

University of Groningen

Modeling the dynamics of networks and continuous behavior

Niezink, Nynke Martina Dorende

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2018

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Niezink, N. M. D. (2018). *Modeling the dynamics of networks and continuous behavior*. University of Groningen.

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Modeling the dynamics of networks and continuous behavior

Nynke Martina Dorende Niezink

© 2018 Nynke M.D. Niezink
ISBN (print): 978-94-034-0630-5
ISBN (digital): 978-94-034-0629-9
Printing: Haveka, Alblasterdam

This work has been supported by the Research Talent funding scheme of the Netherlands Organisation for Scientific Research (NWO grant 406-12-165).



university of
 groningen

Modeling the dynamics of networks and continuous behavior

PhD thesis

to obtain the degree of PhD at the
University of Groningen
on the authority of the
Rector Magnificus Prof. E. Sterken
and in accordance with
the decision by the College of Deans.

This thesis will be defended in public on

Monday 28 May 2018 at 11.00 hours

by

Nynke Martina Dorende Niezink

born on 9 June 1987
in Groningen

Supervisor

Prof. dr. T.A.B. Snijders

Co-supervisor

Dr. M.A.J. van Duijn

Assessment committee

Prof. dr. A. Flache

Prof. dr. M.S. Handcock

Prof. dr. E.C. Wit

Contents

1	Introduction	1
1.1	Stochastic actor-oriented model	2
1.2	Required data	4
1.3	Related models	5
1.4	Model developments	7
1.5	Overview	8
2	Networks and continuous behavior: the practice	11
2.1	Introduction	11
2.2	Stochastic differential equations	13
2.3	Stochastic actor-oriented model	17
2.3.1	Notation and data structure	17
2.3.2	Attribute evolution model	18
2.3.3	Network evolution model	20
2.3.4	Integration of network and attribute model	22
2.4	Estimation	23
2.4.1	Statistics for the conditional moment equation	24
2.5	Interpretation	25
2.6	Example: co-evolution of friendship and distress	27
2.6.1	Sample and procedure	28
2.6.2	Plan of analysis	29
2.6.3	Results	32
2.6.4	Conclusion	42
2.7	Discussion	42
2.A	Appendix: the distress model – step by step	45
3	Networks and continuous behavior: the theory	47
3.1	Introduction	47

3.1.1	Notation and data structure	49
3.2	Continuous attribute evolution	50
3.2.1	Period dependence	52
3.2.2	Exact discrete model	52
3.2.3	Identifiability	53
3.3	Co-evolution model	54
3.3.1	Network evolution	54
3.3.2	Network-attribute co-evolution scheme	57
3.4	Parameter estimation	57
3.4.1	Statistics for network evolution parameters	60
3.4.2	Statistics for attribute evolution parameters	60
3.5	Application: co-evolution of friendship and BMI	62
3.6	Simulation study	66
3.7	Discussion	67
3.A	Appendix: justifying the approximation in Section 3.3.2	69
3.B	Appendix: covariance estimation	71
4	Networks and continuous behavior in RSiena	75
4.1	Introduction	75
4.2	Estimation	76
4.3	Example: co-evolution of friendship and grades	79
4.3.1	Data specification	79
4.3.2	Model specification	81
4.3.3	Specification of the estimation algorithm	83
4.3.4	Running the analysis	84
4.3.5	Convergence and goodness of fit	84
4.3.6	Interpreting the results	86
4.4	Technical notes	90
4.4.1	Approximation in continuous behavior dynamics	91
4.4.2	Jacobian estimation accuracy	92
4.5	Discussion	96
5	Standard error accuracy	99
5.1	Introduction	99
5.1.1	Simulation example	101
5.2	Standard error estimation	102
5.2.1	Monte Carlo estimation	103
5.2.2	Application to the simulation example	104
5.3	Diagnosing standard error inflation	105
5.3.1	Collinearity in linear regression	105

5.3.2	The condition number	106
5.3.3	Standard error inflation	108
5.3.4	Application to the simulation example	109
5.4	Empirical example: friendship and body mass index	110
5.4.1	Convergence of the standard error estimates	111
5.4.2	Bootstrap distribution	113
5.4.3	Exploring the dependencies	117
5.5	The effect of a particular Monte Carlo simulation	117
5.5.1	Defining the ‘detrimental’ simulations	119
5.5.2	Detecting the ‘detrimental’ simulations?	119
5.6	Alternative estimators	121
5.7	Discussion	124
5.A	Appendix: proofs of the propositions	127
6	Continuous versus discretized behavior	129
6.1	Introduction	129
6.2	Models for attribute dynamics	131
6.2.1	Discrete attribute evolution	131
6.2.2	Continuous attribute evolution	132
6.3	Analytical comparison	133
6.3.1	Stationary distributions	134
6.3.2	Comparison	137
6.4	Real data study	138
6.4.1	Treatments of the grade data	139
6.4.2	Results	140
6.5	Simulation study	143
6.5.1	Study design	144
6.5.2	Results	146
6.6	Discussion	152
7	Conclusion and discussion	157
7.1	Summary of the research	157
7.2	Empirical applicability	159
7.3	Directions for future research	160
7.3.1	Non-linear transformations	160
7.3.2	Maximum likelihood estimation	161
7.3.3	Revision of model assumptions	163
	Samenvatting	167
	References	171

Acknowledgements	185
About the author	187
ICS dissertation series	189

