

# Table of Contents

<b>List of Figures</b>	<b>xi</b>
<b>List of Tables</b>	<b>xv</b>
<b>List of Boxes</b>	<b>xvii</b>
<b>List of Abbreviations</b>	<b>xix</b>
<b>1. Innovative Places in Europe</b>	<b>1</b>
1.1. Introduction and Motivation . . . . .	1
1.2. Outline of the Thesis and Research Questions . . . . .	15
<b>2. Research Clustering, Co-Inventor Networks and Innovative Places: A Literature Survey</b>	<b>21</b>
2.1. A Survey of the Theoretical Literature . . . . .	21
2.1.1. The Co-Evolution of Research Strands in the Cluster Literature . . . . .	21
2.1.2. From First-Nature Agglomerations to Knowledge-Intensive Industries . . . . .	25
2.1.3. Agglomeration, Indivisibilities and Fragmentation . . . . .	28
2.1.4. Agglomeration, Clustering and External Economies . . . . .	31
2.1.4.1. Industrial Districts and External Economies . . . . .	31
2.1.4.2. Interpretations of Marshall's Agglomeration Economies . . . . .	34
2.1.4.3. Agglomeration Economies, Spillovers and Networks: A Taxonomy . . . . .	36
2.1.5. Agglomeration, Research Clustering and Pecuniary Externalities . . . . .	37
2.1.5.1. Pecuniary Externalities, Local Scale and Efficiency . . . . .	37
2.1.5.2. Localization Economies . . . . .	39
2.1.5.3. Urbanization Economies . . . . .	41
2.1.5.4. A Taxonomy of Urbanization and Localization Economies . . . . .	42
2.1.5.5. Core-Periphery Structures and Endogenous Location . . . . .	43
2.1.5.5.1. The Origins of the New Economic Geography . . . . .	43
2.1.5.5.2. Industry Agglomeration, Core-Periphery and Footloose Labor . . . . .	46
2.1.5.5.3. Alternative Core-Periphery Models . . . . .	48
2.1.5.5.4. Critical Remarks and Discussion . . . . .	49
2.1.6. Industry and Research Clustering and Innovation Externalities . . . . .	51
2.1.6.1. Non-Pecuniary Externalities . . . . .	51
2.1.6.2. Marshall-Arrow-Romer Externalities and Specialized Clusters . . . . .	53
2.1.6.3. Jacobs Externalities and Diversity in Cities . . . . .	55
2.1.6.4. Porter Externalities and the Competitive Advantage of Regions . . . . .	57
2.1.6.5. A Taxonomy of Innovation Externalities . . . . .	58
2.1.6.6. Endogenous Growth Theory and Research Clustering . . . . .	59
2.1.6.6.1. Knowledge Stocks and Knowledge Spillovers . . . . .	59

2.1.6.6.2.	Technological Externalities and Specialization . . . . .	61
2.1.6.6.3.	Conclusions and Critical Remarks . . . . .	62
2.1.6.7.	Research Clustering and Knowledge Flows in Core-Periphery Models . .	64
2.1.6.7.1.	Agglomerations, Blueprints and Technological Externalities . . . . .	64
2.1.6.7.2.	Growth-Cum-Geography Models and R&D . . . . .	66
2.1.6.7.3.	Critical Remarks and Discussion . . . . .	70
2.1.7.	Agglomerations, Networks and Knowledge Transmission . . . . .	71
2.1.7.1.	Knowledge Flows, Network Linkages and Spillovers . . . . .	71
2.1.7.2.	Tacit versus Codified Knowledge and the Embodiment Concept . . . . .	72
2.1.7.3.	Agglomerations, Innovative Milieus and the Proximity Hypothesis . . .	75
2.1.7.4.	Long-Distance Linkages and R&D Collaboration Networks . . . . .	78
2.1.7.5.	Localized Networks versus Inter-Regional Network Linkages . . . . .	80
2.1.7.6.	City Networks and Inter-Regional Research Collaborations . . . . .	81
2.1.7.7.	Agglomeration vs. Networks: Critical Remarks . . . . .	84
2.2.	A Survey of the Empirical Literature . . . . .	86
2.2.1.	The Co-Evolution of Different Strands of Empirical Research . . . . .	86
2.2.2.	Regional Disparities, Urbanization and Research Clustering . . . . .	87
2.2.3.	The Regional Knowledge Production Function . . . . .	91
2.2.3.1.	The Origins of the Knowledge Production Function . . . . .	91
2.2.3.2.	The Regional Knowledge Production Function . . . . .	93
2.2.3.3.	Knowledge Flows and R&D Spillovers in Europe and the US . . . . .	94
2.2.4.	Localization, Urbanization and Regional Development . . . . .	100
2.2.5.	Patent Citations, Paper Trails and Real Spillovers . . . . .	102
2.2.6.	Researcher Mobility, Social Networks and Diaspora . . . . .	106
2.2.7.	Research Collaborations and Co-Patenting Networks . . . . .	110
<b>3.</b>	<b>Innovative Places, Research Clustering and Co-Agglomeration in Europe</b>	<b>117</b>
3.1.	Analyzing Research Clustering in Europe . . . . .	117
3.2.	Patent Data as Indicators in Empirical Analysis . . . . .	122
3.2.1.	Advantages of Patent Data as Indicators . . . . .	122
3.2.2.	Drawbacks and Technical Issues of Patent Data . . . . .	125
3.3.	The Database: Patent Data, Regions and Research Activity . . . . .	126
3.3.1.	Overview and General Information . . . . .	126
3.3.2.	The Spatial Classification System . . . . .	128
3.3.3.	The IPC-Technology Field Concordance . . . . .	129
3.4.	Geographic Concentration and Regional Disparities of Research Activities	130
3.4.1.	Measuring Geographic Concentration and Regional Disparities . . . . .	130
3.4.1.1.	Aggregate Distribution, Specialization and Disparity . . . . .	130
3.4.1.2.	Skewness and Kurtosis . . . . .	132
3.4.1.3.	The Herfindahl-Hirschman Index . . . . .	133
3.4.1.4.	The Location Quotient and Relative Technological Advantage . . . . .	134
3.4.1.5.	The Relative Technology Density . . . . .	135
3.4.1.6.	The Locational Gini Coefficient . . . . .	135
3.4.1.7.	The Spatial Gini Coefficient . . . . .	140
3.4.2.	Three Decades of EPO Patenting in Europe . . . . .	141

3.4.2.1.	Skewed Distributions and Core-Periphery Structures . . . . .	141
3.4.2.1.1.	Whisker Box-Plot . . . . .	141
3.4.2.1.2.	Core-Periphery Structures and Patent Densities . . . . .	144
3.4.2.1.3.	Kurtosis, Skewness and Herfindahl-Hirschman Index . . . . .	145
3.4.2.2.	Regional Patenting Activity and EPO Inventors in Europe . . . . .	153
3.4.2.2.1.	Patent Applications by Technology Field . . . . .	153
3.4.2.2.2.	EPO Inventors by Technology Field . . . . .	156
3.4.2.2.3.	Revealed Technological Advantage . . . . .	156
3.4.2.3.	Regional Disparities of EPO Patenting Activity . . . . .	158
3.4.2.3.1.	Locational and Spatial Gini Coefficients by Technology Field . . . . .	158
3.4.2.3.2.	Dynamics of Gini Coefficients by Technology Field . . . . .	176
3.5.	Identifying Research Clusters and Co-Agglomeration in Europe . . . . .	180
3.5.1.	Research Clusters, Cities and Inventorship . . . . .	180
3.5.2.	The Research Cluster Index . . . . .	181
3.5.2.1.	Constructing a Research Cluster Index . . . . .	181
3.5.2.2.	Interpretation of the Research Cluster Index . . . . .	183
3.5.3.	Patent Data, Regional Typology and Technology Fields . . . . .	184
3.5.4.	Research Clusters in Europe by Technology Field . . . . .	185
3.5.4.1.	Global Statistics: Research Clusters by Technology Field and Country . . . . .	185
3.5.4.2.	Local Statistics: Innovative Places and Leading Regions . . . . .	200
3.5.5.	Co-Agglomeration of Research Clusters in Europe . . . . .	210
3.5.6.	Research Clustering in Urban Areas and Capital Regions . . . . .	213
<b>4.</b>	<b>European Co-Patenting Networks and Inter-Regional Linkages</b>	<b>219</b>
4.1.	Analyzing European Research Collaborations . . . . .	219
4.2.	Spatial Interdependence of European Patenting Activity . . . . .	224
4.2.1.	Measuring Spatial Interdependence . . . . .	224
4.2.1.1.	Explanatory Spatial Data Analysis . . . . .	224
4.2.1.2.	Spatial Analysis and the Modifiable Areal Unit Problem . . . . .	226
4.2.1.3.	Neighborhood Effects, Distances and Weight Matrices . . . . .	227
4.2.1.4.	Spatial Dependence and Regional Spillovers . . . . .	229
4.2.2.	Spatial Interdependence of Patenting Activity in Europe . . . . .	232
4.3.	European Co-Patenting Networks and Foreign Co-Inventors . . . . .	235
4.3.1.	International versus Inter-Regional Co-Patenting Linkages . . . . .	235
4.3.2.	The Relational Database . . . . .	236
4.3.2.1.	Regional Classification and Raw Data . . . . .	236
4.3.2.2.	From IPC to Technology Field Aggregates . . . . .	237
4.3.3.	The Research Methodology . . . . .	238
4.3.3.1.	Calculating Co-Patenting Network Linkages . . . . .	238
4.3.3.2.	Measuring Network Centralities of Regions . . . . .	241
4.3.4.	Foreign Co-Inventors and Research Collaborations in Europe . . . . .	243
4.3.5.	European Regional Co-Patenting Networks: Global Network Statistics . . . . .	246
4.3.5.1.	Network Size and Structure by Technology Field . . . . .	246
4.3.5.2.	Spatial Proximity versus Inter-Regional Linkages . . . . .	249
4.3.5.3.	Core-Periphery Structures and the East-West Gradient . . . . .	260
4.3.6.	European Regional Co-Patenting Networks: Local Network Statistics . . . . .	276

4.3.6.1.	Co-Patenting Networks and the Centrality of Regions . . . . .	276
4.3.6.2.	Co-Agglomeration of Co-Patenting Networks . . . . .	280
<b>5.</b>	<b>Research Clustering, Income Disparities and the Growth of Regions in Europe</b>	<b>283</b>
5.1.	Analyzing Regional Disparities and Growth . . . . .	283
5.2.	The Database: Regions, Patents and the Settlement Structure . . . . .	291
5.3.	The Development of Income Disparities in Europe . . . . .	292
5.3.1.	A Descriptive Overview . . . . .	292
5.3.2.	Measures of Concentration, Disparity and Inequality . . . . .	298
5.3.2.1.	Regional Disparities and the Gini Coefficient . . . . .	298
5.3.2.2.	Measures of Regional Disparity and Inequality Decomposition . . . . .	301
5.3.3.	The Development of European Income Disparities . . . . .	304
5.3.3.1.	Global Income Disparities in Europe . . . . .	304
5.3.3.2.	Regional Disparities within and between European Countries . . . . .	308
5.4.	Research Activity, Settlement Structure and Regional Growth . . . . .	309
5.4.1.	Income Levels and Regional Growth: A Descriptive Overview . . . . .	309
5.4.2.	Unconditional Convergence and European Regional Growth . . . . .	313
5.4.3.	Conditional Convergence and Regional Growth in Europe . . . . .	316
5.4.3.1.	Conditional Convergence and Regional Growth . . . . .	316
5.4.3.2.	Regional Growth in the EU-15 . . . . .	321
5.4.3.3.	Regional Growth in the New Member States . . . . .	323
5.4.4.	European Regional Growth and Spatial Spillovers . . . . .	325
5.4.4.1.	A General Spatial Model . . . . .	325
5.4.4.2.	Regional Growth Models and Spatial Interdependence . . . . .	327
5.4.4.3.	Estimation Results . . . . .	330
<b>6.</b>	<b>Summary, Conclusions and Future Research</b>	<b>337</b>
6.1.	The Literature Review . . . . .	337
6.2.	Research Clustering in Europe . . . . .	342
6.3.	Inter-Regional Co-Patenting Linkages in Europe . . . . .	345
6.4.	Regional Growth and Income Disparities in Europe . . . . .	349
<b>A.</b>	<b>Appendix: Figures</b>	<b>xxiii</b>
<b>B.</b>	<b>Appendix: Tables</b>	<b>lxxiii</b>
	<b>Bibliography</b>	<b>lxxxvii</b>