

Contents

1	Introduction	1
1.1	Introduction	1
1.2	The dynamics of the first order difference equations	5
1.3	Higher dimensional systems	10
1.4	What is chaos?	13
1.5	Chaos versus random noise	19
1.6	Chaos and statistics	23
2	A Nonlinear Cobweb Model	33
2.1	Introduction	33
2.2	The cobweb model	34
2.3	The model	35
2.4	Qualitative behavior	38
2.4.1	The period-doubling road to chaos	39
2.4.2	Chaos in the Li/Yorke sense	46
2.4.3	Dynamic behavior in the two-dimensional parameter plane	51
2.5	Summary	54

2.6	Appendix	57
3	Are Time Series From Agricultural Markets Nonlinear? The Case of German Prices	64
3.1	Introduction	64
3.2	The data	65
3.3	Correlation integral methods	77
3.3.1	The wing and shuffle diagnostics	83
3.3.2	The BDS test	90
3.3.3	Results of the BDS test	92
3.4	A nonlinear analysis of the time series	95
3.4.1	Some definitions	96
3.4.2	A nonlinear approach to time series modeling	97
3.4.3	Testing the linearity assumption	99
3.4.4	The effect of picking data at different time intervals . .	110
3.5	Appendix: Results of linear model fitting	119
3.5.1	Pig prices	119
3.5.2	Potato prices, sample 1-800	120
3.5.3	Egg prices	121
4	A Nearest Neighbor Approach to Forecast Nonlinear Time Series	122
4.1	The forecasting algorithm	123
4.2	A robust test	127
4.3	A simulation study	129
4.4	Results for commodity price series	134
4.5	Summary	134
4.6	Appendix: Simulation study results	140
4.7	Results for residuals of linear models fitted to the growth rates	146

5	Conclusions and Outlook	148
5.1	Summary and conclusions	148
5.2	Outlook: Modeling nonlinear time series	151