

The Econometric Analysis of Network Data

Edited by

Bryan Graham

University of California, Berkeley
Berkeley, CA, United States

Áureo de Paula

University College London
London, United Kingdom



ACADEMIC PRESS

An imprint of Elsevier

Contents

Preface	ix
List of contributors	xi
1. Introduction	
<i>Bryan S. Graham and Áureo de Paula</i>	
Paths, distance and diameter	4
Measuring homophily	8
Measuring agent centrality	10
Degree centrality	10
Refinements of degree centrality	11
Katz–Bonacich centrality	18
Outdegree-based centrality measures	19
References	20
2. Dyadic regression	
<i>Bryan S. Graham</i>	
2.1 Population and sampling framework	25
Sampling assumption	27
2.2 Composite likelihood	28
2.3 Limit distribution	29
Variance calculation	31
Variance estimation	34
Limit distribution	35
2.4 Empirical illustration	35
Monte Carlo experiment	36
2.5 Further reading	37
Appendix 2.A Derivations	38
References	39
3. Strategic network formation	
<i>Áureo de Paula</i>	
3.1 Basic ingredients of the environment	42
3.2 Relation to empirical games	46

3.3	Network formation	49
3.3.1	Iterative network formation	49
3.3.2	Non-iterative network formation	53
3.4	Concluding remarks	59
	References	59
4.	Testing for externalities in network formation using simulation	
	<i>Bryan S. Graham and Andrin Pelican</i>	
	A strategic network formation game with transfers	65
	Test formulation	68
	Similarity of the test	70
	Choosing the test statistic	71
	Simulating undirected networks with fixed degree	73
	The algorithm	74
	Importance sampling	76
	Illustration using the Nyakatoke network	79
	References	81
5.	Econometric analysis of bipartite networks	
	<i>Stéphane Bonhomme</i>	
	5.1 Introduction	83
	5.2 Bipartite network models: the linear case	87
	5.2.1 Bipartite networks	87
	5.2.2 Fixed effects: the AKM estimator	89
	5.2.3 Random-effect approaches	92
	5.3 Identification in nonlinear models	97
	5.3.1 Motivation for nonlinearity	97
	5.3.2 Identification in one-sided random effects	99
	5.3.3 Identification in two-sided random effects	101
	5.4 Estimation in nonlinear models	104
	5.4.1 Fixed-effect and random-effect approaches	104
	5.4.2 Discrete heterogeneity I: finite mixture methods	105
	5.4.3 Discrete heterogeneity II: classification-based methods	107
	5.5 Endogenous link formation and network dynamics	113
	5.5.1 A static model of network formation	113
	5.5.2 Network dynamics and externalities	114
	5.6 Conclusion	116
	References	116
6.	An empirical model for strategic network formation	
	<i>Nicholas Christakis, James Fowler, Guido W. Imbens, and Karthik Kalyanaraman</i>	
	6.1 Introduction	123

6.2	Set up	126
6.3	Exponential random graph and strategic network formation models	128
6.3.1	Exponential random graph models	128
6.3.2	Strategic network formation models	129
6.4	The model	130
6.4.1	Opportunities for establishing links	131
6.4.2	Link formation	132
6.4.3	Preferences	133
6.4.4	The likelihood function	135
6.5	Markov-chain-Monte-Carlo methods	138
6.5.1	Drawing from the posterior distribution of the parameters given the augmented data	138
6.5.2	Updating the sequence of opportunities	139
6.6	An application to high school friendships	140
6.6.1	Data	140
6.6.2	Estimation and inference	142
6.6.3	Goodness of fit	145
6.6.4	The effect of single-sex classrooms on network formation	145
6.7	Conclusion	146
	References	147
7.	Econometric analysis of models with social interactions	
	<i>Brendan Kline and Elie Tamer</i>	
7.1	Introduction	149
7.2	Identification of models of social interactions	151
7.2.1	The linear-in-means model	151
7.2.2	Non-linear models	158
7.2.3	Response functions	160
7.2.4	Treatment effects mediated through networks	162
7.2.5	Other approaches to identification	166
7.3	Specification of models of social interactions	168
7.3.1	Empirical individual treatment response	168
7.3.2	Empirical group treatment response	169
7.3.3	Recap	170
7.3.4	Immunization and infectious disease with social interaction	171
7.4	Policy relevance of models of social interactions	176
	References	177
8.	Many player asymptotics for large network formation problems	
	<i>Konrad Menzel</i>	
8.1	Introduction	183

8.2 Model	185
8.2.1 Data	185
8.2.2 Link preferences	185
8.2.3 Network statistics	186
8.2.4 Payoff specification	187
8.2.5 Solution concept	189
8.2.6 Tâtonnement and equilibrium selection	191
8.3 Many player asymptotics for economic models	192
8.3.1 Asymptotic sequence	193
8.3.2 Cross-sectional dependence	195
8.3.3 Asymptotic independence of η_{ij} and $W_i(\mathbf{D}^*)$	197
8.3.4 Limiting approximations to model components	198
8.4 Limiting model	203
8.4.1 Link frequency distribution.	204
8.4.2 Unique edge-level response	205
8.4.3 Equilibrium selection	206
8.4.4 Convergence results	206
8.5 Identification and estimation	207
8.5.1 Identification	208
8.5.2 Maximum likelihood estimation	210
8.6 Conclusion	214
Appendix 8.A Bounds for set-valued edge-level response	215
8.A.1 Set-valued edge-level response	215
8.A.2 Set estimation and bounds	216
Appendix 8.B Convergence of link formation probabilities to logit	220
References	221
 Index	 225