Index

Absolutely summable sequence, 28	bias, 316
of matrices, 76	consistency, 331, 343
see also Sequence	covariance of estimators, 314-315
ACF, see Autocorrelation function	distribution, 333
Additive outlier, 460	least squares residuals, 484-486
AIC, 438	variance of, 314-315
Alias, 136	of moving average time series, 22
Amplitude, 14	properties of, 7-10
Amplitude spectrum, 174. See also Cross	of second order autoregressive process, 55
amplitude spectrum	spectral representation, 127
Analysis of variance, 356	of vector process, 15-17
AR, see Autoregressive time series	Autoregression, on residuals, 519-520. See
ARCH, 110 (Exercise 43), 494	also Autoregressive time series,
ARIMA, 101	estimation
Arithmetic means, method of, 129. See also	Autoregressive moving average time series,
Cesáro summability	70–75
ARMA, 70. See also Autoregressive moving	autocorrelation function, 72
average time series	autoregressive representation, 74
Associated polynomial, see Characteristic	estimation, 431-443
equation	properties, 432-434
Autocorrelation function, 7-10	model selection, 437-438
definition, 7	moving average representation, 72-73
estimation, 317	prediction, 88-90
bias, 317	spectral density, 161
covariance of estimators, 317	state space representation, 200
distribution of estimators, 335	vector, 79
least squares residuals, 484-486	Autoregressive time series, 36-41, 54-58
partial, 10-12, 24, 27	autocorrelation function, 40, 56, 61
spectral representation, 127	backward representation, 63-64
for vector valued time series, 17	estimation for, 404-421
see also Autocovariance	bias, 412
Autocovariance, 4	distribution, 408
of autoregressive moving average time	empirical density, 412
series, 72	first order, 404-407
of autoregressive time series, 40, 55, 62	higher order, 407-418
difference equation for, 55, 62	least squares, 407-413
of complex valued time series, 12	maximum likelihood, 405, 413-414
estimation, 313	multivariate, 419-421

Autoregressive time series, estimation for	for linear functions, 329
(Continued)	for martingale differences, 235
nonlinear, 451	for m-dependent random variables.
order of, 412, 437-439	321
residual mean square, 408	multivariate, 234
from residuals, 519-520	for regression coefficients, 478
first order, 39-41	for sample autocovariance, 333
infinite order, 65	Cesáro summability, 129
likelihood for, 405, 413-414	for Fourier Series, 129
model selection, 412, 437-439	Characteristic equation, of autoregressive
moving average representation, 39, 59,	series, 54, 59, 64
63	of difference equation, 46
nonstationary, 546, 583	of moving average time series, 65
order of, 39	roots greater than one, 68-70
partial correlation in, 40, 62	roots, 46-48
prediction for, 83-85	of vector difference equation, 50
with estimated parameters, 444-449	Characteristic function, 9, 133, 143
as representation for spectral density,	Characteristic roots, of autoregressive series
165	46-48
root representation for, 67-68	of circulant matrix, 151
second order, 54-58	of explosive process, 611-612
autocorrelation, 56	of matrix, 298
autocovariance function, 55, 61-62	of moving average time series, 65
correlogram, 57	of unit root process, 591
spectral density of, 159	Chebyshev's inequality, 219
threshold, 454	Circulant, 150
unit root, 64, 546, 555-560, 563-564	characteristic roots of, 151
vector, 77-78	characteristic vectors of, 151
estimation, 419-421	Circular matrix, 150
Autoregressive transformation, 520. See also	symmetric, 151
Gram Schmidt orthogonalization	Coherency, 172
Auxiliary equation, 46. See also	inequality, 172
Characteristic equation	see also Squared coherency
	Coincident spectral density, 169
Backward shift operator, 43-44, 67	Cointegrated time series, 608
autoregressive moving average	Cointegrating vectors, 608
representation, 74	estimators, 617, 627
Bandpassed white noise, 212	Complete convergence, 228, See also
Bartlett window, 384	Convergence in distribution
Basis vectors, 112	Complete system of functions, 119
Bessel's inequality, 118	Complex exponential, 9
Bilinear model, 457	Complex multivariate normal, 207
Bounded in probability, 216. See also Order	(Exercise 10)
in probability	Complex trigonometric series, 130
Bricks, pottery, glass and cement, 535	Complex valued time series, 12-13
Burg estimator, 418	Component model, 475, 509. See also
	Structural model
Causal, 108 (Exercise 32)	Conjugate transpose, 151, 170
Centered moving average, 501	Continuity theorem, 230
Central limit theorem, 233	Continuous process, 5
for ARMA parameters, 432	Convergence, complete, 228
for finite moving average series, 320	in distribution, 227
for infinite moving average series, 326	of functions, 222
Liapounov, 233	of matrix functions, 233
Lindeberg, 233	in law, 228
· ·	· · · · · · · · · · · · · · · · · · ·

in mean square (squared mean), 31-32, 35, 120	Determinantal equation, 50, 77, 78
of moving average, 31-37	Deterministic time series, 81, 96
in probability, 215	Diagnostic checking, see Residuals, least
in r-th mean, 221	squares
of series, 27-29	Difference, 41, 507-509
in squared mean (mean square), 31–32,	of autoregressive moving average series, 516
35, 120	effects of, 513-514, 516
of sum of random variables, 31-37	fractional, 100
weak, 236	gain of operator, 514-515
Convolution, 30, 136	of integrated time series, 508
Fourier transform of, 136-138	of lag H, 508
of sequence, 30	as moving average, 508
Correlation, cross, 17	of periodic functions, 508
Correlation function, 7-9. See also	of polynomials, 46, 508
Autocorrelation function; Cross	of time series. 507
correlation	Difference equation, 41-54
Correlation matrix, 17	auxiliary equation, 46
Correlation, partial, 10-12	characteristic equation, 46
autoregressive time series, 40-41	determinantal equation, 50
moving average time series, 24	general solution, 45
see also Partial autocorrelation	homogeneous, 44
Correlogram, 57. See also Autocorrelation	Jordan canonical form, 52
function	particular solution, 45
Cospectrum, 169	reduced, 44
estimation of, 391	second order, 47-48
Covariance, 4. See also Autocovariance:	solution of <i>n</i> -th order, 48
Cross covariance	solution of second order, 47–48
Cross amplitude spectrum, 174	solution of vector, 50-51, 53-54
confidence interval for, 394	stochastic, 39
estimation, 393-394	systems of, 49-54
Cross correlation, 17	vector, 49-54
estimation, 341–342	vector, 49-34 vector <i>n</i> -th order, 53-54
consistency of, 343	Dirac's delta function, 141 (Exercise 8)
covariance of, 342	Distributed lags, see Regression with lagged
distribution of, 345	variables
Cross covariance, 15	Distribution function, 2-3
estimation, 339-343	Donsker's theorem, 237
consistency, 343	Drift, random walk, 565
covariance of, 342	Durbin-Levinson algorithm, 82
Cross periodogram, 388	
definition, 388	Durbin's moving average estimator, 425
expected value of, 388	error in, 426 Durbin-Watson d, 486
smoothed, 389–394	* * **
expected value of, 390	t approximation for, 488
variance of, 390	Ensemble 2
Cross spectral function, 169	Ensemble, 3 Ergodic, 308
Cycle, 14	Error spectral density, 177
0,0.0, 11	Error spectrum, 177
Delay, 167	estimation of, 392
frequency response function of, 167	Estimated generalized least squares, 280
phase angle of, 167	distribution of, 280
Delta function, 141 (Exercise 8)	based on residuals, 288
Des Moines River, 184, 192, 346, 394	Estimator, 79. See also various models and
sample correlations, 347	parameters
-	F

Even function, 8-9	of correlation function, 127, 132
Event, 1	of covariance function, 357. See also
Expectation, of products of means, 242	Spectral density
of sequence of functions, 243	of estimated covariance function, 357. See
Explanatory variable, 605	also Periodogram
Explosive autoregression, 583-596	inverse transform, 133
estimation, 584-596	pair, 132
prediction, 595-596	of product, 138-139
Extrapolation, 79-94	on real line, 132
polynomial, 482	table of, 134
see also Prediction	Fourier transform pair, 132
	Fractional difference, 100
Fast Fourier transform, 357	Frequency, 14
Fieller's confidence interval, 393	Frequency domain, 143
Filter, 79, 165	Frequency response function, 167
delay, 167	Fubini's theorem, 34
frequency response function, 167	Function, complete system of, 119
gain of, 167	
Kalman, 188	delta, 141 (Exercise 8)
linear, 165, 497-509	distribution, 2-3
matrix, 179	even, 8–9
for mean, 497-502	expectation of, 243
	generalized, 140 (Exercise 8)
mean square error of, 184	integrable, 117
moving average, 497-509	odd, 8-9
phase of, 167	periodic, 13, 14
power transfer function, 167	piecewise smooth, 121
for signal measurement, 181	sample, 3
time invariant, 166	smooth, 121
transfer function, 167	symmetric distribution, 10
see also Moving average; Difference;	trigonometric, 13
Autoregressive transformation	
Fisher's periodogram test, 363	Gain, 174
table, 364	bivariate time series, 174
Folding frequency, see Nyquist frequency	confidence interval for, 394
Forecast, 79-94. See also Prediction	of difference operator, 514
Fourier coefficients, 114	estimation, 394
analysis of variance, 356	of filter, 167
complex, 130-131	of trend removal filter, 513-514
of finite vector, 114	Gauss-Newton estimator, 269, 437
of function on an interval, 117	estimator of variance of, 271
multivariate, 385-386	moving average time series, 422-424
distribution of, 389	one step, 269
as regression coefficients, 114-115, 356	unit root moving average, 630
of time series, 355-356	Generalized function, 140 (Exercise 8)
uniqueness, 119	Generalized inverse, 80
Fourier Integral Theorem, 132	Generalized least squares, 280
Fourier series, Cesáro summability, 129	efficiency, 479–480
convergence, 121-130	estimated, 280, 520-522
integral formula, 123	for trend, 476
of periodic function, 125	Gibb's phenomenon, 140 (Exercise 3)
see also Fourier transform; Trigonometric	Grafted polynomials, 480-484
polynomial	definition, 481
Fourier transform, 132	for trend, 482-484
of convolution, 136-138	Gram-Schmidt orthogonalization, 86, 520

Helly-Bray theorem, 230
Hermitian matrix, 170
Heterogeneous variances, 488, 492-497
Hölder inequality, 243
Homogeneous difference equation, 44. See also Difference equation

Implicit price deflator, 593 Impulse response function, 529 Index set, 3, 5 Initial condition equation, 188 Innovation algorithm, 86 Innovation outlier, 460, 461 Input-output system, 174 Instrumental variables, 273, 532-534 distribution of estimator, 275 estimator, 274 example of, 277 for lagged dependent variables. 532-534 Integral formula, Fourier Series, 123 Integrated spectrum, 144 Integrated time series, 502 moving average for, 502-503 see also Unit root autoregression Inverse autocorrelation function, 211 Inverse transform, 133 Invertible moving average, 66. See also Moving average time series

Joint distribution function, 3 Jordan canonical form, 52 Jump discontinuity, 122

Kalman filter, 188, 497
initial condition equation for, 188
with missing data, 198
for predictions, 198, 202
for unit root process, 195
updating equations, 190
see also State space
Kernel, 382. See also Window
Kolmogorov-Smirnov test, 363
Kronecker's Lemma, 126

Lagged value, 42
in regression, 530
Lag window, 382
Law of large numbers, 253-255. See also
Convergence in probability
Least squares estimator, 251
for autoregressive time series, 405-412. See
also Autoregressive time series,
estimation

of autoregressive unit root, 603 distribution of, 256, 478 efficiency of, 312, 479-480, 518-519 of explosive process, 584, 591 Fourier coefficients, 114, 117 of mean, 311 of mean function, 476-480 moving average, 497 for moving average time series, 421-429. See also Moving average time series. estimation nonlinear, 251. See also Gauss-Newton estimator for prediction, 79-80. See also Prediction residuals, 484-497 autoregressive parameters from, 490 heterogeneous variances, 488, 492-497 with time series errors, 518-529 for trend, 476 with trigonometric functions, 117 variance of, 256 variance estimator, 260 of vector unit root process, 578-629 see also Generalized least squares; Maximum likelihood; various models Lebesque-Stieljes integral, 9 Liapounov central limit theorem, 233 Likelihood estimation, see Maximum likelihood estimation Limited information maximum likelihood, 274 Lindeberg central limit theorem, 233 Linear filter, 165, 497-509 Linear operator, see Filter Line spectrum, 146 Long memory time series, 98-101 estimation for, 466-471 spectral density of, 168 Lynx, 455

Martingale difference, 235
Martingale process, 234
Matrix, absolutely summable sequence, 76
circulant, 150
circular, 150
circular symmetric, 151
covariance of least squares estimator, 256.
See also Least squares estimator;
Gauss-Newton estimator; Generalized least squares; Instrumental variables covariance of n observations, 80
covariance of prediction errors, 90-91
covariance of vector time series, 15
diagonalization of covariance, 151-154

Matrix (Continued)	for trend, 498-501, 513
difference equations, 49-54	see also Filter; Difference
Hermitian, 170	Moving average process, 21-26. See also
Jordan canonical form, 52	Moving average time series
positive definite, 154	Moving average time series, 21-26
positive semidefinite, 154	autocorrelation function, 22-23
Maximum likelihood estimation,	autoregressive representation, 65
autoregression, 405, 413-414	covariance function, 22-23
autoregressive moving average, 431,	estimation for, 421-429
434	autocovariance estimator, 421–422
lagged dependent variable, 535-538	distribution, 424, 432
regression model with autoregressive	Durbin's procedure, 425
errors, 526-527	empirical density, 429
unit root autoregressive process, 546-547,	first order, 421–425
574-578	higher order, 430–432
m-dependent, 321	initial estimators, 425
Mean, best linear estimator of, 311	residual mean square, 424
central limit theorems for, 321, 329	first order, 23-25, 66
consistency of, 309, 325-326	finite, 21–22
distribution of sample, 321	infinite, 23
efficiency of sample, 312	invertible, 66
estimation of, 308	one sided, 22
function, 475-476	order of. 22
local approximation to, 497–499	
moving average estimator, 497-502	partial correlation in, 23, 65
structural model for, 509-513	prediction for, 85-88
product of sample, 242	as representation for spectral density, 163
of time series, 4	as representation for general time series,
variance of, 309	96
Mean prediction error, 438	root representation for, 66
	spectral density of, 156
Mean square approximation, 120	unit root, 66, 629-636
Mean square continuous, 6	vector, 75-76
Mean square convergence, 31-32, 35 Mean square differentiable, 7	Multiplicative model, 440
	Multivariate random walk, 596-599
Measurement error, 181	Multivariate spectral estimation, 385-399
Measurement equation, 187	Multivariate time series, 15-17. See also
Missing data, Kalman filter for, 198	Vector valued time series
maximum likelihood with, 458–459	71770 12 10 m 1 m
Moorman Manufacturing Company, 278	$NI(0, \sigma^2)$, 19 (Exercise 9)
Moving average, 21–26, 31–39, 497–509	Noise to signal ratio, 177
centered, 501	Nondeterministic, 81, 86, 94
computation of, 499-500, 506-507	Nonlinear model, 250
covariance function, 22	autoregression, 451
covariance of, 33–39, 501–502	estimator for, 251, 269
difference as, 508	Nonlinear regression, 250. See also
filter, 497–509	Gauss-Newton estimator
for integrated time series, 502	Nonlinearity, test for, 453-454
least squares, 499	Nonnegative definite, 7, 9
for mean, 498-501	Nonstationary autoregression, 547-596. See
mean square convergence of, 31-32, 35	also Explosive autoregression; Unit root
for nonstationarity, 502	autoregression
for polynomial mean, 501, 504	Nonstationary time series, 4, 475, 547
for seasonal, 504-507, 515 for seasonal component, 504-507	types of, 475
spectral density, effect on, 513-514	see also Nonstationary autoregression Nyquist frequency, 136
opoonal deaphy, elicel Ull. 3137314	INVOKINE HELDECKEY, 13D

Observation equation, 187 Odd function, 8, 9	Phase angle, 14 of delay, 167
One-step Gauss-Newton, 269	of filter, 167
One-step prediction, see Prediction	Phase spectrum, 174
Order, of autoregressive moving average	confidence interval for, 393
time series, 70	estimation, 392
of autoregressive time series, 39	Pig feeding experiment, 277
of difference equation, 41, 53	Polynomial, extrapolation, 482
of expected value of functions, 214-250	grafted, 480
of expected value of moments, 242	moving average for, 501, 504
of magnitude, 214	trend, difference of, 508
of moving average time series, 22	trigonometric, 112
in probability, 215	Positive definite Hermitian matrix, 170
of trigonometric polynomial, 117	Positive semidefinite, 7
Ordinary independent variable, 530	Hermitian matrix, 170
Ordinate, periodogram, 358	Power spectrum, see Spectral density
Orthogonal basis, 112	Power transfer function, 167
Orthogonal system of functions, 112, 116	Prediction, 79–94
Orthogonal vectors, 112	
Orthogonality, of trigonometric functions,	for autoregressive moving average, 88-94 for autoregressive time series, 83-85
112-114, 116	confidence interval for, 90
Outliers, 460-466	estimated explosive process, 595-596
additive, 460	with estimated parameters, 443–457
innovation, 461	
innovation, 401	estimated unit root process, 582-583
PACF, see Partial autocorrelation	first order autoregressive, 83-84
Parseval's theorem, 120	with Kalman filter, 198, 202
Partial autocorrelation, 10–12	linear, 80
autoregressive time series, 40, 62	minimum mean square error, 80
estimators, 416	for moving average time series, 85-88 polynomial, 482
moving average time series, 23-24, 65	
Partial regression, 10	recursive equations for, 86–87 variance of, 80
Period, 13	Probability limit, 215
Periodic function, 13	of functions, 222
difference of, 508	Probability space, 1-2
Periodic time series, 13-14	Process, 3-5. See also Time series; various types
Periodicity, test for, 363	
Periodogram, 357–363	Product, expectation of, 242
chi-square distribution of, 360	Ovadratura anastral danaity 160
confidence interval based on, 375	Quadrature spectral density, 169 Quadrature spectrum, 169
covariance of ordinates, 369	estimation of 391
cross, 388. See also Cross periodogram	esumation of, 591
cumulative, 363	Random variable, 2
definition. 357	*
	Random coefficient autoregression, 457
distribution of, 360 expected value of, 359	Random walk, 546 with drift, 565
as Fourier transform of sample	estimation, 546
covariances, 357	vector, 596–599
Fisher's test, 363	see also Unit root
Kolmogorov-Smirnov test, 363	Realization, 3, 5, 81
smoothed, 371-374	Regression, with lagged variables, 530-538
distribution of, 372, 374	for time series, 518-529
expected value of, 372	see also Least squares estimator;
variance of, 372	Generalized least squares; Partial
test for periodicity, 363	regression

Regular time series, 81, 86, 94	covariance estimator of, 382
Residuals, least squares, 484-497. See also	distribution of, 382–384
Least squares estimator	windows for, 384-385
Response function, see Frequency response	of convolution, 138
function	cross, 169. See also Cross spectrum
Roots, of characteristic equation, 46-48	of differenced time series, 513-514
of matrices, 298	error, 177
of polynomial, 291	estimation, 355-385. See also Cross
see also Characteristic roots	periodogram; Periodogram; Spectrum estimation
Sample function, 3	existence of, 127
Seasonal adjustment, 504-507. See also	of filtered time series, 156, 166-167,
Filter; Moving average	179-180, 513-514
Seasonal component, 14, 475, 504-507	of long memory process, 168
moving average estimation, 504-507	moving average representation, 163
see also Mean; Filter; Moving	of moving average time series, 156
average	properties of, 127
Sequence, 26-39	quadrature, 169
absolutely summable, 28	rational, 161
convergent, 28	of seasonally adjusted time series, 515-516
convolution of, 30	of vector autoregressive process, 180
of expectations, 243	of vector moving average process, 180
infinite, 26–27	of vector time series, 172
of matrices, 76	estimation, 385-399
of uncorrelated random variables, 5	see also Spectrum
white noise, 5	Spectral distribution function, 144
Serial correlation, see Autocorrelation; Cross	vector process, 172
correlation	Spectral kernel, 382
Serial covariance, see Autocovariance: Cross	Spectral window, 382. See also Window
covariance	Spectrum, 132
Series, infinite, 27	amplitude, 174
absolutely convergent, 28	cospectrum, 169
convergent, 28	cross, 169
divergent, 28	discrete, 146
Fourier, 123-130. See also Fourier series	error, 177
trigonometric, 117	estimation of, 392
Shift operator, see Backward shift operator;	estimation, 355-385. See also Cross
Lagged value	periodogram; Periodogram; Spectral
Short memory process, 98	density, covariance estimator
Sigma-algebra, 2	integrated, 144
Sigma-field, 2	line, 146
Signal measurement, 181	phase, 174
Singular time series, 81, 96	quadrature, 169
Skew symmetric, 13	see also Spectral density
Smoothed periodogram, 371-374	Spline functions, 484. See also Grafted
Smoothing, see Moving average; Filter;	polynomials
Periodogram	Spirits, 522, 528
Spectral density, 132	Squared coherency, 172, 175
approximation for, 163, 165	confidence interval, 392
autoregressive estimator, 385	estimation, 391
of autoregressive moving average, 161	multiple, 391-392
autoregressive representation, 165	test of zero coherency, 392
of autoregressive time series, 159	Starting equation, 188
coincident, 169	State equation, 187
confidence interval for, 375	State space, 187

measurement equation, 187	of trend removal filter, 514
representation for ARMA, 200	Transformation, autoregressive:
state equation, 187	Gram-Schmidt orthogonalization, 86
Stationarity, 3-4	see also Filter; Moving average
covariance, 4	Transform pair, 132
second order, 4	Transition equation, 187
strictly, 3	Treasury bill rate, 564, 577, 581, 624
weakly, 4	Trend, 4, 475
wide sense, 4	filter for, 497-502
see also Nonstationary time series	global estimation of, 476-480
Stochastic difference equation, 39	grafted polynomial, 480–482
estimation, 404-407. See also Autoregressive	moving average estimation, 497-502
time series, estimation	structural model for, 509-513
vector, 77	see also Mean; Least squares estimator;
see also Autoregressive time series	Moving average
Stochastic process, 3-5	Trigonometric functions, 14, 112
continuous, 6	amplitude, 14
definition, 3	completeness of, 119
mean square continuous, 6	frequency, 14
see also Time series	orthogonality of, on integers, 112-114
Stochastic volatility model, 494-497	on interval, 116
Strictly stationary, 3	period, 14
Structural model, 509-513	phase, 14
Symmetric estimators, 414-416	polynomial, 112, 355
simple, 414	sum on integers, 112-114
simple for unit root, 568-573	see also Fourier series; Fourier transform
weighted, 414-416	Trigonometric polynomial, 112
weighted for unit root, 570-574	order of, 117
•	Trigonometric series, 117
Taylor's series, for expectations, 214-250	complex representation, 130
for random functions, 224-226	Two-stage least squares, 274, 532
Threshold autoregression, 454	
smoothed, 455	Unemployment rate, 336, 379, 412
Time domain, 143	autoregressive representation, 412
Time series, causal, 108 (Exercise 32)	correlogram for, 339-340
complex, 12-13	monthly, 379
covariance stationary, 4	Unit root, autoregression, 63-64, 546
continuous. S	autoregressive estimation, 547-583
definition. 3	distribution, 550–551, 556, 561–563
deterministic, 81	drift, 565-568
long memory, 98–101	first order, 547-563
nonsingular, 82	higher order, 555-560
nonstationary, 4	maximum likelihood, 573-577
periodic, 13	mean estimated, 560-565
realization of, 81	median unbiased, 578-579
regular, 81, 94	trend estimated, 567-568
short memory, 98	•
singular, 81, 96	explanatory variable, 603-606 first order, 546
stationary, 3, 4	Kalman filter for, 195
strictly stationary, 3	moments of, 547, 639 (Exercise 4)
see also Autoregressive time series; Moving	moving average, 66, 629-636
average time series; various time series	prediction for, 573-577
entries	test for, univariate, 553, 555, 558,
Transfer function, 167	568-577
model, 529	tables, 641-645
	WOIND, CTA OTO

Unit root (Continued)
test for, vector, 622
tables, 646-652
vector autoregression, 596-629
Unobserved components, 509
Updating equation, 190

Variance, 4 heterogeneous, 488, 492-497 see also Autocovariance; Cross covariance Vector process, 15-17, 75-79. See also Vector valued time series Vector valued time series, 15-17, 75-79 autoregressive, 77-78 unit root, 607-610 covariance matrix, 15 covariance stationary, 15 estimation, 419-421. See also Cross covariance, estimation; Cross periodogram moving average, 75-76 spectral density, 172 estimation, 385-399 unit roots, tests for, 622 tables, 646-652 Wiener process, 238, 596-599 see also Cross correlation; cross spectral

function von Neumann ratio, 319, 486 t approximation for, 488

Weak convergence, 236 Weakly stationary, 4 Weighted average, see Filter; Moving average Wheat yields, 510, 527 White noise, 5 band passed, 212 Wiener process, 236 Window, 382, 384 Bartlett, 384 Blackman-Tukey, 385 hamming, 385 hanning, 385 lag, 382 Parzen, 385 rectangular, 384 spectral, 382 triangular, 384 truncated, 384 Wold decomposition, 94-98

Yule-Walker equations, 55, 408 multivariate, 78