estimators, 65
 - of regression models, 72
 - asymptotic uncorrelatedness, 264
 - asymptotic variance, 479–482
 - attenuation, 83–90, 761
 - attributes, 720
 - augmented Dickey-Fuller test, 643, 646, 658
 - autocorrelation. *See also*
 - nonautocorrelation
 - ARDL models, 571, 581–582
 - defined, 15
 - of disturbances, 545
 - Durbin-Watson test and, 126
 - estimation of models with, 274–276
 - forecasting and, 279–280
 - generalized regression model and, 191
 - GLS estimator and, 209
 - GNP deflator, 634
 - Grunfeld investment model, 333
 - labor force participation study, 710
 - long memory models, 647
 - models with, 195
 - negative autocorrelation, 251–253, 647
 - panel data, 317–318, 324–326
 - stationarity assumption and, 258–259
 - of stationary stochastic process, 614–616
 - SUR model, 360–362
 - testing for, 268–271
 - time-series data and, 192, 255–256
 - autocorrelation coefficient, 256
 - autocorrelation function (ACF)
 - AR(2) model, 622–624
 - of AR process, 618
 - correlogram as counterpart, 621
 - gross correlation, 617
 - moving-average process and, 616
 - spectral density function, 626
 - stationary stochastic processes, 614
 - autocorrelation matrix, 256
 - autocovariance, 256, 264, 626, 630
 - autocovariance at lag k , 612, 625
 - autocovariance function, 614, 625
 - autocovariance matrix, 256
 - autoregression. *See* AR(1) model;
 - univariate autoregression;
 - vector autoregression (VAR)
 - autoregressive, fractionally
 - integrated, moving-average (ARFIMA) model, 647–649
 - autoregressive conditional
 - heteroscedasticity, 238–246
 - autoregressive distributed lag (ARDL) model, 571–579, 660
 - autoregressive form, 257, 563, 611
 - autoregressive integrated
 - moving-average (ARIMA) model, 632
 - autoregressive moving-average (ARMA) model
 - ADF-GLS procedure, 645
 - ARCH model and, 240
 - autocorrelation of stationary stochastic process, 614–616
 - frequency domain, 624–631
 - nonstationary processes, 631–632
 - parameters for univariate time series, 621–624
 - partial autocorrelation, 617–619
 - stationarity and invertibility, 611–614
 - stationary stochastic processes, 609–611
 - univariate time series, 619–621
 - Yule-Walker equations for, 616
 - average propensity to consume (APC), 2
- B**
- bandwidth, 454–456, 458
 - Bartlett window, 628, 645
 - basis for a vector space, 813
 - basis vectors, 811
 - Bayes factor, 153, 438–439
 - Bayesian estimation, 290, 318, 426, 429–439, 461, 512
 - Bayesian information criterion, 36, 152–153, 160, 589, 644
 - Bayes theorem, 429–430, 437–443
 - behavioral equations, 380
 - Behrens-Fisher problem, 133n11
 - Ben-Akiva measure, 719
 - Bernoulli distribution, 855
 - Bernstein-von Mises Theorem, 447
 - best linear unbiased (BLU), 193
 - best linear unbiased estimator (BLUE), 890
 - beta
 - consistency of least squares estimator, 66–67
 - Gauss-Markov theorem, 48
 - least squares and, 84
 - beta distribution, 855
 - beta function, 928
 - beta kernel, 455
 - beta parameter, 65
 - between-groups estimator, 289–290
 - BFGS algorithm, 170
 - BFGS method, 939
 - BHHH algorithm, 242, 795
 - BHHH estimator
 - asymptotic covariance matrix, 741, 773, 797
 - condition moment tests, 507
 - example, 482
 - GMM estimation, 550
 - hypothesis tests and, 673, 678
 - Lagrange multiplier test, 490, 492, 500, 769
 - likelihood test, 491
 - MLE and, 481
 - production function example, 499
 - pseudo-MLE, 246, 520
 - two-step MLE, 511–512
- bias
- aggregation bias, 341
 - biased test, 894
 - fixed effects models, 697
 - least squares estimator and, 679
 - measurement error and, 85
 - model and, 160
 - omission of relevant variable and, 148–149
 - pretest estimator and, 150
 - in sampling, 673
 - simultaneous-equations bias, 379n3, 396
 - testing aggregation bias, 341
 - truncated regression model, 761
- biased estimator, 150
- binary choice models
- bivariate probit models, 710–719
 - data, 951
 - dynamic binary choice models, 708–710
 - estimation and inference, 670–689
 - estimator comparisons, 705
 - goodness of fit measure, 683–686
 - hypothesis testing, 676–678
 - individual effects example, 700
 - latent regression, 668–670
 - log-likelihood function, 688
 - marginal effects, 674–676, 712–713
 - maximum score estimator, 702–704
 - MSL estimation, 514–517

1002 Subject Index

- binary choice models (*continued*)
 multivariate probit models, 710–719
 proportions data, 686–689
 random utility models, 670
 regression, 665–668
 sample selection, 713–714
 semiparametric analysis, 700–702
 semiparametric estimation, 452–453, 704–706
 specification tests, 679–683
 binary variables
 categories, 117–118
 groupings, 118–120
 marginal effect, 740
 probability model example, 676
 in regression, 116–117
 spline regression, 121–122
 binomial distribution, 856
 bivariate distribution, 781–782, 863–868
 bivariate probit models, 710–719
 bivariate random variables, 862–864
 bivariate regression, 22–23, 453
 block diagonal matrix, 823–824
 Boot-de Witt data, 348
 bootstrapping
 computation, 920, 924–925
 discrete choice models, 702–703
 inference, 113
 lagged variables, 579, 595, 600
 box and whisker plot, 879–882
 Box-Cox regression model, 498, 500–501
 Box-Cox transformation, 171, 173–175, 179
 Box-Jenkins methods, 619–621, 649
 Box-Ljung statistic, 274, 276, 623–624
 Box-Pierce statistic, 271, 274, 276, 622–624
 Box-Pierce test, 269–270
 Breusch-Godfrey test, 269–270
 Breusch-Pagan LM test, 223–225, 769
 Broyden-Fletcher-Goldfarb-Shanno (BFGS) method, 939
 Broyden's method, 939
 Bureau of Economic Analysis (BEA), 282
 Butler and Moffitt method, 692–694, 700, 715
- C**
 calculus, matrix algebra, 837–845
 CAN estimators, 460, 473, 917
 CAN functions, 480n3
 canonical correlation, 657, 659
 capital asset pricing model (CAPM), 240, 339, 351–357
 Cauchy-Schwartz inequality, 92, 904
 causality, 381–382, 590, 593
 CDF. *See* cumulative distribution function (CDF)
 censored data
 estimation, 766–768
 normal distribution, 762–764
 specification, 768–773
 tobit model, 764–766
 censored regression (tobit) model, 764–766
 censored variables, 762–763
 censoring
 applications, 774–780
 dependent variables, 761
 heteroscedasticity and, 768
 model for counts, 773–774
 central limit theorem. *See also* Lindberg-Feller central limit theorem; Lindberg-Levy central limit theorem; Lyapounov central limit theorem
 chi-square and, 108
 consistent estimation, 527
 convergence to normality, 262–265
 dependent observations and, 260
 depicted, 911
 GMM estimation, 542
 Gordin's central limit theorem, 265
 large sample distribution theory, 908–913
 limiting normal distribution, 532
 martingale difference, 263, 273, 463, 542
 moment condition tests, 506–507
 random variables, 859
 central moments, 529, 848
 CES (constant elasticity of substitution), 129, 162
ceteris paribus analysis, 28
 characteristic equation, 574, 614, 825
 characteristic roots, 825–827, 830–831
 characteristics, 720
 characteristic vectors, 825–827, 830
 Chebychev's inequality, 848, 898, 903
 Chebychev theorem, 463, 900–901, 912
 chi-squared distribution
 degrees of freedom and restrictions, 110, 678
 distribution theory, 851–853
 Lagrange multiplier statistic, 177, 489
 Lagrange multiplier test, 224
 noncentral chi-squared distribution, 487n8
 normal disturbances and, 104–105
 statistical tables, 955
 Wald criterion, 96, 302
 chi-squared statistic
 degrees of freedom, 155
 Hausman test and, 699
 testing restrictions, 172
 choice based sampling, 673, 730
 choice models, 719–735
 Cholesky decomposition, 922n4
 Cholesky factor, 445–446, 832, 932
 Chow test, 130n8, 132–133, 135–136, 139, 681
 Civil Aeronautics Board, 118
 classical regression
 Bayesian analysis, 430–434
 estimator case, 204
 gross correlation and, 617
 heteroscedasticity and, 314, 323
 homoscedastic disturbance and, 215
 marginal effects, 560
 nonstochastic regressors and, 590–591
 normal linear model, 872–873
 ordinary least squares and, 341
 panel data, 289
 posterior odds for, 438–439
 weighted least squares, 240
 closed-form solution, 934
 CMLE (conditional maximum likelihood estimator), 699
 Cobb-Douglas model
 LAD estimation, 449–450
 log linear model, 12
 Nerlove's study and, 125–126
 nonnormal disturbances, 502
 production function example, 102–104, 498–499
 systems of equations, 363–365
 translog cost function, 366–367
 Cochrane-Orcutt estimator, 273–275, 318, 360n20
 coefficient of determination (R^2). *See also* adjusted R -squared analysis of variance, 34, 867
 classical regression, 686
 comparing models, 37–38
 constant term and, 36–37
 depicted, 33
 hypothesis testing, 678
 Lagrange multiplier as, 680, 940

- multiple regression, 35
- nonlinear setting and, 943
- significance of regression, 54–55
- theorem, 34
- coefficients
 - changes in subsets, 132–133
 - as elasticities, 123
 - individual regression, 27
 - linear restrictions on, 122
 - significant effects, 739n65
 - testing hypotheses about, 50–52, 676
- cofactor, 817, 840
- cointegrating rank, 652, 659
- cointegrating vectors, 650, 652–653, 659
- cointegration
 - common trends, 653–654
 - German money demand, 657–660
 - long memory models, 647
 - testing for, 655–657
 - VAR representations, 654–655
- cointegration relationship, 658
- collinearity, 154, 470
- column rank, 814–815
- column space, 814–815
- column vector, 803, 816n3
- common factor, 583–586
- common factor model, 278–279
- common trend, 653–654
- compactness, 461
- completeness condition, 384
- complete systems, 379
- comprehensive model, 153
- computation, optimization and, 919–946
- concavity, 461–462, 840
- concentrated log-likelihood, 349, 495, 498, 940–941, 945–946
- conditional density, 427, 530n1
- conditional distribution, 864–867
- conditional likelihood function, 482–483, 698–699
- conditional logit model, 720, 723–724, 729–735
- conditional maximum likelihood estimator (CMLE), 699
- conditional mean, 14–15, 457, 676, 713, 864
- conditional moments
 - relationships, 865–867
 - tests, 505–508, 743, 771
- conditioning, bivariate distribution, 864–867
- condition number, 56–58, 829
- confidence interval
 - confidence interval test, 491
 - impulse response function, 595
 - latent class model example, 442
 - for linear combination of coefficients, 53–54
- normal mean, 891–892
- for parameters, 52–53
- Phillips curve example, 570
- prediction interval and, 111
- tests based on, 895–896
- confidence level, 891
- conformable for addition, 804
- conformable for multiplication, 805
- congruent generators, 921
- conjugate prior, 435
- consistency
 - asymptotic efficiency of estimators and, 71
 - asymptotic normality, 72
 - criterion function and, 462
 - GMM estimator and, 204
 - least squares estimator, 66–67, 679
 - as LS property, 518
 - maximum likelihood estimator and, 690
 - mean of functions, 900
 - M estimators theorem, 464
 - MLE property, 473, 477–478
 - nonlinear least squares estimator, 167–169
 - nonlinear restrictions and, 109
 - of OLS in generalized regression model, 194
 - regression estimation, 621
 - of sample mean, 899
 - of s-squared, 69
 - as statistical property, 460
 - stochastic regressors, 74
 - superconsistent, 572
- consistent estimator. *See also* White estimator
 - distribution theory, 899
 - estimation frameworks, 463
 - GMM, 526–533
 - least squares, 70
 - simultaneous-equations models, 397–398, 405
- consistent test, 894–895
- constant elasticity, 11–12
- constant elasticity of substitution (CES), 129, 162
- constant returns hypothesis, 103–104, 126
- constants
 - coefficient of determination and, 36–37
 - dummy variables as, 482
 - gasoline consumption study, 132
 - observations with, 272
 - prediction and, 111
 - random effects model and, 694
 - regression and, 15, 28, 40
- constant variance. *See* homoscedasticity
- constrained optimization, 842–843
- constraints, 941–942
- consumption
 - application data set, 946–947
 - cointegration in, 650–652, 656
 - economic analysis and, 624
 - as economic variable, 631
 - error correction and, 580
 - macroeconomic model, 380
 - as macroeconomic variable, 649
 - permanent income model of consumption, 8, 525, 548
 - rational lag model example, 575
 - relationship to income, 3, 8–9
- consumption function
 - binary variables and, 117–118
 - Cox test for, 157
 - example, 33
 - Hausman test for, 83
 - J test for, 155
 - Keynes', 1–2, 8–9, 587
 - least squares and, 75
 - macroeconomic models, 380–381
 - nonlinear, 171–173
 - nonlinear instrumental variables estimator, 183
- contagion property, 859
- continuous variables, 845–846, 857–858
- contrasts, 291
- convergence
 - assessing, 943
 - in distribution, 906–908
 - of empirical moments, 541
 - forms of, 900–903
 - of functions, 903–904
 - in lower powers, 902
 - in mean, 902, 905
 - of moments, 203, 260–262, 905
 - to normality, 262–265
 - in probability, 897, 903
 - in quadratic mean, 897
 - to random variables, 904–905
- convex, 840
- correlation, 56, 712, 861–862, 879. *See also* autocorrelation; serial correlation
- correlation matrix, 879
- correlogram, 621
- cosine kernel, 455
- cosine law, 819

1004 Subject Index

- cost function
 - airline production example, 286
 - data sets, 948–950
 - example of flexible, 174
 - functional form, 126
 - groupwise heteroscedasticity, 236–237
 - nonparametric example, 458–459
 - translog cost function, 366–369
- count data
 - censoring and truncation, 773–774
 - defined, 663
 - discrete choice models, 740–752
- covariance
 - of disturbances, 15–16
 - estimation and inference, 879
 - identification through restrictions, 394–395
 - joint distribution, 861–862
 - theorem, 865
- covariance matrix
 - estimation, 940
 - estimation and inference, 879
 - inference and prediction, 100
 - least squares estimator, 48, 217–219
 - for ordinary least squares, 219–221
 - probability theory, 869
- covariance stationarity, 612
- covariance stationary, 254, 612
- covariance structures, 286, 314, 320–334
- covariates, 7
- Cox statistic, 156–157
- Cox test, 155–159, 682–683. *See also* sum of squared residuals
- CPI
 - Dickey-Fuller test, 638
 - inflation studies, 600–602
 - investment equation, 21
 - restricted investment equation, 98
- Cramér-Rao lower bound, 429, 473, 479–480, 493, 889–890
- Cramer-Wold device, 908
- criterion function
 - asymptotic property, 461–462
 - for estimation, 704
 - GMM estimations, 537
- critical region, 892
- cross-sectional data
 - covariance structures for, 320–334
 - estimation, 878
 - heteroscedasticity, 215, 238
 - limitations of, 284
 - production functions, 284
 - time effects and, 283
- cumulated effect, 561
- cumulated multipliers, 416
- cumulative distribution function (CDF)
 - computing integrals, 926–927
- discrete choice models, 692–693, 710
- hazard function, 792
- limiting distribution, 906
- probability theory, 846, 857
- sampling distributions, 882
- truncated normal distribution, 757
- CUSUM test, 135–139
- cyclical variation, 624
- D**
- data
 - behavior of, 463
 - data problems, 56–61
 - default data, 952
 - deseasonalizing, 118
 - duration data, 790–792
 - economic analysis and, 624
 - education data, 953
 - frequency data, 723
 - individual data, 686
 - linear transformations
 - exercise, 39
 - and methodology, 4–5
 - ordered data, 736–740
 - well behaved data, 478, 483
- data generating process (DGP)
 - assumptions, 17, 65–66
 - computation and optimization, 920–923
 - estimation and inference, 880
 - generalized method of moments, 533
 - linear regression model and, 10–18
 - nonlinear model, 163–164
 - nonstationary processes, 635
 - probability density function, 468
 - random variables, 845
 - regression model and, 72
- data series, 131–132, 262
- data sets, 283, 946–953
- Davidon-Fletcher-Powell (DFP) method, 938–939, 942, 945
- Deaton statistic, 156
- decomposition
 - singular value decomposition, 833
 - symmetric matrix, 835
 - of variance, 48, 625, 628, 866
- definite matrices, matrix algebra, 834–837
- degree of inconsistency, 87
- degree of truncation, 759
- degrees of freedom
 - adjusted R^2 , 35
 - chi-squared distribution, 678
 - chi-squared statistic and, 155
 - distributions with, 853–854
 - least squares and, 566
 - maximum likelihood estimators and, 493n12
 - number of restrictions and, 110
 - partial correlation coefficient, 35
 - restrictions and, 489, 593
 - sample periodogram and, 627
 - testing hypotheses, 106
- delta method
 - ARDL model and, 573
 - asymptotic distribution of function, 70
 - CES production function, 129
 - impulse response function, 595
 - large sample distribution theory, 913–914
 - marginal effects and, 674
 - Phillips curve example, 569
 - standard error and, 128, 172–173, 175, 776
 - stochastic frontier model, 504
 - theorem, 527
 - two-step estimation, 188
- demand
 - elasticities of demand, 12, 52–53
 - for gasoline, 570–571
 - macroeconomic model
 - example, 380
 - for money, 657–660
- demand equations
 - common structures, 339–340
 - deterministic relationships, 7
 - example, 378
 - inverse demand equations, 7–8
 - multivariate regression model, 362
 - stability of, 658
 - testing model instability, 660
- demand system, 364
- DeMoirve's theorem, 625
- density
 - hazard function, 792
 - negative binomial model, 745
 - parametric estimation, 427
 - probability density function, 468
 - properties of, 474–475
 - of truncated random variable, 757
- dependent observations, 73–74, 260, 541

- dependent variables. *See also* independent variables
 - binary choice model, 665
 - censoring, 761–762
 - computing considerations, 37
 - defined, 837
 - discrete choice models, 663–664
 - jointly dependent variables, 379
 - lagged response, 571
 - least squares estimator and, 42
 - linear regression models, 7–9
 - maximum likelihood estimator, 686
 - measurement error, 84
 - Phillips curve example, 569
 - prediction and, 111n8
 - price and quantity as, 8n1
 - regression model and, 33
 - transformation of, 174
 - uncommon usage, 673
 - variations as deviations from mean, 31
 - depreciation, 84
 - derivatives
 - computing, 933
 - of empirical moments, 541
 - maximum likelihood estimation, 840
 - probit and logit models, 675
 - Slutsky theorem, 668
 - deseasonalizing data, 118
 - determinant, 816–817, 823, 830, 840
 - deterministic relationship, 2, 7–8
 - detrending, 635–636
 - deviance, 742
 - deviations
 - correlation of, 15
 - of costs, 125
 - from means, 824
 - from production function, 502
 - variation in dependent variable, 31
 - DGP. *See* data generating process (DGP)
 - diagonal matrix, 803, 816, 823, 827
 - Dickey-Fuller test, 602, 637–646, 655–656
 - difference operators, 562–564
 - differencing
 - integrated processes, 631–632
 - long memory models, 647
 - manipulating series via, 649
 - and white noise, 635
 - differentiation, Taylor series, 837–840
 - digamma function, 928
 - dimensions, 803
 - discrepancy vector, 96, 101, 108
 - discrete, 845
 - discrete choice models. *See also* binary choice models
 - count data models, 740–752
 - features, 663–664
 - logit models, 719–735
 - ordered data, 736–740
 - discrete Fourier transform, 630
 - discrete population, 922
 - discrete random variables, 845, 855–856
 - discriminant analysis, 685n19
 - disposable income, 575
 - distributed lag
 - autoregressive distributed lag models, 571–579
 - form, 563, 573
 - marginal propensity to consume, 109
 - models with lagged variables, 565–571
 - distribution. *See also* gamma distribution
 - contagion property, 859
 - degrees of freedom, 853–854
 - of function of random variable, 856–858
 - heterogeneity in, 72
 - idempotent quadratic forms, 874
 - for logit model, 667
 - parameters of, 527–531
 - of standardized normal vector, 876
 - distribution theory
 - central limit theory and, 262
 - large sample, 896–919
 - probability and, 845–877
 - distributive law, 806
 - disturbance
 - ARDL models, 582
 - assumption, 73
 - asymmetrically distributed, 71
 - autoregression and, 609
 - bootstrapped, 579
 - GMM estimation, 545
 - heteroscedasticity and, 191, 222
 - independent variables and, 10, 14
 - as innovations, 610
 - maximum likelihood estimation, 679
 - nonnormal disturbances, 501–505
 - normal distribution and, 17, 518
 - population regression and, 19
 - serial correlation, 256–259
 - stable relationships and, 8
 - as stationary, 611
 - SUR model linkages with, 342
 - and testing, 104–108
 - variances and covariances, 15–16
 - as white noise, 643
 - zero mean of, 163
 - disturbance variance, 133
 - dominant root, 417
 - dot product, 805
 - double-length regression, 243
 - downhill simplex, 935
 - duality (theory of), 125
 - dummy variables
 - computing marginal effects, 668
 - as constants, 482
 - criterion function and, 462n27
 - in earnings equation, 116–117
 - elasticities and, 123
 - fixed effects models and, 695
 - LSDV and, 289
 - probability model example, 676
 - in production of airline services study, 118–120
 - specification issues, 768
 - treatment effect, 788
 - dummy variable trap, 118
 - duration dependence, 794
 - duration model, 756, 790–798
 - Durbin's test, 271
 - Durbin-Watson statistic, 275–276, 582–583, 958
 - Durbin-Watson test, 126n6, 270–271
 - dynamic equation, 573–576
 - dynamic models
 - binary choice models, 708–710
 - lagged effects in, 560–562
 - methodological issues, 579–586
 - properties of, 415–420
 - simultaneous-equation models, 380
 - dynamic multipliers, 415–417, 420
 - dynamic panel data model, 75, 307–314, 551–555
 - dynamic regression, 75
 - dynamic regression models, 558–564
- E**
- earnings equation, 55, 116–117. *See also* income
 - econometric model, 1–4, 125, 379–380, 482–483, 544–547
 - econometrics. *See also* capital asset pricing model (CAPM)
 - Almon lag, 566
 - computation in, 925–933
 - data analysis and, 284
 - defined, 1
 - GMM estimation in, 447–448
 - growth in field, 4–5
 - identification in, 621
 - model concept, 160
 - QR models, 689
 - strong stationarity, 612n5

1006 Subject Index

- economics
 - ceteris paribus* analysis, 28
 - data analysis and observation
 - frequency, 624
 - econometrics and, 1
 - economic variables, 619n11, 631
 - economies of scale, 125–126, 284, 499
 - education
 - descriptive statistics example, 880
 - as human capital variable, 54
 - labor force participation
 - model, 681
 - lack of measurement for, 84
 - observable indicators and, 87
 - partial correlation coefficient, 28–29
 - regression approach, 665
 - relationship to income, 9–10
 - study with labor, 87–90
 - threshold effects, 120
 - treatment effects, 788
 - efficiency
 - asymptotic efficiency, 70–71, 460–461
 - of FGLS estimator, 210, 273
 - of GLS estimator, 217
 - in production of airline services
 - study, 118–120
 - as statistical property, 41
 - efficient, 71, 79, 886
 - efficient estimator
 - covariance of, 301
 - generalized regression model, 210
 - least squares as, 572
 - maximum likelihood estimation, 470–472, 526
 - serial correlation, 271–273
 - simultaneous-equation
 - models, 414
 - efficient scale, 92
 - efficient score test, 489
 - efficient two-step estimator, 244
 - efficient unbiased estimator, 886, 888–890
 - eigenvalue, 659, 827
 - elasticity
 - coefficients as, 123
 - cointegrating vector example, 653
 - constant elasticity, 11–12
 - of demand, 12, 52–53
 - estimates, 7
 - lagged variables and, 570
 - money demand example, 658
 - MPC and, 109
 - partial adjustment model
 - and, 568
 - of probabilities, 723
 - of substitution, 12
 - translog cost function, 368
 - travel mode choice example, 733
 - U.S. manufacturing example, 369
 - EM algorithm, 774
 - empirical moment equation, 202, 534, 541
 - encompassing principle, 153
 - endogeneity, 379, 381–382
 - endogenous variables
 - distinction, 381
 - dynamic models, 416
 - nonlinear model example, 404
 - VARs and, 587
 - Epanechnikov kernel, 455
 - equality
 - null hypothesis, 289
 - of row and column rank, 815
 - equations. *See also* systems of
 - equations
 - adjustment equation, 568
 - characteristic equation, 574
 - complete systems of, 379
 - stability of dynamic equation, 573–576
 - equilibrium
 - adjustment to, 418–420
 - dynamic models and, 560
 - and substitution, 594
 - equilibrium condition, 378, 380, 390
 - equilibrium error, 579, 652, 654
 - equilibrium multiplier, 416–417, 562
 - equilibrium relationship, 579, 655
 - ergodic, 74, 262, 621
 - ergodicity, 261–262, 559, 621
 - Ergodic theorem, 260–262, 273, 541, 621
 - Erlang distribution, 854
 - error correction, 579–581, 650
 - error correction model, 654–655, 659–660
 - error function, 926
 - estimable parameters, 469
 - estimation. *See also* methods of
 - estimation; parametric
 - estimation
 - of ARDL model, 572–573
 - based on orthogonality
 - conditions, 534–536
 - in binary choice models, 670–689
 - censored data, 766–768
 - change points and historic
 - events, 142n19
 - cointegration relationships, 658
 - ergodicity and, 261
 - exercise, 39–40
 - in finite sample, 885–888
 - GLS, 207–211, 370–371
 - hypothesis testing and, 95
 - inference and, 877–896
 - with informative prior density, 435–437
 - instrumental variable
 - approach, 308
 - investment equation, 21–24
 - least squares, 42, 48–49, 266–267
 - linear regression models and, 93
 - minimum distance
 - estimators, 205
 - of models with autocorrelation, 274–276
 - nonparametric estimation, 453–459
 - parameters for univariate time
 - series, 621–624
 - parameters of distributions, 527–531
 - properties, 460–465
 - qualitative choices and, 664
 - in selection model, 784–787
 - semiparametric estimation, 447–453
 - serial correlation, 273–277
 - standard error of, 49, 128
 - of SUR models, 350–351
 - with unknown parameters, 227–232
 - VAR, 588–589, 597–600
- estimation criterion, 427
- estimation methods. *See* methods of estimation
- estimators
 - alternative estimators, 180–189
 - asymptotic covariance matrix, 69
 - of asymptotic covariance
 - matrix, 198
 - asymptotic efficiency and, 71
 - asymptotic properties of, 464–465
 - least squares, 41–42
 - minimum distance estimator, 205–206, 538–539
 - statistical properties of, 460
 - statistics as, 882–885
 - truncation and windowing, 627–628
 - within- and between-groups, 289–290
- Euler equation, 526–527
- Euler's theorem, 284n4
- E-Views (computer program), 244n31, 377
- exactly identified, 129, 536, 548
- exactly identified model, 411
- exchange rates
 - data, 949
 - economic analysis and, 624
 - long memory models, 647
 - as macroeconomic variable, 649

Subject Index 1007

- purchasing power parity theory, 650
 - exclusion restriction, 102, 348–349, 394, 404
 - exogeneity
 - of GDP, 659
 - of interest variable, 658
 - linear regression model
 - assumptions, 10, 42
 - long run models, 659
 - nonlinear model assumption, 164
 - regression model, 72
 - vector autoregression, 590–592
- exogenous variables
 - assumption, 542
 - cointegration, 652
 - in context of models, 591
 - distinction, 381
 - duration models, 796–797
 - forecasting and, 576
 - identification and, 708
 - labor force participation
 - example, 709
 - macroeconomic model
 - example, 380
 - simultaneous-equation models, 379
 - specification tests, 414
 - expansion by cofactors, 817
 - expectation, 558, 567, 865, 904
 - expectations-augmented Phillips curve, 251
 - expenditure system, 362
 - explained variable, 7
 - explanatory variable, 7
 - exponential distribution
 - depicted, 910
 - distribution theory, 855
 - likelihood functions, 888–889
 - limited models, 771, 794
 - exponential family, 529–530
 - ex post forecast, 113
 - extended product, 807
 - extramarital affairs data, 952
 - extremum estimator, 461–463, 520
- F**
 - F* distribution
 - distribution theory, 851–853
 - example, 908
 - noncentral *F* distribution, 852
 - probability theory, 875
 - statistical tables, 956–957
 - F* ratio, 172, 289
 - F* statistic
 - adjusting, 685
 - ARDL model, 574, 583
 - Chow predictive test and, 132
 - Cobb-Douglas model, 103
 - fixed effects, 292
 - gasoline consumption study, 136–137, 571
 - hypothesis testing, 177
 - least squares, 83, 95–99, 220
 - linear model and, 175
 - maximum likelihood
 - estimation, 496
 - normal disturbances and, 104–105
 - robust estimation and, 200
 - significance tests for restrictions, 175–177
 - SUR model example, 350
 - testing common factor
 - restrictions, 586
 - testing hypotheses, 106, 114
 - testing joint significance, 82
 - Wald test and, 593
 - F* test, 130, 592, 632
 - factoring, matrix, 832–833
 - fast Fourier transform (FFT), 631
 - FDI variables, 700
 - feasible GLS (FGLS)
 - AR(1) model, 273
 - AR(2) model, 274
 - autocorrelation and, 253, 317, 582
 - binary choice models, 665
 - generalized regression model, 209–211
 - groupwise heteroscedasticity, 236
 - Grunfeld investment model, 331
 - instrumental variables estimator
 - and, 277
 - multiplicative
 - heteroscedasticity, 234
 - panel data, 322
 - random effects model, 296–299, 304
 - restrictions, 689
 - SUR model, 344–347
 - two-step estimation, 227–228, 231
 - FIML. *See* full information maximum likelihood (FIML)
 - final form, 416
 - finite lags, 560, 565–566
 - finite sample properties
 - estimation in, 885–888
 - least squares, 55–56, 65
 - Ljung-Box statistic, 622
 - of ordinary least squares, 193–194
 - unbiased estimation, 41
 - “first generation RCM,” 319
 - first-order autoregression.
 - See* AR(1) model
 - first-order condition, 840
 - fit measures, 159, 209
 - fitting criterion, 19
 - fixed effects model
 - binary choice model
 - extensions, 690
 - cost equations, 292
 - lagged dependent variables
 - and, 307
 - panel data, 285, 287–293, 694–700
 - robust estimation, 314–316
 - flexible functional form, 12, 366–369
 - forecast error, 111, 576
 - forecasting. *See also* prediction
 - accuracy of, 113
 - adjusted R^2 , 159
 - ARDL model and, 576–579
 - ARMA models, 610
 - autocorrelation and, 279–280
 - distinction, 111n8
 - as growth industry, 5
 - Klein’s Model I, 587
 - macroeconomics and, 587n9
 - model performance, 608
 - prediction and, 113
 - regression analysis and, 33
 - VAR approach, 595
 - foreign exchange markets, 238, 649
 - forms of convergence, 900–903
 - Fourier transform, 705n47
 - fractional integration, 632n14, 647–648
 - frequency domain, 624–631
 - Frisch-Waugh theorem, 27, 38–39
 - full column rank, 815
 - full information, 396, 398
 - full information maximum likelihood (FIML)
 - discrete choice models, 716, 727
 - joint estimation and, 405
 - Klein’s Model I, 412
 - labor supply example, 786
 - method of estimation, 407–409
 - travel mode choice example, 732
 - two-step maximum likelihood estimation, 508
 - full rank
 - assumption, 542
 - least squares, 21
 - linear regression model, 10, 13–14, 42
 - regression model and, 72
 - VAR model and, 655
 - full rank matrices, 815–816
 - full rank quadratic form, 875–876
 - fully recursive model, 394–395, 397, 411
 - functional form, 116, 122–124, 126, 163

1008 Subject Index**G**

- gamma distribution
 - computation and optimization, 944–945
 - distribution theory, 855
 - example, 530–531
 - GMM estimation, 538–540
 - limited models, 794
 - MLE, 490n9
 - negative binomial model, 745
- gamma function, 490n9, 927–928
- gamma regression model, 71, 129
- GARCH model, 16, 240–245
- Gauss (computer program), 942
- Gauss-Hermite quadrature, 692, 929
- Gaussian quadrature, 928
- Gauss-Laguerre quadrature, 929
- Gauss-Markov theorem
 - counterparts to, 70–71
 - generalized regression model, 208
 - least squares estimator and, 45–47, 56, 265
 - prediction and, 111
 - stochastic frontier model, 502–503
 - theorems, 47–48
- Gauss-Newton method, 169, 942
- Gauss's method, 448
- GD-84P, 83
- GDP
 - augmented Dickey-Fuller test, 646
 - cointegration and, 650–652
 - cointegration in, 656
 - Dickey-Fuller test, 639
 - as economic variable, 631
 - exogeneity of, 659
 - long memory models, 647
 - nonstationary series example, 632
- GEE estimator, 690n26
- generalized inverse, 82–83, 833–834
- generalized least squares (GLS). *See also* feasible GLS (FGLS)
 - asymptotic covariance matrix, 212, 321, 342
 - asymptotic normality of, 260
 - autocorrelation, 253
 - efficiency of, 217
 - efficient estimation, 207–211, 271
 - groupwise heteroscedasticity, 235
 - heteroscedastic regression model, 216–217, 227
 - log-likelihood function, 688
 - nonlinear systems and, 370–371
 - panel data, 321
 - random effects model, 295–296, 316
 - SUR model and, 341–343
 - weighted least squares, 224
- generalized method of moments (GMM), 426, 447, 559, 590
- generalized method of moments (GMM) estimator
 - asymptotic efficiency, 460
 - CAPM model and, 356
 - consistent estimation, 526–533
 - convenience of, 139
 - demand for money example, 143
 - discrete choice models, 690n26
 - dynamic panel data model, 307–314, 551–555
 - as extremum estimator, 461
 - features, 533–547
 - GLS and, 371
 - heteroscedastic regression model, 221
 - identification, 463
 - identification condition for, 203
 - important results, 201–207
 - joint estimation and, 405
 - Klein's Model I, 412
 - least squares, 43, 165
 - LR statistic, 593
 - method of estimation, 400–401, 409–410
 - as modeling framework, 465
 - municipal expenditures example, 604
 - nonlinear least squares, 169
 - nonlinear systems, 372–373
 - optimal, 140
 - ordinary least squares, 588
 - probit model with random effects, 694
 - pseudo-MLE, 246, 518
 - random effects model, 308–309
 - restrictions in, 142n18
 - semiparametric estimation, 447–448
 - serial correlation, 268
 - testing hypotheses, 548–551
- generalized regression (GR) model
 - asymptotic distribution, 196
 - covariance matrix and, 321
 - nonspherical disturbances, 191–214
 - ordinary least squares, 521
 - R^2 and, 209
 - time-series cross-sectional data, 320
- generalized residual, 671n8, 793
- generalized sum of squares, 209, 211, 229
- general-to-simple method, 151–152, 564, 583, 589
- geometric lag model, 566–571
- GHK simulator, 710, 932–933
- Gibbs sampler, 445–446, 922–923
- globally concave, 840
- globally convex, 840
- global maximum, 840
- GLS. *See* generalized least squares (GLS)
- GMM. *See* generalized method of moments (GMM)
- GMM estimator. *See* generalized method of moments (GMM) estimator
- GNP
 - GNP deflator, 634, 647
 - investment equation, 21–23
 - long memory model example, 648
 - spectral analysis of growth rate, 628–631
- Godfrey LM test, 223–225
- golden section method, 934n23
- Goldfeld-Quandt test, 223–224
- goodness of fit, 31–38, 209, 345
- goodness of fit measure, 683–686, 741–743
- Gordin's central limit theorem, 265
- GPH test, 649
- GQOPT (computer program), 942
- GRADE model, 703
- gradient, 171, 838, 937
- gradient methods, 935–939, 943
- Granger causality
 - lagged variables, 587, 589, 592–593, 604–605
 - simultaneous-equations models, 382
 - time-series models, 658–659
- Granger noncausality, 591
- Granger representation theorem, 654n26
- Grenander conditions, 67–68, 194, 566n5
- grid search, 934
- GR model. *See* generalized regression (GR) model
- grouped data, 686, 688–689
- group means, 288, 315
- group means estimator, 290
- groupwise heteroscedasticity
 - consistent estimation, 317
 - estimation, 327
- Grunfeld investment model, 333
- heteroscedasticity, 223, 232, 235–237, 296
- panel data, 323, 325
- specification issues, 768

- Grunfeld-Boot and de Witt investment model, 339
 Grunfeld's investment data, 329–333, 340
 Gumbel distribution, 720
- H**
- Hansen's test, 134
 Harvey's model of heteroscedasticity, 328
 hat matrix, 60
 Hausman and Taylor estimator, 303–304, 308, 311
 Hausman test
 chi-squared statistic, 699
 instrumental variable and, 80–83
 least squares, 90
 nonnormality, 771
 panel data, 301
 random effects model, 301–303
 travel mode choice example, 731
 hazard function, 759, 793–794, 799, 859
 hazard rate, 792, 799
 Heckit estimator, 784
 Hermite polynomials, 926
 Hermite quadrature, 694, 745n71
 Hessian, 838, 945
 heterogeneity
 in binary choice model, 700
 conditioning and, 699
 in distributions, 72
 duration models, 797–798
 hazard function and, 799
 latent heterogeneity, 440n15
 modeling, 318
 negative binomial regression model, 744–745
 panel data and, 283–286
 Poisson model, 748
 random effects model, 690
 heteroscedastic 2SLS (H2SLS), 401
 heteroscedastic 3SLS (H3SLS), 411
 heteroscedastic extreme value (HEV) model, 733
 heteroscedasticity. *See also*
 groupwise heteroscedasticity
 classical regression, 314, 323
 conditional moment tests, 506
 disturbances and, 545
 estimator case, 204
 generalized regression model and, 191
 GLS estimator and, 209
 GMM estimator, 206
 Grunfeld investment model, 331
 household expenditures and, 15
 Klein's Model I, 412–413
 labor force participation model, 682
 linear regression model, 679
 models with, 195
 multiplicative heteroscedasticity, 232–235, 239n24
 nested logit models, 726
 ordinary least squares estimation, 216–221
 random effects model, 316–317
 robust estimation, 198
 specification issues, 768–769
 specification tests, 680–682
 structural break and, 133
 SUR model, 360–362
 testing, 222–225, 508
 travel mode choice example, 733
 heteroscedastic logit model, 727
 heteroscedastic regression
 applications, 232–237
 discrete choice models, 688
 GMM estimator, 221
 heteroscedasticity, 215–216
 nonlinear weighted least squares, 687
 two-step estimation of, 231
 HEV model, 733
 Hierarchical Bayes estimation, 444–447
 hierarchical regression, 319
 histogram, 454, 880, 885, 911
 homogeneity, 699
 homogeneity restriction, 347, 351, 700
 homogeneous equation system, 820
 homoscedastic extreme value (HEV) distribution, 727
 homoscedasticity
 CAPM model, 356
 conditional moment tests, 506
 defined, 15
 groupwise heteroscedasticity, 236–237
 linear regression, 10, 42, 867
 nonlinear model assumption, 163
 null hypothesis of, 224
 probability theory, 865
 regression models, 72
 testing for, 681–682
 time-series data and, 192
 travel mode choice example, 733
 L'Hôpital's rule, 174, 500
 HPD (highest posterior density) interval, 435, 437
 hurdle model, 749–752
 hyperplane, 33, 38, 813
 hypothesis testing
 approaches to, 95–104
 BHHH estimator, 673
 binary choice models, 676–678
 Cox statistic, 156
 estimation, 465, 892–896
 GMM estimation, 548–551
 least squares estimator, 48, 50–52
 linear regression models and, 93
 maximum likelihood estimation, 484–492
 nonlinear consumption functions, 172
 nonlinear regression models, 175–180
 nonlinear restrictions, 108–110
 nonnested hypothesis, 153
 parametric estimation, 437–439
 t and *F* tests, 632
 Wald statistic, 327, 551, 590, 741
 Wald test, 676
- I**
- I*(1) series
 cointegration, 650
 macroeconomic flows, 632
 structural variables and, 636
 testing unit roots, 637
 idempotent, 24–25, 79
 idempotent matrix, 808–809
 idempotent quadratic forms, 836, 873–875
 identically distributed (iid), 263, 468, 477, 532
 identical regressors, 343–344
 identification
 assumption, 541
 covariance restrictions, 394–395
 defined, 85, 469
 exogenous variables, 708
 intrinsic linearity, 127–130
 M estimator and, 463
 of model parameters, 163
 moment equations
 assumptions, 203
 of parameters, 468–470
 problem of identification, 385–389
 rank and order conditions, 389–394
 stationary stochastic processes, 621
 structural VAR model, 597–600
 identification condition, 13, 129, 542
 identification problem. *See* problem of identification
 identity matrix, 803
 ignorable case, 59
 IIA. *See* independence from irrelevant alternatives (IIA)
 iid. *See* identically distributed (iid)
 impact multiplier, 416, 561

1010 Subject Index

- importance function, 931
 - impulse response, 587, 594
 - impulse response function, 420, 593–595
 - incidental parameters problem, 690, 697
 - incidental truncation, 780–782
 - inclusion of superfluous variables, 148
 - inclusive value, 726
 - income
 - application data set, 946–947
 - data set, 953
 - descriptive statistics example, 880
 - disposable income, 575
 - earning equation, 51–52
 - income elasticity, 53
 - as independent variable, 8n1
 - kernel density estimator, 881–882
 - Keynes' consumption function and, 1–2
 - as macroeconomics variable, 649
 - partial correlation coefficient, 28–29
 - permanent income, 8, 84, 525, 548
 - relationship to consumption, 8
 - relationship to education, 9–10
 - unit root, 650
 - voting behavior and, 665
 - inconsistency
 - degree of inconsistency, 87
 - in Gauss-Markov theorem, 76
 - least squares, 75
 - indefinite matrix, 835
 - independence, 875–877
 - independence from irrelevant alternatives (IIA), 724, 726, 731, 733–735
 - independent observations
 - assumption, 66
 - asymptotic distribution with, 68
 - defined, 878
 - regression model and, 72
 - independent variables. *See also* dependent variables
 - defined, 837
 - and disturbance, 10
 - income as, 8n1
 - lagged response, 571
 - lagged variables and, 307
 - linear regression models, 7–8, 42
 - marginal effects for, 668
 - measurement error and, 84
 - regression model and, 72
 - theorem, 51
 - index function model, 668–670, 695
 - indicator, 87
 - indirect least squares, 396
 - individual data, 686
 - individual effect, 285, 700
 - inequality
 - Cauchy-Schwartz inequality, 92, 904
 - Chebychev's inequality, 848, 898, 903
 - Jensen's inequality theorem, 477, 849, 902, 904
 - likelihood inequality, 477
 - Markov's inequality, 898, 903
 - inference
 - in binary choice models, 670–689
 - estimation and, 877–896
 - parametric estimation and, 427–447
 - vector autoregression, 600
 - infinite lag model, 560, 565–571
 - infinite lags, 567
 - inflation studies
 - ARCH model and, 238
 - CPI and, 600–602
 - inflation data, 949
 - structural VAR and, 596
 - information matrix, 479, 489, 498, 890
 - information matrix equality, 474, 476
 - informative prior, 432, 435–437, 439
 - initial conditions, 255, 416, 708
 - innovation, 254, 264, 594, 610
 - instability
 - demand for money, 142–143
 - testing, 659–660
 - of VAR model, 605
 - instrumental variables
 - empirical moment equation, 541
 - estimation by, 397–398
 - FGLS and, 277
 - GMM estimator, 540, 545, 548
 - Hausman's specification test and, 80–83
 - method of moments estimation and, 201
 - possibilities with, 202
 - twins study, 88
 - two stage least squares and, 74–80
 - instrumental variables estimator
 - GMM estimator, 310, 313
 - least squares, 192–197
 - method of estimation, 397–398
 - nonlinear model, 181–183
 - random effects model, 303–306
 - simultaneous equations model, 379
 - specification tests, 414
 - insufficient observations, 131–132
 - integrals, 926, 928–929
 - integrated hazard function, 793
 - integrated of order one, 631
 - integrated processes, 631–632
 - integrated series. *See* I(1) series
 - intelligence
 - lack of measurement for, 84
 - observable indicators and, 87
 - interaction term, 123–124
 - interdependent systems, 379
 - interest rates
 - ARCH model and, 238
 - cointegrating vector example, 652–653
 - exogeneity of variable, 658
 - investment equation and, 21
 - measurement difficulties for, 8
 - testable implications and, 93–94
 - as variable, 84
 - interval estimate, 435, 885, 890–892
 - intrinsic linearity, 127–130
 - invariance, 473, 480
 - invariance of maximum likelihood estimators, 359
 - inverse, 836
 - inverse function, 844, 921
 - inverse Gaussian distribution, 528, 794
 - inverse matrices, 820–822, 831
 - inverse Mills ratio, 759, 789
 - inverses, 823–824
 - inverted gamma distribution, 431, 436
 - invertibility, 611–614
 - invertible polynomial, 564
 - investment equation
 - analysis of variance for, 33–34
 - estimating, 21–24
 - prediction for, 111–113
 - restricted example, 98–99
 - semilog equation in, 123
 - investment model
 - application data set, 947
 - Grunfeld's investment data, 329–333
 - investment data, 950
 - macroeconomic model example, 380
 - testable implications for, 93
 - irrelevant variables, 150–151
 - iterated expectations, 865
 - iteration, 171, 936, 944
 - iterative algorithm, 935, 943
- J**
- J* test, 154–155, 178
 - jackknife, 220, 924–925
 - Jacobian
 - defined, 844
 - distribution of function of random variables, 863

- limited model, 795
 - MLE, 493, 497, 499–500
 - probability theory, 845
- Jensen's inequality theorem, 477, 849, 902, 904
- joint density, 860–864, 922
- joint distribution, 860–864
- jointly dependent variables, 379
- joint posterior distribution, 433
- K**
- k* class, 401–403, 411n23
- Kaplan-Meier estimator, 797–798
- kernel density estimator
 - depicted, 911
 - discrete choice model, 704–705
 - dynamic models, 709
 - estimation, 456, 465
 - income, 881–882
 - latent class model example, 443
 - MSL estimation, 516–517
 - nonparametric regression function, 706–708
 - semiparametric estimation, 452–453
 - as substitute for histogram, 881
- kernel function, 706
- Keynes' consumption function, 1–2, 8–9, 587
- Khincine theorem, 69, 76, 463, 527, 900
- Klein's Model I
 - adjustment to equilibrium, 419
 - comparison of methods, 411–413
 - forecasting and, 587
 - identification, 390
 - stability, 417
 - statistical tables, 950
 - testing overidentifying restrictions, 415
- knots, 120–122
- Kolmogorov's theorem, 901–902
- Kronecker product, 342, 824–825
- Kruskal's theorem, 214, 343n7
- kurtosis, 772, 848, 879
- L**
- labor studies
 - application data set, 947
 - with education, 87–90
 - participation example, 664, 709–710
 - supply example, 782
- lack of invariance, 110
- LAD. *See* least absolute deviations (LAD)
- lagged variables
 - autoregression and, 610
 - autoregressive distributed lag models, 571–579
 - distributed lag models, 565–571
 - Durbin-Watson test and, 270
 - dynamic models, 558–564, 579–586
 - estimation with, 277
 - forecasting and, 111n8
 - GMM estimator, 310, 545
 - panel data and, 307
 - random effects model, 308
 - testing with, 270
 - vector autoregression, 586–605
- lag length, 564–565, 589, 644, 646
- lag operator
 - AR (1) process, 610
 - ARIMA model, 632
 - models, 562–564, 571, 594
 - polynomials in, 596, 613
- Lagrange multiplier (LM) statistic
 - as alternative, 350
 - autocorrelation and, 271, 582
 - CAPM model, 353, 355
 - computing, 679, 940
 - convenience of, 141
 - count data models, 741
 - GARCH effects, 244
 - GMM, 550–551
 - Grunfeld investment model, 332
 - heteroscedasticity, 769
 - hypothesis testing, 177–178, 496, 678
 - labor force participation model, 682
 - likelihood function and, 494–495
 - likelihood ratio test and, 324
 - LM test example, 500
 - MLE, 501
 - model based tests, 230
 - negative binomial model, 744
 - Poisson regression model, 746–747
 - problem with approach, 139
 - simultaneous equations models, 413–414
 - SUR model example, 351
 - testing correlation, 712
 - testing for homoscedasticity, 681
 - theorems, 489
 - tobit model, 775
- Lagrange multiplier (LM) test
 - application example, 492
 - autocorrelation and, 269, 271
 - basis of, 177
 - Box-Pierce test and, 270
 - Breusch-Pagan LM test, 223–225, 769
 - discrete choice models, 678–679
 - functional form, 143
 - GMM, 548–551
 - Grunfeld investment model, 330
 - Hausman test, 303
 - heteroscedasticity, 223–224, 328, 769
 - hypothesis testing, 327, 465, 484, 489–490
 - inference, 100–101, 108, 115
 - lack of invariance and, 110
 - linear regression model, 495
 - for log-linearity, 500–501
 - maximum likelihood estimation and, 298
 - model based tests, 230
 - Nerlove's study, 125
 - nonnormality, 771
 - omitted variables, 680
 - overdispersion, 743
 - random effects model, 298
 - specification tests, 682
 - stationary stochastic processes, 609n2
 - structural changes and, 602
 - time-series models, 622n13
 - Wald test and, 486
- lag weights, 562, 567, 573
- lag window, 628
- latent class model, 426, 439–443, 516–517
- latent regression, 668–670
- latent roots, 827
- latent vectors, 827
- laws
 - associative law, 806
 - cosine law, 819
 - distributive law, 806
 - of large numbers, 900–902
 - strong law of large numbers, 901–902
 - weak law of large numbers, 900
- leading term approximation, 917
- least absolute deviations (LAD)
 - bootstrapping, 925
 - limited models, 771
 - as M estimator, 465
 - semiparametric estimation, 448–450
- least squares. *See also* weighted least squares (WLS)
 - asymptotic normality of, 260
 - as efficient estimator, 572
 - estimator, 41–42
 - as extremum estimator, 461
 - FGLS and, 211
 - finite-sample properties of, 55–56
 - F* statistic, 95–99, 220
 - GMM estimation, 165, 548
 - goodness of fit, 31–38

1012 Subject Index

- least squares (*continued*)
 groupwise heteroscedasticity, 237
 inconsistent models for, 75
 inefficiency of, 217
 instrumental variables
 estimation, 192–197
 lag models and, 559, 566
 least squares regression, 19–25
 matrix algebra, 817
 as maximum likelihood
 estimator, 518
 as modeling framework, 465
 optimal linear predictor, 43–44
 partial correlation coefficients,
 28–31
 partialing out, 27–28
 partitioned regression, 26–27
 population orthogonality
 conditions, 42–43
 problem, 934
 testing model instability, 660
least squares dummy variable
 (LSDV) model
 autocorrelation and, 317
 FGLS and, 297
 fixed effects, 287
 Hausman test, 302
 panel data, 289
 return to schooling example, 306
 time effects and, 291
least squares estimator. *See also*
 nonlinear least squares
 estimator
 asymptotic distribution and, 105
 asymptotic properties, 65–74,
 265–267
 bias, 679
 CAPM model and, 356
 covariance matrix, 217–219
 distinctions, 80
 estimating variance of, 48–49,
 266–267
 fire-order conditions for, 165
 gamma model, 129
 Gauss-Markov theorem, 45–48
 GMM estimator and, 540
 identification and, 463
 large sample properties, 167–169
 maximum likelihood, 156, 588
 nonstochastic regressors
 and, 45–46
 production function, 449–450
 as robust estimator, 590
 serial correlation, 265–267
 tobit model, 766, 775
 truncated regression model, 761
 twins study, 88
 unbiased estimation, 44–45, 151
least variance ratio, 402
- Leibnitz theorem, 475
L'Hôpital's rule, 174, 500
Liapounov. *See* Lyapounov central
 limit theorem
likelihood equation, 472, 476, 670
likelihood function, 431, 468–470,
 472, 494, 888–889
likelihood inequality, 477
likelihood ratio (LR) statistic
 as alternative, 349
 Cox test and, 155
 GMM, 550, 593
 Grunfeld investment model, 332
 hypothesis testing, 327, 678
 misspecification and, 770
 MSL estimation, 514
 SUR model example, 350
 VAR testing and, 593
likelihood ratio (LR) test
 application example, 490–492
 discrete choice models, 678
 GMM, 548–551
 heteroscedasticity, 230, 237
 hypothesis testing and, 327,
 484–486
 LIML and, 413
 linear regression model, 494
 LM statistic and, 324
 MLE and, 329
 Poisson distribution, 745
 Poisson regression model, 746
 testing hypotheses, 465
 univariate model and, 686
LIMDEP (computer program),
 244n31, 377
limited information maximum
 likelihood (LIML)
 discrete choice models, 726
 example, 523
 Klein's Model I, 412
 methods of estimation, 396–404
 specification tests, 413–414
 travel mode choice example, 732
 two-step maximum likelihood
 estimation, 509
limiting distribution
 central limit theorem, 532
 convergence in distribution,
 906–908
 F statistic, 106
 for function, 913–914
 probability theory, 853
 random variables, 107
LIML. *See* limited information
 maximum likelihood (LIML)
Lindberg condition, 910
Lindberg-Feller central
 limit theorem
 distribution theory, 909, 913
 estimation frameworks, 463
 generalized method of moments,
 532, 542
 generalized regression model,
 195, 203
 least squares, 67–68
 serial correlation, 262–263
Lindberg-Levy central limit
 theorem
 distribution theory, 909–910, 912
 estimation, 889
 generalized method of
 moments, 527
 generalized regression
 model, 203
 least squares, 67n3
 MLE, 478, 506
 serial correlation, 262–263
linear approximation, 837–838
linear association, 37, 867
linear combination, 806, 811
linear dependence, 811
linear equations, 819–822
linear forms, 876–877
linear function, 838,
 869–870, 873
linear independence, 812
linearity, 10–13, 42, 72
linearly deterministic
 component, 619
linearly indeterministic
 component, 620
linear regression model
 assumptions, 10–18, 42
 Box-Cox transformation
 and, 173–175
 characteristics, 7–10
 classical normal, 872–873
 coefficient of determination
 for, 37
 comparing, 152
 Cox test and, 156
 discrete choice models, 663
 estimated money demand
 equations, 180
 example, 428–429
 F statistic and, 175
 functions for, 93
 Gauss-Markov theorem,
 47–48
 incidental parameters problem
 and, 697
 linear restrictions, 94
 maximum likelihood estimation,
 492–496
 omitted variables, 679
 probability theory, 866–867
 testing for heteroscedasticity, 508
 theorem, 185

- linear restrictions
 - on coefficients, 122
 - likelihood function, 494
 - linear regression model and, 94
 - structures and, 390
 - line search, 935–936, 945
 - LISREL (computer program), 919n1
 - Ljung-Box statistic, 622
 - Ljung's refinement, 269–270
 - LM statistic. *See* Lagrange multiplier (LM) statistic
 - LM test. *See* Lagrange multiplier (LM) test
 - local maxima, 840
 - local optima, 840
 - location, 878
 - logistic distribution, 667–668, 855
 - logit kernel, 455–456
 - logit model
 - derivatives, 675
 - distribution for, 667
 - fixed effects models, 698
 - heteroscedasticity, 680
 - LS estimator, 701
 - for multiple choices, 719–735
 - name origin, 687
 - nonlinear regression models, 186
 - normal distribution, 691
 - as probability model, 675
 - state dependence, 708
 - two-step MLE, 511
 - weighted least squares, 688
 - log-likelihood function. *See also* concentrated log-likelihood
 - AR(1) model, 273
 - binary choice models, 688
 - Butler and Moffitt method, 694
 - fixed effects model, 695
 - groupwise heteroscedasticity, 236
 - maximum likelihood estimation and, 326, 347
 - multiplicative
 - heteroscedasticity, 233
 - multivariate regression model, 358
 - probability models and, 675
 - testing hypothesis, 681
 - two-step estimation, 231–232
 - loglinear model
 - Cobb-Douglas model, 12
 - coefficient of determination for, 37
 - count data, 740
 - Cox test and, 156
 - depicted, 11–12
 - estimated money demand equations, 180
 - gasoline consumption study, 132
 - Lagrange multiplier test, 500–501
 - Nerlove's study, 125–126
 - regression model and, 122–123
 - testing linear specification, 179
 - lognormal distribution, 771, 794, 854, 931
 - lognormal variables, 854
 - longitudinal data sets, 283–284, 320
 - Longley data, 58, 61, 948
 - long-run multiplier, 561–562, 564
 - loss function, 434
 - loss of fit, 95, 101–104
 - lower triangle, 803
 - lower triangular matrix, 832, 922n4, 932
 - LR statistic. *See* likelihood ratio (LR) statistic
 - LR test. *See* likelihood ratio (LR) test
 - LSDV model. *See* least squares dummy variable (LSDV) model
 - LSQ procedure, 919–1
 - Lucas critique, 587
 - Lyapounov central limit theorem, 195, 262–263, 463, 483, 542, 912
- M**
- M* estimator, 461, 463–465, 521
 - M* variables, 654–655
 - MA process. *See* moving average (MA) process
 - macroeconometrics
 - data set, 948
 - distinctions, 5
 - forecasting performance, 608
 - macroeconomics
 - consumption function and, 381
 - deterministic relationships, 7
 - example, 380
 - forecasting and, 587n9
 - unit roots and data, 636
 - vector autoregressions and, 586–587
 - macroeconomic variables
 - rational lag model and, 575
 - time-series models, 649
 - VAR model, 596
 - main diagonal, 803
 - marginal distributions, 860, 871–872
 - marginal effects
 - binary choice models, 665, 674–676, 705, 712–713
 - binary variable, 740
 - in censored regression model, 765
 - censoring and truncation, 774
 - computing, 668
 - functional form, 124
 - labor force participation model, 682
 - lagged variables, 560
 - probability model example, 676
 - recursive model, 716
 - tobit model example, 766
 - truncated regression model, 760
 - marginal moments, 865–867
 - marginal probability density, 860
 - marginal propensity to consume (MPC)
 - Bayesian estimation, 437
 - consumption function, 172–173
 - distributed lag model, 109–110
 - Keynes' consumption function, 2
 - Markov Chain Monte Carlo (MCMC) method, 426, 444–447, 513, 920, 923
 - Markov's inequality, 898, 903
 - Markov's theorem, 69, 902
 - martingale difference sequence, 263, 273, 463, 542
 - martingale sequence, 262
 - Matlab (computer program), 631
 - matrices
 - comparing, 836–837
 - condition number of, 829
 - determinant of, 816–817, 830
 - diagonalization of, 827
 - factoring, 832–833
 - generalized inverse of, 833–834
 - powers of, 830–832
 - rank of, 814–816, 827–829, 874
 - spectral decomposition, 827, 832
 - trace of, 829–830
 - matrix algebra
 - algebraic manipulation of matrices, 803–809
 - calculus, 837–845
 - Cox test and, 156–158
 - geometry of matrices, 809–819
 - idempotent matrix, 808–809
 - linear equations, 819–822
 - matrix addition, 804–805
 - matrix multiplication, 805–807
 - matrix product rule, 904
 - partitioned matrices, 822–825
 - quadratic forms, 834–837
 - roots and vectors, 825–834
 - sums of values, 807–808
 - systems of linear equations, 819–822
 - terminology, 803
 - two-way effects, 291n9
 - usefulness of, 23
 - matrix inverse rule, 904
 - matrix power, 830–832
 - matrix weighted average, 290

1014 Subject Index

- maximum likelihood estimator (MLE). *See also* full information maximum likelihood (FIML); pseudo-MLE
 applications of, 492–508
 approximating, 768
 AR(1) model, 273
 aspects of, 939–941
 asymptotic covariance matrix, 672–673, 688
 asymptotic properties, 476–482, 689
 autocorrelation and, 275
 bias in, 697
 binary choice models, 670, 710–712
 CAPM model and, 357
 cautions, 239n24
 CMLE, 699
 consistency and, 690
 dependent variables and, 686
 determinants and derivatives, 840
 discrete choice models, 663
 disturbances and, 679
 duration models, 794–795
 efficient estimation, 211, 470–472, 526
 estimating probabilities, 714
 estimation, 426, 428
 example, 128
 as extremum estimator, 461
 fixed effects models, 697
 gamma distribution, 530
 gamma model, 129
 GARCH model, 242–245
 GMM estimation, 540, 548–549
 grouped data, 689
 groupwise heteroscedasticity, 236–237
 Grunfeld investment model, 331
 heteroscedasticity, 228–229
 identification, 463
 invariance of, 359
 Lagrange multiplier statistic, 940
 Lagrange multiplier test, 298
 least squares estimator, 65, 71, 156, 588
 likelihood function, 468–470
 linear regression model, 492–496
 log-likelihood function, 688
 maximum simulated likelihood, 512–517
 MCSE and, 688
 as modeling framework, 465
 multiplicative heteroscedasticity, 235
 nonlinear regression models, 496–501
 nonlinear systems, 371–372
 overdispersion, 743
 panel data, 326–329
 Poisson model, 742
 predictions and, 686
 principle of, 470
 probit models, 711–712
 properties of MLE, 472–483
 QMLE, 246, 673–674
 random effects and, 299
 serial correlation, 274
 stochastic frontier model, 429
 structural breaks and, 141
 SUR model, 347–351, 357–360
 test procedures, 484–492
 theorem, 164
 tobit model, 775, 777
 truncated regression model, 761
 two-step estimation, 184, 508–512
 maximum score estimator (MSCORE), 685, 702–706, 703n42
 maximum simulated likelihood (MSL), 512–517, 693
 MCSE (minimum chi-squared estimator), 687–689
 mean
 asymptotic distribution of, 915
 deviations from, 824
 estimation, 878
 of functions, 900
 of lognormal distribution, 931
 Monte Carlo study, 923–924
 one-sided test, 896
 of random variables, 847
 testing hypothesis, 893–895
 truncated mean, 759
 mean absolute error, 113
 mean lag, 562, 564
 mean square convergence, 67, 69, 897–898
 mean-squared deviation matrix, 702
 mean squared error (MSE), 43–44, 150, 887
 mean value theorem, 543
 measure
 of central tendency, 847
 of closeness, 19
 condition number, 56–57
 of linear association, 867
 of model fit, 644
 measurement errors in, 8
 lacking for variables, 84
 standard deviation units, 123
 measurement error, 75, 83–90
 median, 847, 878, 916, 923–924
 median lag, 562
 MELO (minimum expected loss) estimator, 434–435
 method of kernels, 706
 method of moment generating functions, 529
 method of moments, 429, 447, 526–533, 536–540, 943
 method of moments estimators, 528, 531–533, 535. *See also* generalized method of moments (GMM) estimator
 method of scoring, 672, 723, 939–941
 methods of estimation
 GMM estimation, 400–401, 409–410
 instrumental variables, 75, 397–398
 limited information, 396–404
 ordinary least squares, 396–397
 simultaneous equations models, 396
 system methods of estimation, 404–411
 two-stage least squares, 398–400
 Metropolis–Hastings algorithm, 445–446
 MGF (moment-generating function), 859
 microeconometrics, 5, 125
 microeconomics, 602–605
 minimal sufficient statistic, 697
 minimum distance estimator, 205–206, 538–539
 minimum expected loss (MELO) estimator, 434
 minimum mean squared error, 43–44
 minimum variance linear unbiased estimator (MVLUE), 44, 890
 minimum variance unbiasedness, 887
 minor, 817
 missing observations, 59–60
 misspecification, 250–251, 770
 mixed estimation, 436n9
 mixed logit model. *See* random parameters logit (RPL) model
 MLE. *See* maximum likelihood estimator (MLE)
 MNP. *See* multinomial logit (MNL) model
 MNP (multinomial probit) model, 727–728
 models
 autoregressive distributed lag models, 571–579
 distributed lag models, 565–571

Subject Index 1015

- dynamic models, 558–564, 579–586
 - exogenous variables and, 591
 - general-to-simple strategy, 151–152
 - for panel data, 283–286
 - and prediction, 7
 - selection of, 148–161
 - simple-to-general approach, 151
 - specification analysis and, 148–152
 - structural form, 130–134, 382
 - tests, 229–232
 - tests of stability, 134–143, 659–660
 - univariate time series, 619–621
 - vector autoregression, 586–605
 - moment-generating function (MGF), 859
 - moments
 - asymptotic moments, 918
 - central moments, 529, 848
 - conditional moments, 505–508, 743, 771, 865–867
 - convergence of, 203, 260–262, 905
 - empirical moments, 202, 541–542
 - marginal moments, 865–867
 - probability theory, 866, 868–869
 - and random variables, 614
 - uncentered moment, 527
 - money demand
 - cointegrating vector, 652–653
 - cointegration, 657–660
 - data, 951
 - example, 180, 250
 - instability of, 142–143
 - as macroeconomic variable, 649
 - Monte Carlo integration, 715
 - Monte Carlo methods
 - Bayesian estimator and, 430
 - data sets, 920
 - functional form, 141
 - testing unit roots, 637
 - Monte Carlo studies
 - AR(1) model, 274
 - computation, 920
 - features, 923–924
 - GNP deflator, 634
 - heteroscedasticity, 246n35, 681
 - least squares estimator, 59–60
 - replicating data, 921
 - systems estimators, 413
 - White estimator, 220
 - Moore-Penrose generalized inverse, 83, 833–834
 - most powerful test, 893
 - moving average, 240, 610, 614. *See also* vector moving average (VMA)
 - moving-average form, 258, 563, 598, 611
 - moving average (MA) process, 257, 318, 616, 618
 - MSCORE. *See* maximum score estimator (MSCORE)
 - MSE. *See* mean squared error (MSE)
 - MSL. *See* maximum simulated likelihood (MSL)
 - multicollinearity
 - absence of, 163, 542
 - data problems, 56–59
 - dummy variables and, 118
 - nonlinear regression models, 173
 - multinomial logit (MNL) model, 720–723, 728, 732, 734
 - multinomial probit (MNP) model, 727–728
 - multinormal integrals, 690n26
 - multiple correlation, 36
 - multiple linear regression model, 7–10
 - multiple regression, 21, 23, 35, 88
 - multiplication, 805–807, 809, 823
 - multiplicative heteroscedasticity, 232–235, 239n24
 - multipliers, 415–417, 420, 561–562
 - multivariate Lindberg-Feller central limit theorem, 913
 - multivariate Lindberg-Levy central limit theorem, 912
 - multivariate normal distribution, 871–877
 - multivariate normal population, 922
 - multivariate normal probabilities, 931–933
 - multivariate probit models, 710–719
 - multivariate regression model, 340, 358, 362
 - multivariate standard normal, 871
 - multivariate t distribution, 434, 436
 - MVLU (minimum variance linear unbiased estimator), 44, 890
- N**
- naive predictor, 685–686
 - National Institute of Standards and Technology (NIST), 833n12
 - National Longitudinal Survey of Labor Market Experience (NLS), 283
 - nearest neighbor, 457
 - negative autocorrelation, 251–253, 647
 - negative binomial model, 744–745, 747, 774
 - negative definite matrix, 834–835
 - negative duration dependence, 794
 - nested logit models, 725–727
 - nested models, 93–95
 - netting out, 27–28
 - Newey-West covariance matrix, 267, 628
 - Newey-West estimator
 - functional form, 142
 - generalized method of moments, 544, 546
 - generalized regression model, 200–201, 206
 - panel data, 316
 - regression equations, 373
 - serial correlation, 280
 - Newton's method
 - computation, 937–939, 944–945
 - discrete choice models, 672, 696, 723, 741
 - limited models, 767, 797
 - New York Stock Exchange, 240
 - Neyman-Pearson methodology, 153, 892
 - NLS (National Longitudinal Survey of Labor Market Experience), 305
 - nonautocorrelation
 - assumptions, 324–325
 - CAPM model, 356
 - defined, 15
 - error correction and, 581
 - nonlinear model assumption, 163
 - regression models, 10, 42, 72
 - noncentral chi-squared distribution, 487n8
 - noncentral F distribution, 852–853
 - nonconstructive test, 223
 - nonhomogeneous equation system, 820, 822
 - noninformative prior, 431
 - noninvariance of Wald test, 110
 - nonlinear instrumental variable estimator, 183, 545
 - nonlinearity, 122–130
 - nonlinear least squares
 - asymptotic properties of, 196
 - geometric lag model and, 568
 - as modeling framework, 465
 - nonlinear regression models, 496
 - two-step estimation, 183–186
 - nonlinear least squares estimator
 - computing, 169–170
 - consistency of, 168
 - production function example, 499
 - properties, 193, 196
 - solving explicitly, 934n21

1016 Subject Index

- nonlinear models
 - alternative estimators for, 180–189
 - applications, 171–175
 - Cox test and, 156
 - error correction and, 580
 - general forms, 162–171
 - hypothesis testing and parametric restrictions, 175–180
 - industry structure example, 404
 - maximum likelihood estimation, 496–501
 - Poisson model as, 740
- nonlinear restriction, 104, 108–110, 130
- nonlinear systems
 - GLS estimation, 370–371
 - GMM estimation, 369–373
 - maximum likelihood estimation, 371–372
 - simultaneous equation models, 382n6
 - two-stage least squares and, 403–404
- nonlinear weighted least squares, 687
- nonnegative definite matrix, 832, 834–836
- nonnested models
 - choosing between, 152–159
 - specification tests, 682–683
 - testable implications and, 94
 - test statistic for, 751
- nonnormality
 - large sample tests and, 104–108
 - specification issues, 771–773
- nonparametric estimation
 - econometrics literature, 708
 - estimation frameworks, 425, 453–459
 - extremum estimators and, 461
 - nonparametric regression, 457–459
- nonpositive definite matrix, 834–835
- nonsample information, 388, 394
- nonsingular matrix, 821
- nonspherical disturbances, 191–214, 314–318
- nonstationarity, 632, 647, 650
- nonstationary process, 631–649
- nonstochastic regressors
 - ambiguity and, 590–591
 - data generation process, 16
 - finite-sample properties theorem, 193
 - least squares estimator and, 45–46
- nonstructural models, 379n2
- normal distribution
 - censored data, 762–764
 - conditional normal distributions, 871–872
 - confidence intervals and, 55
 - depicted, 50
 - disturbances and, 17, 164, 518
 - features, 849–850
 - information matrix, 479
 - likelihood function, 472, 888–889
 - limiting for function, 913–914
 - linear regression model
 - assumptions, 10, 42
 - logit model, 691
 - mixtures of, 529
 - MSL and, 693
 - multinomial models and, 727–728
 - nonlinear restrictions and, 109
 - normit, 687
 - probit model, 666
 - sample moments and, 203
 - sampling and, 531
 - spherical disturbance and, 16n3
 - theorem, 876
 - truncated normal distribution, 757
 - VAR testing and, 593
- normal equations, 21, 24
- normal-gamma prior, 436
- normality
 - assumptions, 17, 50–55, 110
 - Breusch-Pagan LM test, 224
 - Butler and Moffitt method, 693
 - central limit theorem, 262–265
 - least squares, 65
 - linear regression model, 17
 - selection model, 789
 - t distribution value and, 106
 - VAR testing, 590
 - Wald statistic and, 110, 356
- normalization, 163, 383, 389–390, 470, 669, 825
- normit, 687
- null hypothesis
 - ARCH model, 244
 - average log density, 155
 - Box-Pierce test, 269
 - CAPM model, 354
 - Cox test, 158
 - CUSUM test, 136
 - of equality, 289
 - F statistic, 106
 - groupwise heteroscedasticity, 236
 - Grunfeld investment model, 331–332
 - Hausman test, 301, 771
 - of homogeneity, 699
 - of homoscedasticity, 224
 - of interest, 80–81
- Lagrange multiplier test, 299
- model constancy, 141
- no natural, 153
- nonconstructive test, 223
- normal distribution, 105
- significance test for
 - restrictions, 176
- structural break and, 133
- test equivalence, 484
- testing, 323
- testing restrictions, 95–98
- Type I and II errors, 892
- Wald statistic and, 133, 590
- null matrix, 804
- O**
 - Oaxaca's decomposition, 53–54
 - Oberhofer-Kmenta algorithm, 299
 - Oberhofer-Kmenta conditions, 347, 349
 - observationally equivalent theories, 385–386
 - observations. *See also* independent observations
 - with constant terms, 272
 - dependent observations, 73–74, 260, 541
 - deterministic theories and, 3
 - dummy variables and, 117
 - economic analysis and, 624
 - exercise, 39
 - Goldfeld-Quandt test, 223
 - identically distributed, 468
 - insufficient observations, 131–132
 - missing observations, 59–60
 - panel data set, 72–73
 - Poisson regression model, 745
 - time-series process and, 254
 - weighting of, 128
- OLS. *See* ordinary least squares (OLS)
- Olsen's reparameterization, 767
- omission of relevant variables, 148–149, 151
- omitted variable formula, 148–149
- omitted variables, 673, 679–680
- one-period-ahead forecast, 576
- one step ahead prediction error, 135
- one-step estimation, 939–940
- one-to-one function, 844
- OPG (outer product of gradients) estimator, 481
- optimality, 663
- optimal linear predictor, 43–44
- optimization
 - computation and, 919–946
 - constrained optimization, 842–843

Subject Index 1017

- criterion function and, 461
 - matrix algebra, 840
- order, 803, 837, 918–919
- order condition, 203, 389–394, 404, 542
- ordered choice models, 719
- ordinary least squares (OLS)
 - absolute value and, 768
 - Aitken estimator and, 207
 - classical regression, 341
 - common factor restrictions and, 585
 - FGLS and, 322
 - finite-sample properties, 193–194
 - GARCH model and, 244
 - generalized regression model, 521
 - GLS estimator, 342–343
 - GMM estimator, 221, 588
 - groupwise heteroscedasticity, 235–236
 - Grunfeld investment model, 331
 - heteroscedasticity, 216–221
 - Klein's Model I, 411–413
 - maximum likelihood estimation, 211
 - method of estimation, 396–397
 - as method of moments estimator, 535
 - multiplicative
 - heteroscedasticity, 234
 - random effects model and, 316
 - rational lag model example, 575
 - standard error, 323
 - superconsistency, 656
 - testing unit roots, 637
 - truncated regression model, 761
 - White estimator, 220
- orthogonality conditions
 - disturbances and, 167
 - estimation based on, 534–536
 - GMM estimator, 182, 314, 409, 540, 545
 - method of moments estimation and, 201
 - overidentification by, 548
 - sum of squares and, 164–165
- orthogonal random variables, 57–59
- orthogonal regression, 23
- orthogonal vectors, 818, 827
- orthonormal quadratic form, 873
- outcomes, 845
- outer product matrix, 828
- outer product of gradients (OPG) estimator, 481
- outliers, 60
- output, 650, 656, 951
- “overdifferencing,” 647
- overdispersion, 743–744, 746, 751, 779
- overidentification, 414–415
- overidentified, 130, 548
- overidentifying restrictions, 175, 548
- P**
 - p* value, 649
 - PACF (partial autocorrelation function), 618, 622–624
 - panel data. *See also* dynamic panel data model
 - characteristics of, 192
 - covariance structures, 320–334
 - data set, 878
 - estimated models, 701
 - fixed effects model, 287–293, 694–700
 - instrumental variables estimator, 303–306
 - microeconometrics and, 5
 - models for, 283–286
 - nonspherical disturbances and robust covariance matrix, 314–318
 - for Poisson model, 747–749
 - random coefficients models, 318–319
 - random effects model, 293–303, 689–694
 - samples in, 72–73
 - state dependence and, 708
 - Panel Study of Income Dynamics (PSID), 283, 305, 709
 - parameters. *See also* random parameters
 - comparison of estimators, 128
 - confidence intervals for, 52–53
 - criterion function and, 461
 - of distributions, 527–531, 538–540
 - empirical moment equation and, 202
 - estimable parameters, 469
 - estimation with unknown, 227–232
 - exactly identified, 129
 - function of one parameter, 943–944
 - hypothesis testing and, 93
 - identifiability of, 462–463
 - identification of, 468–470
 - Lucas critique, 587
 - overidentified, 130
 - parameter space, 427
 - point estimation, 885–890
 - precision parameter, 480
 - probability limits, 526–527
 - restrictions, 175–180
 - system of demand equations, 362
 - two-step estimation and, 183–186
 - univariate time series, 621–624
 - parameter space, 94, 427, 461, 483
 - parameter vectors
 - condition moment tests, 507
 - functional form, 130–131
 - Gauss-Newton method, 169
 - GMM estimation, 513
 - identifiability, 163
 - identification, 463
 - latent class model example, 442
 - LM test statistic, 678
 - MSL estimation, 513
 - parameter space and, 461
 - structural break tests, 133
 - testing model instability, 659
 - two-step MLE, 508
 - Wald criterion and, 139
 - parametric estimation
 - Bayesian estimation, 429–439
 - classical likelihood based estimation, 428–429
 - estimation frameworks, 425
 - hierarchical Bayes estimation, 444–447
 - hypothesis testing, 437–439
 - interval estimation, 435
 - latent class model, 439–443
 - point estimation, 434–435
 - parametric models, 192, 451, 708, 792–798
 - partial adjustment model, 568
 - partial autocorrelation, 617–619
 - partial autocorrelation function (PACF), 618, 622–624
 - partial correlation, 36
 - partial correlation coefficients, 28–31
 - partial differences, 272
 - partialing out, 27–28
 - partial likelihood, 799
 - partially linear model, 450
 - partially linear regression, 450–452
 - partial regression coefficients, 28–31
 - partitioned inverse, 100, 695, 824
 - partitioned matrices, 822–825
 - partitioned regression, 26–27, 118, 300
 - Parzen kernel, 455
 - Parzen window, 628
 - PC-GIVE (computer program), 409n22
 - pdf (probability density function), 468, 857, 882, 906
 - PDL (polynomial distributed lag), 566
 - permanent income, 8, 84, 525, 548

1018 Subject Index

- persistence, 635, 708–709, 729
 Personalized System of Instruction (PSI), 675
P_E test, 178–180
 Phillips curve, 251–253, 568–570
 Phillips-Perron statistic, 646
 Phillips-Perron test, 644–645
 piecewise continuous, 122
 pivotal quantity, 891
 point estimate, 434–435, 595, 885–890
 Poisson distribution
 distribution theory, 856
 maximum likelihood model and, 470–471
 MLE, 485–486
 Poisson regression model and, 740
 two-step MLE, 511
 variance bound for, 889–890
 Poisson model
 application, 745–747
 censoring and truncation, 774
 censoring application, 774–780
 count data, 740
 latent class model example, 441
 MLE, 521, 742
 negative binomial model and, 744
 nonlinear regression models, 187, 189
 overdispersion, 743
 for panel data, 747–749
 zero-altered poisson model, 749–752
 polynomial distributed lag (PDL), 566
 polynomials
 ARIMA model, 632
 Hermite polynomials, 926
 inversion in lag operator, 613
 invertible polynomial, 564
 in lag operator, 563, 571, 596
 Taylor series as, 837
 pooled regression, 285, 289, 328
 population moment equation, 201
 population quantity, 19
 population regression, 19–20, 42
 population regression equation, 7
 positive definite matrix, 831, 834–835, 837
 positive duration dependence, 794
 positive semidefinite matrix, 834
 posterior density, 430
 posterior odds ratio, 438–439
 postmultiplication, 805
 Prais-Winsten estimator, 273–276, 318, 325–326, 360
 precision, as statistical property, 41
 precision matrices, 439
 precision parameter, 480
 predetermined variables, 380, 382, 393
 prediction
 linear regression models and, 93
 maximum likelihood estimator, 686
 models and, 7
 nonlinear models, 186
 with probit model, 686
 regression and, 111–114
 prediction criterion, 36, 160
 prediction interval, 111, 576
 prediction variance, 111–112
 predictive test, 137–139
 premultiplication, 805
 pretest estimator, 149–150, 152
 price variable
 cointegrating vector example, 652–653
 deflator data, 951
 as dependent variable, 8n1
 economic analysis and, 624
 as economic variable, 631
 as macroeconomic variable, 649
 principal components, 58
 principal minor, 817n4
 prior beliefs, 430, 435n7
 prior distribution, 431–432
 prior odds ratio, 438
 prior probabilities, 438
 probability
 convergence in, 897, 905
 distribution theory, 845–877
 elasticities of, 723
 size of test and, 893
 probability density function (pdf), 468, 846, 906, 930
 probability distribution
 nonlinear model, 163–164
 ordered data, 738
 population regression, 19
 probability theory, 845–846
 representations of, 858–859
 specific, 849–856
 probability limit, 69, 218–219, 526, 536, 904
 probability models, 664, 666–667, 675–676
 probit, 666, 687
 probit model
 bivariate probit models, 710–719
 derivatives, 675
 heteroscedasticity, 680
 LS estimator, 701
 MSL estimation, 515–516
 prediction with, 686
 probability model, 675–676
 with random effects, 694
 structural equations for, 669–670
 weighted least squares, 688
 problem of identification, 378, 380, 385–395
 production function
 constant elasticity of substitution, 129
 deterministic relationships, 7
 deviations from, 502
 example, 102–104
 generalized example, 498–499
 LAD estimation, 449–450
 problems analyzing, 284
 stochastic frontier model, 505
 production models, 12, 339
 product limit estimator, 798
 product rule, 904
 projection, 24–25, 819
 projection matrix, 24, 60
 properties. *See also* asymptotic properties
 of dynamic models, 415–420
 of estimators, 460–465
 of GLS estimator, 208
 of GMM estimator, 540–544
 of MLE, 472–483
 statistical properties of estimators, 460
 proportional hazard, 799
 proportions data, 686–689
 proxy variables, 87–88
 pseudodifferences, 272
 pseudoinverse, 833
 pseudo-MLE, 245–246, 356, 518–521
 pseudo-random number generators, 920–921
 pseudoregressors, 167, 169, 182, 500
 PSI. *See* Personalized System of Instruction (PSI)
 PSID (Panel Study of Income Dynamics), 283, 305, 709
 Public Use Sample, 721
 purchasing power parity theory, 650–652

Q

- Q test, 269, 271
 QMLE. *See* quasi-maximum likelihood estimator (QMLE)
 QR models. *See* qualitative response (QR) models
 quadratic approximation, 837
 quadratic forms
 full rank quadratic form, 875–876
 independence of, 876–877

- matrix algebra, 834–837, 839
 - orthonormal quadratic form, 873
- quadratic hill-climbing method, 938
- quadrature, 692–694, 928–929
- qualification indices, 145
- qualitative choices, 664
- qualitative response (QR) models
 - discrete choice models, 663
 - econometrics, 689
 - NIST and, 833n12
 - selection in, 790
- quantile regression, 448
- quasi differences, 272
- quasi-maximum likelihood
 - estimator (QMLE), 246, 673–674
- quasi-Newton methods, 938–939
- R**
 - R^2 (coefficient of determination), 439. *See also* sum of squared residuals
 - generalized regression model and, 209
 - Grunfeld investment model, 330
 - hypothesis testing, 678
 - Poisson model, 741
 - Theil U statistic and, 113
- random coefficients, 318–319
- random effects model
 - heteroscedasticity, 316–317
 - instrumental variables estimator, 303–306
 - panel data and, 285, 293–303, 689–694
 - persistence and, 729
- random number generators, 920
- random parameters
 - logit models and, 728–729
 - MSL estimation, 516–517
 - panel data and, 285–286
- random parameters logit (RPL) model, 728–729, 734
- random parameters model, 700
- random sample
 - consistent estimation, 527–531
 - descriptive statistics, 880
 - method of moments, 526–529
 - multivariate probit models and, 714
 - regression estimation, 621
 - samples and, 878
- random utility model, 670, 719
- random variables
 - bivariate random variables, 862–864
 - censored example, 763–764
 - convergence to, 904–905
 - data generating mechanism, 427
 - distribution of function, 856–858
 - distribution theory, 845–846
 - expectations, 847–849
 - hazard function, 859
 - of interest, 155
 - limiting distribution of, 107
 - moments and, 614
 - probability density function, 468
 - probability model example, 676
 - random effects model, 690
 - random vector and, 868
 - theorem 22.1, 757
 - variance of, 847
- random vector, 868
- random walk
 - common trends and, 653
 - Dickey-Fuller tests, 637, 643
 - nonstationary processes, 632–636
 - random walk with drift model, 572
 - serial correlation, 263
- random walk with drift
 - ADF-GLS procedure, 645
 - deterministic trends, 635
 - Dickey-Fuller tests, 639, 643
 - model, 572
 - money demand example, 657–658
 - nonstationary processes, 631, 634
 - testing, 636
- rank
 - of a matrix, 814–816, 827–829, 874
 - of a product, 828
 - of a symmetric matrix, 828, 832
- rank condition
 - generalized regression model, 203
 - GMM estimation, 542
 - identification, 389–394
 - nonlinear model example, 404
- ranking, 664
- rank two correction, 939
- rank two update, 939
- rate of inflation
 - Dickey-Fuller test, 638
 - investment equation and, 21
 - Phillips curve, 251
 - testable implications and, 93–94
- rational lag model, 573, 575
- ratio rule, 904
- RATS (computer program), 244n31, 631
- recursion, computations and, 698n31
- recursive model, 383, 715–716
- recursive residual, 135–137
- recursive systems, 411
- reduced form, 379–380, 384, 415–416, 598
- reduced-form disturbances, 384
- reduced form equation, 87
- regressand, 7
- regression
 - binary choice models, 665–668
 - binary variables in, 116–117
 - changes in R^2 , 34
 - conditional mean, 15, 864
 - with constant term, 28
 - constant term and, 37
 - diagnostics for, 60–61
 - dummy variables in, 117
 - duration model, 792–798
 - gamma model estimates, 129
 - individual coefficients, 27
 - linearity and, 11
 - linear regression model and, 14–15
 - median regression, 448
 - multiple correlation, 36
 - and prediction, 111–114
 - probability models and, 667
 - residual variance in, 866
 - in selection model, 782–784
 - testing significance of, 54–55
 - variables added to, 30
 - without constants exercise, 40
- regression analysis
 - forecasting and, 33
 - Frisch-Waugh theorem and, 38
 - projection matrix and, 24
 - test statistics, 51
- regression models
 - assumptions, 75–76
 - asymptotic properties of, 72
 - constant terms and, 15
 - function form, 116
 - interaction term and, 123–124
 - loglinear model, 122–123
 - nonspherical disturbances, 191–214
 - prediction and, 111n8
 - semiparametric analysis, 50
 - truncation, 760–761
- regression variance, 867
- regressors
 - cointegration, 652
 - data generation, 16–17
 - determining appropriateness of, 152
 - identical regressors, 343–344
 - LSDV estimators and, 298
 - nonlinearity and, 124
 - nonstochastic regressors, 16, 45–46, 193, 590–591
 - population regression equation, 7

1020 Subject Index

- regressors (*continued*)
 pseudoregressors, 167, 169, 182, 500
 stochastic regressors, 47–48, 74, 280, 307
 theorem, 186
 transformed, 210
 zero values, 174
 regularity conditions, 473–474
 rejection region, 892
 relationships
 cointegration relationships, 658
 conditional moments, 865–867
 deterministic relationships, 2, 7–8
 earnings and education, 9–10
 equilibrium relationship, 579, 655
 income and consumption, 8
 linear relationships, 13
 marginal moments, 865–867
 persistence, 635
 and random walk, 633
 between variables, 665
 reliability ratio, 88
 residual
 analysis of variance table
 example, 34
 detrending and, 635
 dummy variable model, 316
 estimating equilibrium error, 655
 misspecified models, 252
 population regression and, 19
 in regressions, 29
 two-step MLE, 512
 residual based tests, 229–230
 residual maker, 24, 39
 residual variance, 866–867
 response, treatment and, 117
 restricted least squares, 99–104
 restrictions
 common factor restrictions, 583–586
 degrees of freedom and, 110, 489, 593, 678
 on disturbance covariance matrix, 390
 of equal correlation across periods, 693
 nested models and, 93–95
 normalization and, 383
 significance tests for, 175–177
 testing, 172, 414–415, 484, 548–551
 ridge regression estimator, 58
 risk set, 798
 robust covariance estimations, 673–674
 robust covariance matrix, 314–318, 518–521
 robust estimation
 of asymptotic covariance matrix, 198–201
 fixed effects model, 314–316
 generalized regression model, 192
 GMM, 312, 534
 heteroscedastic regression model, 216
 least squares as, 590
 nonnormality, 771
 robustness to unknown heteroscedasticity, 226
 root mean squared error, 113, 602
 root- n consistent, 909
 roots, 825–834
 row rank, 815
 row space, 815
 row vector, 803
 RPL (random parameters logit) model, 728–729, 734
 rules
 for limiting distributions, 907–908
 matrix multiplication, 806–807
 for probability limits, 904

S
 sacrifice ratio, 596–597
 sample midrange, 878
 sample minimum, 883, 898
 sample periodogram, 627–628
 sample selection, 713–714, 756, 781–782
 sample variance, 887–888, 918
 sampling, 878, 915, 921–922
 sampling distribution, 42, 44–45, 882–885. *See also* normal distribution
 sampling variance, 46–47, 128, 885
 SAS (computer program), 409n22
 scalar addition, 809
 scalar matrix, 803
 scalar multiplication, 805–807, 809
 scalar-valued function, 838
 scale, 878
 scaling, 112–113, 728
 scatter diagram, 879–882
 scedastic function, 865
 Schwartz criterion, 160, 565, 589, 644
 score test, 489
 score vector, 476
 scoring method. *See* method of scoring
 seasonal adjustment, 649
 second derivatives matrix (Hessian), 838
 second-order effects, 12
 seemingly unrelated regressions (SUR) model
 autocorrelation and heteroscedasticity, 360–362
 capital asset pricing model, 351–357
 feasible GLS, 344–347
 generalized least squares, 341–343
 identical regressors and, 343–344
 linkages in disturbances, 342
 maximum likelihood estimation, 347–351, 357–360
 selection model
 estimation in, 784–787
 normality assumption, 789
 qualitative response models, 790
 regression in, 782–784
 treatment effects, 787–789
 semilog earnings equation, 664
 semilog model, 12, 116, 123
 semiparametric, 50, 164, 192, 700–702
 semiparametric estimation
 binary choice models, 452–453, 690, 704–706
 estimation frameworks, 425
 extremum estimators and, 461
 fixed effects model, 699
 LAD estimation, 448–450
 partially linear regression, 450–452
 semiparametric model, 799
 serial correlation
 common factor model, 278–279
 disturbance processes, 256–259
 efficient estimator, 271–273
 estimation, 273–277
 examples, 250–253
 forecasting with autocorrelation, 279–280
 GMM estimator, 268
 least squares estimator, 265–267
 testing for autocorrelation, 268–271
 time-series data, 253–256, 259–265
 Shazam (computer program), 244n31
 short rank, 13–14, 83, 815–816
 shuffling, 920
 SIC33 (primary metals industry), 102n5, 948
 signature of the matrix, 827
 significance level, 893
 significance of group effects, 289
 significance tests, 175–177
 simple-to-general approach, 151, 564, 583

Subject Index 1021

- Simpson's rule, 928
- simulated annealing, 935
- simulated moments, 931–933
- simulation, 693
- simulation-based estimation, 426
- simultaneous-equations bias, 379n3, 396
- simultaneous-equations models
 - discrete choice models, 716
 - dynamic models, 415–420
 - fundamental issues, 378–385
 - Klein's Model I, 411–413
 - single equation, 396–404
 - specification tests, 413–415
 - system methods of estimation, 404–411
 - VARs and, 586, 588, 597
- single equation, 396–404, 414
- singular systems, 362–369
- singular value decomposition, 833
- size distributions, 854, 893
- skewness
 - choice based sampling and, 673
 - estimation, 454, 879
 - nonnormality, 772
- Slutsky theorem
 - discrete choice models, 668
 - distribution theory, 903–904
 - generalized method of moments, 527, 538
 - generalized regression model, 204
 - least squares, 70, 85
 - nonlinear regression models, 184
 - serial correlation, 265
 - simultaneous-equations models, 399
- smoothing function, 452, 457–458
- software packages, 244n31, 377, 409n22, 631
- Solow's technological change data, 949
- spanning vectors, 813
- specification, 564–565, 664, 768–773
- specification analysis, 148–161, 582–583
- specification error, 783
- specification tests
 - binary choice models, 679–683
 - conditional moments, 505–508
 - distribution theory, 896
 - GMM estimation, 549
 - Hausman's specification test, 80–83, 301–303
 - for nonlinear regressions, 178–180
 - panel data, 323–324
 - simultaneous-equations models, 413–415
 - specificity, 924
 - spectral analysis, 624, 628–631.
 - See also* frequency domain
 - spectral decomposition, 827, 832
 - spectral density function, 625–627
 - spherical disturbances, 15–16, 192–193
 - spline function, 120
 - square matrix, 803, 816–817, 840
 - square summable, 619
 - stability
 - of demand equations, 658
 - of dynamic equation, 573–576
 - dynamic models, 417–418
 - impulse response functions, 593–594
 - testing model, 134–143
 - vector autoregression and, 602
 - Standard and Poor's Index, 240
 - standard deviation, 647, 848, 878
 - standard deviation units, 123
 - standard error
 - bootstrapping method, 113
 - comparison of estimators, 705
 - delta method, 128, 172–173, 175, 776
 - estimation, 885
 - GMM estimator and, 540
 - Grunfeld investment model, 330
 - LAD estimation, 450
 - least squares, 49, 267
 - MCS estimator and, 689
 - OLS estimation, 323
 - Phillips curve example, 569
 - probability model example, 676
 - Taylor series, 741
 - standard error of the regression, 49
 - standard normal cumulative distribution function, 926
 - standard normal distribution, 850
 - standard normal vector, 873–874, 876
 - starting values, 171
 - Stata (computer program), 244n31, 377, 742
 - state changes, time effects as, 283
 - state dependence, 690, 708–710
 - stationarity
 - ARMA model, 611–614
 - economic variables and, 631
 - manipulating series, 649
 - MLE, 483
 - models with lagged variables, 559
 - regression models and, 649
 - serial correlation, 256, 258, 261
 - stationary, 559
 - stationary conditions, 241–242
 - stationary process, 74, 609–631
 - statistic, 882
 - statistical interference, 50–55, 200–201
 - statistical properties, 41, 47
 - statistical tables, 953–958
 - statistics
 - estimation and inference, 878–882
 - as estimators, 882–885
 - sufficient statistics, 530
 - steepest ascent method, 937
 - stepwise model building, 152
 - Sterling's approximation, 928
 - stochastic elements, 3, 8, 688
 - stochastic frontier model, 429, 501–505
 - stochastic regressors, 47–48, 74, 280, 307
 - stochastic volatility, 238
 - stock market returns
 - ARCH model and, 238
 - economic analysis and, 624
 - fast Fourier transform, 631
 - long memory models, 647
 - Stone's expenditure system, 362
 - strike duration data, 952
 - strong exogeneity, 591
 - strong law of large numbers, 901–902
 - strongly exogenous variables, 382
 - strongly trended, 632, 635
 - strong stationarity, 260, 612n5
 - structural breaks
 - gasoline consumption study, 136–137
 - model constancy and, 141
 - modeling for, 130–134
 - testing model instability, 660
 - unknown timing of, 139–143
 - structural change, 116–147
 - structural disturbances, 382, 384
 - structural equations, 379, 669–670
 - structural models, 87, 379n2, 559–560, 587, 595, 597
 - structural VARs, 595–600
 - structures, 386, 390
 - Student's *t* distribution, 954
 - submatrices, 822
 - subspace, 813
 - substitution, 12, 594
 - sufficient condition, 840
 - sufficient statistics, 530
 - summability, 264
 - sum of squared residuals
 - as criterion, 31
 - Lagrange multiplier test, 177
 - least squares regression and, 299
 - testing procedures based on, 159

1022 Subject Index

- sum of squares. *See also* generalized sum of squares
 change and, 30, 39
 as criterion function, 537
 example, 171
 minimizing, 182
 orthogonality condition and, 164–165
 Phillips curve example, 569–570
 sum rule, 904
 sums of values, 807–808
 superconsistent, 572, 656
 superfluous variables, 148
 supply equation, 378
 supremum test, 141, 602
 SUR model. *See* seemingly unrelated regressions (SUR) model
 survival function, 792, 795, 797, 858
 survival model, 800–801
 symmetric matrix
 characteristic roots/vectors, 830
 decomposition, 835
 idempotent, 832
 matrix algebra, 803, 839
 rank of, 828
 system methods of estimation, 396, 404–411, 413
 systems of equations
 matrix algebra, 819–822
 simultaneous-equations models, 378–381
 singular systems, 362–369
- T**
 t distribution, 851–853, 954
 t ratio
 least squares, 83
 MCS estimator and, 689
 MPC example, 110
 restricted investment equation, 99
 robust estimation and, 201
 significant effects, 739n65
 single linear restriction and, 101
 test statistic, 51
 White estimator and, 220
 t statistic, 104–105
 t test, 106, 632
 Taylor series
 asymptotic normality, 464, 478
 CES production function, 129, 162
 classical model, 13
 computation and optimization, 937
 differentiation and, 837–840
 discrete choice models, 687
 distribution theory, 849
 GMM estimation, 543
 inference, 109
 least squares, 70
 limiting distribution and, 914
 method of moments estimator, 532
 Newton's method, 937
 regression models, 165–166, 178–179
 regularity conditions, 474
 second-order, 367
 standard error, 741
 testable implications, 93–94
 testing. *See also* hypothesis testing; specification tests
 aggregation bias, 341
 for autocorrelation, 268–271
 based on LM statistic, 177–178
 causality, 590, 593
 classical procedures, 892–895
 for cointegration, 655–657
 common factors, 278–279, 585–586
 confidence intervals, 895–896
 consistent test, 894–895
 CUSUM test, 135–137
 for GARCH effects, 244–245
 GPH test, 649
 for heteroscedasticity, 222–225, 508
 for homoscedasticity, 506
 maximum likelihood estimation, 484–492
 model stability, 134–143, 659–660
 nonlinear restriction, 108–110
 nonnormal disturbances and, 104–108
 for overdispersion, 743–744
 overidentifying restrictions, 414–415
 Phillips-Perron test, 644
 predictive test, 137–139
 for random effects, 298–301
 recursive residuals, 135–137
 restrictions, 172
 score test, 489
 significance tests, 175–177
 size of, 893
 for structural breaks, 130–134
 summary of procedures, 271
 unit root, 636–637, 639–643
 vector autoregression, 589–590
 for zero correlation, 712
 test statistics
 cointegration, 657
 confidence interval test, 491
 deriving behavior of, 141
 Dickey-Fuller tests, 645
 feasible GLS, 347
 heteroscedasticity, 508
 hypothesis testing, 465, 678
 income elasticity, 53
 known distributions, 155
 likelihood function, 494
 long run models, 659
 marginal distributions of, 55
 nonlinear restrictions and, 109
 nonnested models, 751
 nonnormal disturbances and, 105
 reformulated, 156
 regression analysis and, 51
 structural change, 143
 theorems, 486–487, 489
 Theil U statistic, 113
 three-stage least squares (3SLS), 405–407, 414
 threshold effect, 120
 time profile, 120
 time series data
 analysis of, 284
 autocorrelation and, 192, 250
 covariance structures for, 320–334
 Durbin-Watson test and, 126
 empirical studies and, 283
 ergodicity of functions theorem, 541
 heteroscedasticity in, 215
 homoscedasticity, 192
 macroeconometrics and, 5
 models with lagged variables, 559
 regression estimation, 621
 serial correlation, 253–256, 259–265
 time series process
 cointegration, 649–660
 collinearity and, 154
 dependent observations and, 73–74
 distinguishing, 5
 estimation, 878
 homoscedasticity and, 238
 least squares and, 566
 modeling, 76, 111n8
 nonstationary processes and unit roots, 631–649
 problems with, 284
 stationary stochastic processes, 609–631
 time trend
 cointegration, 652
 Dickey-Fuller tests, 644
 investment equation and, 21–22
 as regression variable, 27
 time-varying covariates, 792
 time window, 254
 tobit model

Subject Index 1023

censored data, 764–766
 censoring application, 774–780
 LM test of normality, 771
 misspecification and, 770
 multiplicative heteroscedasticity in, 768
 total variation, 31
 trace, 829–830, 832
 transformation
 achieving stationarity via, 631
 Box-Cox transformation, 173–175
 Box-Jenkins approach, 620
 continuous distributions, 921
 manipulating series via, 649
 matrix algebra, 844–845
 stabilizing transformation, 908
 transitions, time effects as, 283
 translog
 example, 162–163, 451–452
 systems of equations, 366–369
 translog model
 demand and production studies, 12–13
 inference, 104
 nonlinear cost function, 126
 production function example, 103, 499n17
 transposition, 804, 807
 trapezoid rule, 928
 treatment and response, 117
 treatment effect, 787–789
 trend stationary, 634, 636, 639, 643, 645
 triangular matrix, 803
 triangular system, 383, 395, 397
 trigamma function, 928
 truncated bivariate normal distribution, 781
 truncated distribution, 757–760
 truncated mean, 759
 truncated normal distribution, 757, 759–760, 929, 932
 truncated random variable, 757
 truncated variance, 759
 truncation
 improving estimator with, 627–628
 model for counts, 773–774
 moments of truncated distributions, 758–760
 truncated distributions, 757
 truncated regression model, 760–761
 TSP (computer program), 244n31, 377, 409n22, 919n1, 942
 Tukey window, 628
 Twinsburg, Ohio, 87–88

two-stage least squares (2SLS)
 3SLS and, 406
 estimator, 380
 Klein's Model I, 412–413
 least squares, 74–80
 method of estimation, 398–400
 nonlinear regression models, 183
 nonlinear systems and, 403–404
 panel data, 313
 specification tests, 414
 two-step estimation
 of credit scoring model, 186–189
 heteroscedasticity, 227–228, 231
 limited models, 784
 nonlinear least squares, 183–186
 two-step maximum likelihood estimation, 508–512
 two-step nonlinear least squares, 740n67
 two-variable regression model, 38–39, 46–47
 type I error, 133, 152, 892–893
 type II error, 892–893

U

unbalanced panel, 293, 689
 unbalanced sample, 685
 unbiasedness
 asymptotic unbiasedness, 917
 best linear unbiased (BLU), 193
 best linear unbiased estimator (BLUE), 890
 efficient unbiased estimator, 886, 888–890
 establishing conditionally, 47
 finite-sample results, 41
 least squares estimator, 44–45, 151
 linear unbiased estimator, 46–48
 minimum variance unbiasedness, 887
 MVBLUE, 44, 890
 nonlinear restrictions and, 109
 as statistical property, 41, 460
 unbiased estimator, 886
 unbiased test, 894
 uncentered moment, 527
 unidentified structure, 385
 uniform kernel, 455
 uniformly most powerful (UMP), 894
 unit root, 631–650
 univariate autoregression, 574
 univariate time series, 609, 619–621
 unordered choice models, 719
 upper triangular matrix, 832

V

VAR. *See* vector autoregression (VAR)
 variable metric algorithm, 939
 variables. *See also* lagged variables;
 random variables
 absence of multicollinearity, 163
 added to regressions, 30
 bias caused by omission of, 148–149
 censored variables, 762–763
 changes in R^2 , 34
 deterministic relationships among, 7
 difficulties measuring, 4
 economic variables, 619n11, 631
 endogenous variables, 381, 404, 416, 587
 existence in theories, 84
 explained variable, 7
 FDI variables, 700
 irrelevant variables, 150–151
 jointly dependent variables, 379
 linear relationships and, 13
 lognormal variables, 854
 macroeconomic variables, 575, 596
 matrix algebra and, 23
 measurement error and, 85–86
 nonlinearity in, 122–130
 predetermined variables, 380, 382–383
 proxy variables, 87–88
 relationships between, 665
 superfluous variables, 148
 univariate time series and, 609
 VAR model for, 596
 variance
 analysis of, 867
 attenuation of, 761
 conditional variance, 47, 241, 865
 confidence intervals, 892
 decomposition of, 866
 of disturbances, 15–16
 least squares estimator, 48–49, 56, 266–267
 of the median, 925
 Poisson distribution, 889–890
 of random variables, 847
 tests of structural breaks, 133–134
 truncated variance, 759
 variance inflation factor (VIF), 57
 variation, 31, 37
 vector autoregression (VAR)
 analyzing series as, 649
 cointegration, 654–655
 error correction and, 654
 estimation, 588–589

1024 Subject Index

- vector autoregression (*continued*)
 - exogeneity, 590–592
 - GMM, 555
 - Granger causality, 592–593
 - impulse response functions, 593–595
 - lagged variables, 574, 586–605
 - in microeconomics, 602–605
 - model forms, 587–588
 - policy analysis, 596–602
 - stability, 602
 - structural VARs, 595–596
 - testing, 589–590, 656
 - vector moving average (VMA), 596–597
 - vectors
 - cointegrating vectors, 650, 652–653, 659
 - column vector, 803
 - gradient vector, 838
 - length of, 818
 - linear combinations, 811
 - matrix algebra, 825–834
 - normal vector, 873–875
 - random vector, 868
 - spanning vectors, 813
 - vector multiplication, 805
 - vector space
 - basis for, 813
 - column space, 814
 - matrix algebra, 809–810
 - velocity of money, 658
 - VIF (variance inflation factor), 57
 - VMA (vector moving average), 596–597
 - volatility, market, 238, 647
- W**
- Wald criterion
 - chi-squared test and, 302
 - parameter vectors, 139
 - testing restrictions, 96, 415
 - Wald statistic
 - as alternative test, 328–329
 - assumption of normality and, 110
 - condition moment tests, 507
 - as exponential family, 530
 - feasible GLS, 347
 - functional form, 141
 - GMM estimation, 548, 550–551
 - Grunfeld investment model, 331
 - hypothesis testing, 177, 327, 741
 - inference, 106
 - least squares, 81, 83, 356
 - likelihood function and, 494
 - likelihood test, 491
 - limiting distribution of, 107–108
 - linear regression model, 494
 - model based tests, 230
 - MSL estimation, 514
 - municipal expenditures
 - example, 605
 - null hypothesis and, 133, 323–324
 - restrictions and, 484
 - robust estimation and, 200–201
 - significance tests for restrictions, 175–177
 - tobit model, 775
 - VAR testing, 590
 - White estimator, 220
 - Wald test
 - application example, 491
 - CAPM model, 356
 - F* statistic, 593
 - functional form, 134
 - GMM counterpart, 549–551
 - GMM estimation, 548
 - Grunfeld investment model, 331
 - hypothesis testing, 115, 465, 484, 486–488, 676
 - least squares, 82
 - model based tests, 230
 - noninvariance of, 110
 - Poisson distribution, 745
 - significance test for
 - restrictions, 176
 - specification analysis, 158
 - testing for zero correlation, 712
 - travel mode choice example, 733
 - type I error and, 133
 - usability of, 139
 - White estimator, 220
 - weak law of large numbers, 900
 - weakly exogenous variables, 382, 659–660
 - weakly stationary, 254, 612
 - weak stationarity, 260
 - websites
 - BEA, 282, 948
 - economagic.com, 948
 - Fair data download, 774, 952
 - NIST, 833n12
 - Weibull model
 - discrete choice models, 667, 675, 695, 771
 - limited models, 794–798, 800–801
 - weighted average, 301, 567
 - weighted endogenous maximum likelihood (WESML) estimator, 673
 - weighted least squares (WLS)
 - classical regression, 240
 - GMM estimation, 537
 - heteroscedasticity, 216, 224–227
 - log-likelihood function, 688
 - probit models, 688
 - two-step estimation, 231
 - weighting functions, 929
 - weighting matrix, 205, 207, 295n12, 312, 400–401, 409, 539, 544
 - weighting of observations, 128
 - well behaved data, 478, 483
 - White estimator
 - CAPM model and, 356
 - generalized regression model, 199, 201
 - GMM estimation, 546
 - heteroscedasticity, 220–221
 - panel data, 315–316
 - pseudo-MLE, 520
 - regression equations, 373
 - serial correlation, 267
 - simultaneous-equations models, 401, 410
 - white noise
 - Dickey-Fuller tests and, 643
 - differencing and, 635
 - fractional integration, 647
 - regression models and, 649
 - serial correlation, 257
 - stationary stochastic processes, 609, 611
 - testing for, 622
 - time series and, 635
 - White's test, 222–224, 324, 330
 - windowing, improving estimator with, 627–628
 - Wishart distribution, 445
 - Wishart prior density, 444
 - within-groups estimator, 289–290
 - WLS. *See* weighted least squares (WLS)
 - Wold's theorem, 593, 619–620
 - Wu statistic, 83
 - WZ (with zeros) model, 750n75
- Y**
- Yule-Walker equations, 266, 616
- Z**
- ZAP (zero-altered Poisson) model, 750n75
 - ZAP zero-altered poisson model, 749–752
 - zero correlation, 712
 - zero matrix, 804
 - zero mean, 14
 - zeros, blocks of, 357–360, 589
 - ZIP (zero inflated Poisson) model, 750n75, 751, 779–780