

Michael Sonis • Geoffrey J.D. Hewings  
Editors

# Tool Kits in Regional Science

Theory, Models, and Estimation



Springer

# Contents

<b>Contributors .....</b>	<b>xiii</b>
<b>1 Introduction .....</b>	<b>1</b>
Michael Sonis	
<b>2 Complex Socio-Economic Systems in Regional Science .....</b>	<b>5</b>
<i>Reconsideration of Theories of Linear Spatial Analysis</i>	
Michael Sonis	
2.1 Introduction .....	5
2.2 Catastrophe Effects in Linear Programming.....	7
2.2.1 Cone-Wedge Presentation of the Domain of Structural Stability of Optimal Solutions .....	7
2.3 Structure of Optimal (Minimum Cost) Transportation Flows .....	9
2.3.1 Domains of Structural Stability and Boundaries of Structural Change in Optimal Transportation Networks .....	9
2.3.2 Behavioral Competition Between Suppliers and Demanders within the Minimum Cost Transportation Problem .....	12
2.4 Superposition Principle: The Inverted Problem of Multi-Objective Programming.....	12
2.4.1 Connection Between the Weber Principle of Industrial Location and the Möbius Barycentric Calculus .....	14
2.4.2 The Caratheodory Theorem and the Inverted Problem of Multi-Objective Programming.....	15
2.4.3 Decomposition Formalism for Multi-Objective Analysis Based on Minkovsky-Caratheodory Theorem .....	17
2.5 Polyhedral Catastrophic Dynamics of the Push-Pull States of Migration Streams .....	21
2.5.1 Description and Geometrical Interpretation of the Decomposition Procedure .....	21
2.5.2 Normalized Space of Admissible Migration States .....	23
2.5.3 Example of the Decomposition Analysis .....	24
2.5.4 Interconnections Between Pull and Push Analyses.....	27
2.5.5 Polyhedral Catastrophic Dynamics .....	28
2.6 Reconstruction of Central Places Geometry on the Basis of Barycentric Calculus.....	30
2.6.1 Main Assumptions of the Classical Theory of the Central Places .....	31
2.6.2 Barycentric Coordinates in the Möbius Plane .....	36
2.7 The Superposition Model of Central Place Hierarchy .....	40
2.7.1 Hierarchical Structures of the Central Place System.....	40
2.7.2 Polyhedron of Admissible Central Place Hierarchies for an Actual Central Place System.....	42

2.7.3	Decomposition of an Actual Central Place Hierarchy .....	43
2.7.4	Best Fitting Approximation Procedure and the Algorithm of Decomposition .....	44
2.7.5	Hierarchical Analysis of the Christaller Original Central Place System in Munich, Southern Germany .....	45
2.7.6	Structural Stability, Structural Changes and Catastrophes in Central Place Hierarchical Dynamics .....	47
2.8	Transportation Flows in Central Place Systems .....	48
2.8.1	Spatial Structure of the Minimum Cost Flows in a Bounded Beckmann–McPherson Central Place System .....	48
2.8.2	Aggregated Schemes and Transportation Tables for Derivation of Rotationally Invariant Flows .....	49
2.8.3	Structurally Stable “Top-Down” Transportation Flows in Bounded Three-Tier Beckmann–McPherson Central Place Hierarchies .....	50
2.8.4	Optimal Extensions of the Transportation Network in Growing Urban Systems .....	54
2.9	Feedback Loop Decomposition Analysis of Spatial Economic Systems: Hierarchy of Spatial/Functional Feedback Loop Production Cycles .....	57
2.9.1	Quasi-Permutation Matrices and Closed Feedback Loops of the Intra-Regional Production Cycles .....	58
2.9.2	Superposition of Intra-Regional Production Feedback Loop Cycles: Decomposition Algorithm .....	60
2.9.3	Vertical Specialization of Production and the Economic Meaning of the Multi-Regional Aggregated Spatial Feedback Loop Production Cycles .....	61
2.9.4	The Matrioshka Imbedding Principle for the Nested Disaggregated Hierarchy of Spatial Feedback Loop Production Cycles .....	62
2.9.5	Spatial Production Cycles in the European Common Market, 1965–1980 .....	63
3	<b>New Developments in Input-Output Analysis .....</b>	<b>69</b>
	<i>Fields of Influence of Changes, the Temporal Leontief Inverse and the Reconsideration of Classical Key Sector Analysis</i> Michael Sonis and Geoffrey J. D. Hewings	
3.1	Introduction: Coefficient Change in Input–Output Models .....	69
3.1.1	Three Approaches to Input Coefficient Change .....	71
3.2	Basic Results of the Theory of Field of Influence of Changes in Direct Inputs .....	74

3.2.1	Temporal Multipliers and Temporal Increments.....	74
3.2.2	Multiplicative and Additive Forms of the Temporal Leontief Inverse.....	75
3.2.3	The Fine Structure of the Temporal Increments .....	77
3.3	Direct (First Order) Fields of Influence of Coefficient Change: Matrix Form of the Sherman–Morrison approach .....	80
3.3.1	Definition of Direct (First Order) Field of Influence of Changes .....	80
3.3.2	Cross Structure of the First Order Fields of Influence .....	81
3.3.3	Change in One Row (Column) .....	84
3.4	Reconsideration of Classical Key Sector Analysis .....	85
3.4.1	Intensity of Direct Field of Influence and the Global Intensity Matrix as Multiplier Product Matrix (MPM) .....	85
3.4.2	Backward and Forward Linkages of Economic Sectors and Key Sector Analysis .....	86
3.4.3	Multiplier Product Matrix (MPM) and Structural Economic Landscapes.....	88
3.4.4	Minimum Information Property of MPM .....	90
3.5	Synergetic Second Order Fields of Influence .....	93
3.5.1	Definition of Second Order Field of Influence. ....	93
3.5.2	Structure of Fields of Influence of the Second Order .....	95
3.5.3	Intensity of the Second Order Synergetic Fields of Influence.....	95
3.5.4	Distribution Span of Fields of Influence of the Second Order .....	96
3.5.5	Numerical Distribution Span of Intensities of Fields of Influence of the Second order .....	98
3.5.6	Simonovits' Error Rectangles and the Decomposition of Leontief Inverse.....	99
3.6	Minimum Information Decomposition of Leontief Inverse .....	101
3.6.1	Structure of Synergetic Interactions Between Economic Sectors .....	102
3.7	Key Sector Analysis of the Chinese Economy, 1987, 1990 .....	104
3.7.1	The Chinese National Economy, 1987.....	104
3.7.2	Changes in the Chinese Economy, 1987–1990.....	111
3.7.3	Comparative Analysis: China and the Metropolitan Economies .....	112
4	<b>Interregional Computable General Equilibrium Models .....</b>	<b>119</b>
	Eduardo Haddad	
4.1	Introduction.....	119
4.2	A Stylized Theoretical Interregional General Equilibrium Model .....	120

4.2.1	Regions .....	121
4.2.2	Commodities .....	121
4.2.3	Consumers .....	121
4.2.4	Firms .....	121
4.2.5	Endowments .....	122
4.3	Social Accounting Matrices as the Basis for Modeling .....	125
4.3.1	Scaffolding .....	127
4.4	The State-of-the-Art: Common Features, Common Issues .....	127
4.4.1	Regional Setting and Data Constraints .....	128
4.4.2	Bottom-Up and Top-Down Approaches .....	129
4.4.3	Interregional Linkages .....	131
4.4.4	Production and Consumption Systems .....	134
4.4.5	Transportation Services .....	137
4.4.6	Calibration .....	138
4.4.7	Sensitivity Analysis .....	139
4.4.8	Closure .....	140
4.4.9	Intertemporal Analysis .....	142
4.4.10	Solution Method .....	142
4.4.11	Operational Models .....	143
4.5	The Road Ahead: Challenges and New Directions .....	146
<b>5</b>	<b>Optimality versus Stability: Pattern Formation in Spatial Economics .....</b>	<b>155</b>
	Tõnu Puu	
5.1	Optimality and Linearity in Economics .....	155
5.2	Flows and Areas .....	156
5.3	An Illustrative Case from Solid Geometry .....	157
5.4	Hexagonal Patterns: Optimality of Shape .....	157
5.5	On Boundary Conditions .....	158
5.6	Transversality .....	158
5.7	Further Research Agenda .....	160
<b>6</b>	<b>Urban and Hinterland Evolution Under Growing Population Pressure .....</b>	<b>163</b>
	Wolfgang Weidlich	
6.1	General Design Principles .....	163
6.2	The Integrated Model for Urban and Population Evolution .....	164
6.2.1	The Key-Variables .....	164
6.2.2	Motivation-Driven Probabilistic Transition Rates .....	165
6.2.3	Evolution Equations .....	166
6.3	A Simple Implementation of the Population-Sector: Global Treatment of City- and Hinterland-Population .....	168
6.3.1	The Global Population and Capacity Variables .....	168
6.3.2	Global Personal Utilities and Transition Rates .....	169

6.3.3	Evolution Equations for the Population Configuration.....	170
6.3.4	The Case of Equal Net Birth Rates in City and Hinterland.....	171
<b>7</b>	<b>Socio-Spatial Dynamics and Discrete Non-Linear Probabilistic Chains.....</b>	<b>177</b>
	Michael Sonis and Dimitrios S. Dendrinos	
7.1	Introduction: Universality of Discrete Socio-Spatial Dynamics .....	177
7.2	Definition and Elementary Properties of Probabilistic Chains.....	178
7.3	Types of Discrete Probabilistic Chains Describing Relative Socio-Spatial Dynamics .....	181
7.3.1	Fractional-Linear Probabilistic Chains.....	181
7.3.2	Linear Probabilistic (Markov) Chains .....	182
7.3.3	Logistic Growth Probabilistic Chain .....	182
7.3.4	Statistical Procedure for Estimation of Rates of Change and Initial State of the Logistic Growth Probabilistic Chain (Sonis, 1983, Sonis, 1987a).....	184
7.3.5	Interpolation-Extrapolation Dynamics of the Logistic Growth Probabilistic Chain .....	185
7.3.6	Applications to Analysis of Israeli Regional Employment Co-Influence .....	186
7.3.7	Log-Linear Probabilistic Chains.....	189
7.3.8	Application of Log-Linear Probabilistic Chain Model to the Analysis of Regional Competition and Complementarity .....	190
7.3.9	Interdependence Interpreted from the Viewpoint. of Discrete Relative Dynamics.....	192
7.4	Concluding Comments and Future Directions.....	195
<b>8</b>	<b>Principles of Neural Spatial Interaction Modeling .....</b>	<b>199</b>
	Manfred M. Fischer	
8.1	Introduction .....	199
8.2	The Context .....	201
8.3	Network Learning and Model Performance .....	202
8.4	Local and Global Search Procedures .....	204
8.5	Bootstrap Estimation .....	208
8.6	Model Complexity .....	210
8.7	Assessing the Generalization Performance.....	211
8.8	Concluding Remarks .....	212
<b>9</b>	<b>Quick but not so Dirty ML Estimation of Spatial Autoregressive Models .....</b>	<b>215</b>
	Daniel A. Griffith	
9.1	Background .....	215
9.2	The Normalizing Constant Approximation: History, Description and Generalization .....	217

9.2.1	History .....	218
9.2.2	Derivation of Griffith and Sone's Approximation Specification .....	220
9.2.3	Extensions of Griffith and Sone's Approximation .....	222
9.2.4	Alternatives to the Griffith-Sone Jacobian Approximation .....	225
9.3	Implementation of the Jacobian Approximation.....	228
9.3.1	The Jacobian Approximation when all of the Eigenvalues are Known.....	229
9.3.2	The Jacobian Approximation when the n-1 Nonprincipal Eigenvalues are Unknown but can be Approximated .....	232
9.3.3	The Jacobian Approximation when the n-1 Nonprincipal Eigenvalues are Unknown and Lack a Known Approximation.....	233
9.4	Implications for Standard Error Estimates.....	235
9.5	Discussion and Future Directions .....	239
<b>10</b>	<b>Innovation Diffusion Theory: 100 Years of Development.....</b>	<b>243</b>
	Michael Sonis	
10.1	Introduction .....	243
10.2	Major Actors in the Analysis of the Innovation Diffusion Process .....	246
10.3	Socio-Ecological Mechanisms of Innovation Spread.....	248
10.3.1	Empirical Regularities of Innovation Spread: Competition Between Adoption and Non-Adoption.....	248
10.3.2	Many Competitive Innovations .....	250
10.3.3	Qualitative Analysis of the Innovation Diffusion Process: Some Examples .....	252
10.4	The First Principle of Individual Choice Within the Collective .....	256
10.4.1	Choice Behavior of Homo Oeconomicus.....	256
10.4.2	Choice Behavior of Homo Politicus.....	257
10.4.3	Choice Behavior of Homo Socialis .....	257
10.4.4	Adopter as a "Collective Being" in Innovation Choice .....	258
10.5	Innovators and Innovating Elites .....	258
10.5.1	Duality Between Supply Push and Demand Pull: Meso-Level Competition Between Social Elites vs. Micro-Level Social Contacts .....	259
10.5.2	Captive Manipulation Power of Elites Influence: Ten Commandments of Aggressive Intolerance .....	261
10.6	Active Environment and Socio-Ecological Niches.....	262
10.6.1	Adoption and Non-Adoption Niches in Innovation Diffusion Process .....	263
10.6.2	Case of Many Competitive Innovations and their Niches.....	264
10.7	Conclusion and Future Directions of Development.....	265

<b>11 Urban Economics at a Cross-Road .....</b>	<b>273</b>
<i>Recent Theoretical and Methodological Directions and Future Challenges</i>	
Roberta Capello and Peter Nijkamp	
11.1 Urban Economics in Regional Science .....	273
11.2 Recent Theoretical Directions .....	276
11.3 Recent Methodological Directions .....	280
11.4 Urban Economics and Regional Science Transition.....	283
11.5 Future Challenges.....	286
11.6 Conclusions .....	287
<b>12 Conclusion.....</b>	<b>293</b>
<i>Theories and Models Inspired by Empirical Regularities of Socio-Economic Spatial Analysis</i>	
Michael Sonis	
12.1 Introduction .....	293
12.2 First Meta-Theoretical Principles in Socio-Economic and Socio-Ecological Sciences .....	296
12.2.1 Principle of Collectivity .....	297
12.2.2 Principle of Complication.....	297
12.2.3 The principle of Superposition .....	298
12.2.4 The Duality Principle.....	299
<b>Index .....</b>	<b>303</b>