Papers in Evolutionary Economic Geography

10.01

The Aims and Scope of Evolutionary Economic Geography

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Abstract

This aim of this paper is to present the objectives and scope of an evolutionary approach to economic geography. We argue that the goal is not only to utilise the concepts and ideas from evolutionary economics (and evolutionary thinking more broadly) to help interpret and explain how the economic landscape changes over historical time, but also to reveal how situating the economy in space adds to our understanding of the processes that drive economic evolution, that is to say, to demonstrate how geography matters in determining the nature and trajectory of evolution of the economic system. We will argue that evolutionary economic geography is concerned with the spatialities of economic novelty; with how the spatial structures of the economy emerge from the micro-behaviours of economic agents; with how, in the absence of central coordination or direction, the economic landscape exhibits self-organisation; and with how the processes of path creation and path dependence interact to shape geographies of economic development and transformation, and why and how such processes may themselves be place dependent. Economic transformation proceeds differently in different places, and the mechanisms involved neither originate nor operate evenly across space. Our concern is both with the ways in which the forces making for economic change, adaptation and novelty shape and reshape the geographies of wealth creation, work and welfare, *and* with how the spatial structures and features so produced themselves feed back to influence the forces driving economic evolution. In the final part, we summarize a number of papers that have contributed to evolutionary economic geography, and which will be published in The Handbook on Evolutionary Economic Geography that is edited by the two authors, and forthcoming at Edward Elgar.

Key words: evolutionary economic geography, industry location, geography of networks, institutions, agglomeration economies

JEL-codes: O18, O30, O43, R11, R12, R58

1. Introduction

Over the past two and half decades, key theoretical developments have been taking place in the field of economic geography (Martin and Sunley, 2007b; Martin, 2008). For their part, economic geographers have moved firmly away from traditional economic analysis, and sought insights from various forms of heterodox economics and from other social sciences outside the economics field (see Amin and Thrift, 2000; Sheppard and Barnes, 2000; Martin and Sunley, 2001; Bathelt and Glückler, 2003;

Simmie, 2005; Bagchi-Sen and Lawton Smith, 2006; McCann, 2007; Martin and Sunley, 2007a). Their interest has been on the institutional, cultural and social foundations of regional and urban development: a so-called 'institutional' or 'cultural turn' has taken place. At the same time, since the early- to mid-1990s, several economists, led by Paul Krugman, the Nobel Laureate, on the one hand, and by Michael Porter, the business economist, on the other, have discovered geography, and argued for the importance of a geographical perspective for understanding the dynamics and competitiveness of the economy: both have emphasised the process of spatial agglomeration of economic activity as a source of increasing returns. Krugman and his followers even labelled their formal mathematical approach as the 'New Economic Geography'.

However, what has been lacking from these theoretical developments is any real appreciation of the importance of history in the economic landscape: neither perspective really tells us much about how that landscape *evolves over time*. Yet an evolutionary perspective is essential to a fuller understanding of such issues as the geographies of technological progress, dynamic competitive advantage, economic restructuring, and economic growth. In this context, there is thus considerable scope and potential for applying and extending the ideas and concepts from evolutionary economics to our analysis of regional and urban development.

Until the past few years, evolutionary economics, which itself has only developed in earnest since the early 1980s, has not attracted much attention from either economic geographers or the new breed of geographical economists. But very recently, a new evolutionary-geographic perspective on the economic landscape has begun to emerge amongst geography and economics scholars, especially across Europe. This new body of work, though hitherto somewhat scattered, has gained sufficient momentum to warrant bringing the key conceptual, theoretical and empirical advances together in a clear statement on the aims, objectives and methods of this new paradigm. Our paper is based on a special European Science Foundation Workshop on Evolutionary Economic Geography, held at St Catharine's College in the University of Cambridge in 2006, which drew together a number of the most distinguished scholars in the fields of evolutionary economics and economic geography. A basic conclusion of the workshop was that Evolutionary Economic Geography constitutes a distinctive and promising paradigm, and that the time is ripe for a major collective statement on the subject. While evolutionary economic geography has attracted increasing attention (and debate) since that Workshop (e.g. Frenken, 2007; Boschma and Martin, 2007, Journal of Economic Geography, 2007; Economic Geography, 2009), there are as yet few such comprehensive statements.[1]

[1] A recent book by Jovanovic (2009) entitled Evolutionary Economic Geography is partial in its conception and coverage, and indeed seems to blend evolutionary economic geography with elements of the 'new economic geography', which to our mind is a rather forced – and incompatible – marriage of perspectives.

In this paper, we will discuss the main outline of a new book that covers both theoretical and empirical aspects of evolutionary economic geography. The contributions of this Handbook on Evolutionary Economic Geography are grouped into five parts. The first set of papers address some key theoretical and conceptual issues in Evolutionary Economic Geography, with a dual focus not just on how ideas and concepts from evolutionary economics can be brought to bear on economic-geographic issues and settings, but also on how a geographical perspective itself has implications for our notions of economic evolution. Against this conceptual background, the rest of the book is concerned much more with applying these ideas in specific and empirical contexts. But here too, in so doing the various chapters also make important contributions to the formulation of an evolutionary perspective on the economic landscape. In the second part of the book, the focus shifts from broad conceptual issues to the specific case of firm and industrial dynamics in space. The contributions in this section explore how an evolutionary framework can be fruitfully applied to topics in economic geography both at the micro-level (like the geography of entrepreneurship) and the meso-level (like the tendency of industries to cluster in space). Since networks play a crucial role in understanding the spatial uneven distribution of economic activity, the third part of the book is devoted to the nature and spatial evolution of networks. Part Three of the book concentrates on how networks may be integrated in evolutionary economic geography. The fourth part focuses on the evolution of institutions in territorial contexts and explores how institutions may be incorporated in the explanatory framework of evolutionary economic geography. Part Five of the book deals with the evolution of agglomerations and the economic landscape from an evolutionary perspective.

2. The Aims and Conceptual Foundations of Evolutionary Economic Geography

Constructing an evolutionary economic geography, though an exciting endeavour, is by no means a straightforward task. For one thing there is not a single, generally accepted and commonly used body of evolutionary economics to draw on for inspiration. To be sure, over the past two decades or so a new evolutionary economics has rapidly emerged that seeks to understand precisely how the real economy evolves through real time (see, for example, Nelson and Winter, 1982; Hodgson, 1993; Arthur, Durlauf and Lane, 1997; Foster, 1997; Metcalfe, 1998; Potts, 2000; Dopfer, 2004; Metcalfe and Foster, 2004; Witt, 2003, 2006). But the rush of enthusiasm to adopt an 'evolutionary perspective' has tended to produce a plethora of self-declared approaches – a 'massive hybridisation of theory', as Dopfer and Potts (2004, p.195) put it – rather than a single coherent body of concepts and methods. So to some extent, economic geographers face a still developing corpus of ideas. Nevertheless, although the field of evolutionary economics is still without 'stabilised shared meaning' (Klaes, 2004), and remains somewhat embryonic, some basic principles do seem to be crystallising.

According to Witt (2003, 2006), the key focus of evolutionary economics is on the processes and mechanisms by which the economy *self-transforms itself from within*. Thus theories on economic evolution have to satisfy three basic requirements. First, they must be *dynamical*. This criterion rules out any kind of static or comparative-static analysis, and focuses attention on change. Second, evolutionary economics must deal with *irreversible* processes – the past cannot be recovered and it imparts legacies that condition the behaviour of economic agents in the present and the future; this rules out all 'dynamical' theories that describe stationary states or equilibrium movements, the pre-occupation of traditional mainstream (neoclassical) economics. Rather, in the context of evolutionary economics, 'dynamical' refers to such features as emergence, convergence, divergence, and other patterns and trajectories that are rooted in real historical time. This distinction is critical since while mainstream economists – and the 'new economic geography' theorists – claim to deal with 'history', this notion is merely a logical construct relating to the 'initial conditions' of the abstract mathematical models used to determine stable equilibrium outcomes: there is no real history in such approaches. And third, theories on economic evolution must cover the generation and impact of *novelty* as the ultimate source of self-transformation. As Witt emphasises, the criterion of novelty – its generation and its role in economic transformation – is crucial to any theory of economic evolution. It is the creative capacity of economic agents (individuals and firms), and the creative functions of markets, that drive economic evolution and adaptation (see also Metcalfe, Foster and Ramlogan, 2006) .

As Schumpeter insisted, transformation arises endogenously, from within the socio-economic system, and enterprise-driven innovation and adaptive development are the primary processes (Ramlogan and Metcalfe, 2006). Thus innovation and knowledge assume central importance in evolutionary economics. Knowledge is not something that is separate from, or autonomous to, the economic process in the manner of some pregiven 'factor of production' (as it is in so-called 'endogenous growth' models); rather it is the internal development of knowledge that renders the underlying process of economic evolution both adaptive and transformative in character (Fine, 2000). Knowledge never stands still, but is constantly being created. It is this continual process that drives economic evolution, and renders capitalism restless, in constant motion:

> The origins of restless capitalism lie in its unlimited capacity to generate knowledge and new behaviour from within, and it is the propensity for endogenous variation that makes it so dynamic and versatile, sufficiently so that economies may be completely transformed in structure over relatively short periods of historical time. Growth is not simply a result of calculation within known circumstances, but of human imagination and the search for novelty and competitive advantage. Moreover, every advance in knowledge creates the conditions for further advances… economic growth is an autocatalytic process in which change begets change (Metcalfe, Foster, and Ramlogan, 2006, p. 9).

Thinking about the economy as a dynamical, irreversible and self-

transformational system opens up new space for theoretical, ontological and epistemological exploration. Indeed, as noted by Dopfer, Potts, Klaes and Witt among others, the attraction for many of evolutionary economics is precisely its permissiveness towards heterodox perspectives and approaches, and a range of different metaphors (see also, Castellacci, 2006). Thus it is possible to identify neo-Veblenian, neo-Schumpeterian, neo-Hayekian, and neo-Darwinian approaches. For many, the challenge is to give economic interpretation to the basic ideas of modern evolutionary biology – especially to the notions of variety, selection, fitness, retention, mutation and adaptation. For others, the notions from complexity science - such as self-organisation, co-evolution, emergence, far-from equilibrium dynamics, and criticality - provide a suitable conceptual framework. For yet others, it is the combination of these two perspectives that is most promising.

The upshot is that evolutionary economics offers a rich palette of ideas and concepts for geographers to draw on to help them explain the evolution of the economic landscape. Here of course is the second difficulty. As is the case with any school of economic thought, evolutionary economics is largely aspatial in outlook and formulation, whereas geographers are interested in applying and adapting concepts from evolutionary economics to spatial contexts and processes. As numerous authors have warned, the abduction of metaphors and concepts from one field into another can be problematic (see Wimmer and Kössler, 2006). Just as the use of physical and mechanical analogies and metaphors in mainstream economics is contentious, so the use of biological analogies and concepts in evolutionary economics - and evolutionary economic geography - is not uncontroversial. How far and in what ways the notions taken from traditional and modern evolutionary biology can be translated into meaningful economic equivalents is itself a topic of lively discussion and debate (see, for example, Foster, 2000). Applying a paradigm from one science to another is a risky venture. For example, using biological analogies blindly or slavishly, without due care for inappropriate ontological transfers, will of course hardly constitute a theory of economic evolution (see Mokyr, 2005). However, according to Mokyr, Metcalfe and others, the argument is not so much that the economy is in some ways 'similar' to biological systems, but that Darwinian models and related concepts (of selection, variety, novelty, etc) transcend biology, and that indeed, evolutionary biology is just a special case of a much wider and broader set of models that try to explain how certain kinds of system evolve over time. Thus, despite the risks and inherent dangers involved, importing metaphors, concepts and methodologies from other disciplinary fields remains one of the major sources of theoretical and empirical innovation, providing not only new perspectives but in the process stimulating conceptual advance and creating new intellectual contact points and avenues for cross-disciplinary co-operation.

Such potential benefits are undoubtedly a major factor stimulating evolutionary approaches to economic geography. However, it is not simply a case of applying such concepts and their theoretical and methodological frameworks to economic geography,

though this in itself is a challenging enough task. For an evolutionary economic geography cannot simply be derivative in its ambitions. The goal is twofold: not only to utilise the concepts and ideas from evolutionary economics (and evolutionary thinking more broadly) to help interpret and explain how the economic landscape changes over historical time, but also to reveal how situating the economy in space adds to our understanding of the processes that drive economic evolution, that is to say, to demonstrate how *geography matters in determining the nature and trajectory of evolution of the economic system*. The contributions to this book are all motivated by this dual ambition.

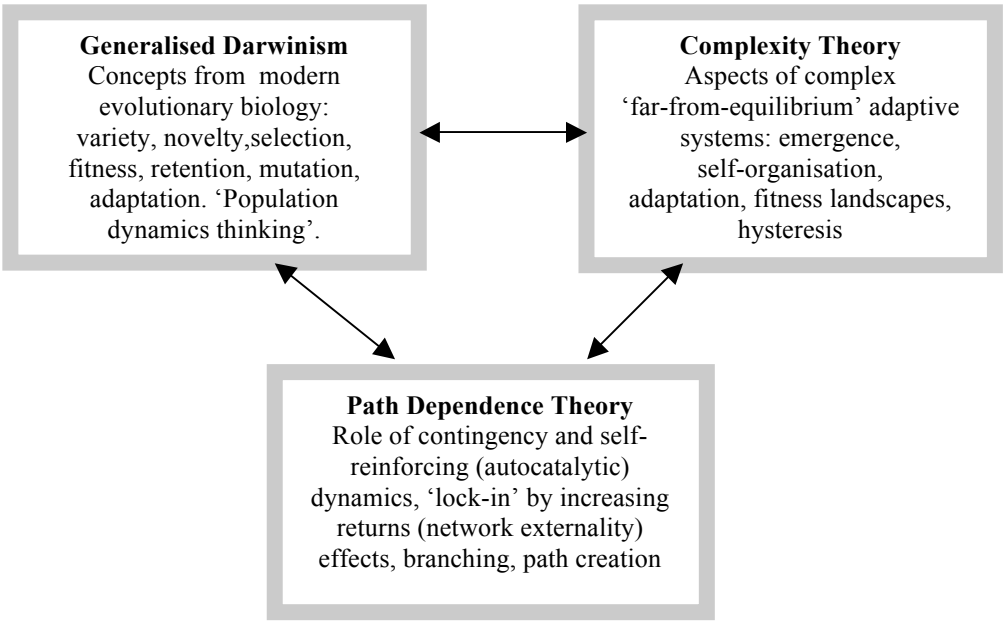
What then are the aims, the distinguishing features, of an evolutionary approach to economic geography? Put broadly, we can say that the basic concern of evolutionary economic geography is with *the processes by which the economic landscape – the spatial organisation of economic production, circulation, exchange, distribution and consumption - is transformed from within over time.* As Boschma and Martin (2007) put it, evolutionary economic geography is concerned with the spatialities of economic novelty (innovations, new firms, new industries, new networks), with how the spatial structures of the economy emerge from the micro-behaviours of economic agents (individuals, firms, organisations); with how, in the absence of central coordination or direction, the economic landscape exhibits self-organisation; and with how the processes of path creation and path dependence interact to shape geographies of economic development and transformation, and why and how such processes may themselves be place dependent. Our concern is both with the ways in which the forces making for economic change, adaptation and novelty shape and reshape the geographies of wealth creation, work and welfare, *and* with how the spatial structures and features so produced themselves feed back to influence the forces driving economic evolution. For the economic landscape is not just the passive outcome or by-product of the process of economic evolution, but a conditioning influence on that process. Economic transformation proceeds differently in different places, and the mechanisms involved neither originate nor operate evenly across space. The emphasis is on understanding the processes and mechanisms that make for or hinder the adaptation of the economic landscape, and how spatial and historical contingency interact with systemic necessity.

Given these aims, what are the theoretical and conceptual foundations on which such an understanding might be based? This question is the focus of Part 1 of the book, where several authors explore and assess some of the possible conceptual foundations for an evolutionary economic geography. Within economics – and indeed in other social sciences - it is possible to identify three main approaches to the study of evolution: Generalised Darwinism, the theory of complex adaptive systems, and path dependence ideas (see Figure 1).[2] Much of evolutionary economics is based on ideas and concepts

[2] In fact a fourth field can be identified, namely that of panarchy (see Gunderson and Holling, 2002), in which the focus is on the evolutionary-type notions of adaptive cycles and resilience in ecological and social systems. These ideas have yet to be taken up by evolutionary economists and economic geographers, though they are beginning to attract interest (eg. Hill, Wial and Wolman, 2008).

taken from Generalised Darwinism, especially those of variety, selection, novelty and retention (see, for example, Witt, 2003; Metcalfe, 2005). By comparison, complexity theoretic ideas have received less attention, although the potential of this approach is increasingly recognised, with some authors linking complexity concepts explicitly with the analysis of economic evolution (e.g., Potts, 2000; Foster, 2005; Beinhoker, 2006; Rosser, 2009). The third approach, based on path dependence, and based especially on the writings of Paul David and Brian Arthur, is concerned with giving economics a prominent historical dimension, and has been a key ingredient of many versions of evolutionary economics. Although distinctive frameworks, there are overlaps between the three approaches, and hybrid frameworks that combine elements from two or all three.

Figure 1: Three Major Theoretical frameworks for Evolutionary Economic Geography



Likewise, in evolutionary economic geography it has been the Generalised Darwinism perspective that has been most frequently invoked, closely followed by the path dependency approach: by comparison, complexity theoretic notions have yet to explored in any concerted way. The basic contours of an evolutionary model of economic dynamics based on the principles of Generalized Darwinism are outlined by Essletzbichler and Rigby in Chapter 2. Employing the core evolutionary principles of variety, selection and retention (continuity), they argue that competition between agents located in different geographical spaces may produce distinct economic regions. While certainly not being units of selection, regions can be conceptualised as *selection environments* within which, and across which, evolutionary processes operate. The authors claim that evolutionary economic geography should focus on the evolution of a population of agents within a single region, as well as on the evolution of different

regions that might, or might not, affect the dynamics of each other's populations. These arguments are extended to illustrate how emergent properties of economic agents and places co-evolve and lead to different trajectories of economic development over space. Whilst there remain numerous issues to be resolved and elaborated, as these authors demonstrate, an approach based on notions and principles derived from Generalised Darwinism offers economic geographers a theoretically rich framework for the analysis of change within the economic landscape. It certainly is a framework that informs many of the chapters in this handbook.

Perhaps the most often used notion used in economic geographic work that has sought to take history seriously in studies of regional development is that of path dependence, that is the idea that the economic landscape does not tend towards some (predefined) unique equilibrium state or configuration, but is an open system that evolves in ways shaped by its past development paths. As Martin and Sunley (2006) argued in their extensive review of the notion, the idea of path dependence has been taken as a fundamental principle of economic evolution by numerous economic geographers. But as Martin and Sunley argued in that work, and even more forcefully in Chapter 3, this assumption is by no means unproblematic. For one thing, there is the problem of defining what it is about regional economies that follows a path dependent trajectory of development – the region's firms, its industries or the regional economy as a whole? Can multiple–paths co-exist, and how do they interact? Second, what are the processes that allegedly engender path dependence in the economic landscape? Further, where do new paths come from, and why do they emerge where they do? And how do old paths come to an end? These questions have not received the critical attention they require. Martin and Sunley's (2006) extensive discussion sought to stimulate just that sort of discussion. Here, however, they are explicitly concerned to elucidate the question of what sort of evolution is implied by the concept of path dependence. They take issue with Paul David's (2005) recent talk of 'path dependent equilibrium economics' on the grounds that the notion of equilibrium is antithetical to that of evolution. The issue is not resolved, in their view, by David's interpretation of path dependence as the historically contingent selection of, and eventual lock-in to, one of a number of possible multiple equilibria outcomes or states. They argue that the case of a technology, industry or regional economy becoming locked into one of a number of possible multiple equilibrium states may be the exception rather than the rule, and that we therefore need a more open notion of path dependence that allows for more or less continuous adaptation and mutation of technologies, industries and regional economies (see also Martin, 2010). Such adaptation and mutation is almost certain to be path dependent in nature, and suggests that development paths need not ever reach any kind of equilibrium, that such paths can atrophy and decline over time as a result of endogenous processes (and not because of 'external shocks', as assumed by David-type path dependence models), and that new paths can emerge out of existing ones.

Compared to the use of the Generalised Darwinian and path dependence approaches, much less attention has been directed to constructing an evolutionary economic geography based on complexity theory. According to Foster (2005), evolutionary biology, with its focus on selection mechanisms is limited in its applicability to socio-economic contexts. For this reason he advocates the exploration of a more morphogenetic perspective that draws on complexity-theoretic notions. Although this approach has it roots in a more fundamental physical level of enquiry, namely non-equilibrium thermodynamics, Foster argues that it offers a more useful analytical representation of structuration for those interested in detecting evolutionary change in time series data. As such, Foster contends, the complexity approach is not used as a metaphor or analogy - as is the case with the Generalised Darwinian perspective – because structuration processes are present at all levels of scientific enquiry, including the socio-economic.

In their paper, Martin and Sunley (Chapter 4) take up this line of enquiry to explore the idea of the economic landscape as a complex adaptive system. They identify several key notions of complexity theory and what is being called the new 'complexity economics' (as championed recently by Beinhocker, 2006, see also Rosser, 2009), and examine whether and in what ways these ideas can be used to help inform an evolutionary perspective for understanding the uneven development and transformation of the economic landscape. Complexity theory deals with open systems subject to constant interaction with their environments, that are dynamic, typically 'far-from-equilibrium', yet which display internal order and the emergence of structure (self-organisation). As Martin and Sunley point out, these notions resonate closely with questions about how the spatial structure of an economy emerges and changes; about how regional and urban economies rise and fall in relative prosperity; about why some regional and urban economies appear more adaptable and resilient than others over time to shifts in technology, markets, policy regimes and the like; about why certain industries and technologies develop in particular geographical areas but not others; and about how the various spatial networks of economic relationships and flows form and evolve. In this sense they argue that complexity thinking could make a valuable contribution to the construction of an evolutionary economic geography. But they also express reservations over the increasingly dominant modelling paradigm associated with complexity analysis in economics, including the functional development of appropriate computational architectures (such as multi-agent models and dynamical systems models), and instead urge a more philosophically-inclined social-ontological approach. What precisely does it mean to talk of the economic landscape as a complex system? In what sense is the economic landscape a meaningful complex system to which the concepts of complexity thinking can be meaningfully applied? What does connectivity mean and how do we distinguish partial from strong connections? These are difficult questions. To be analytically useful, complexity is not something that just bolts on to or can be blended with an existing conceptual/theoretical framework to add a

'complexity perspective' or 'evolutionary perspective'. Nor is it sufficient to invoke the terminology and concepts of complexity science without thinking through what these concepts are being applied to, and what they mean in an economic-geographical context. Challenging questions though these are, in the view of Martin and Sunley the answers could well be rewarding.

A way of dealing with complex systems from an evolutionary perspective is to analyze how networks of agents evolve over time. While the study on network evolution is still in a premature phase (see e.g. Powell et al., 2005), there is growing interest from researchers to employ social network tools to describe and explain the evolution of network structures and their performance over time. Economic geographers have started to contribute to this emerging body of literature only quite recently. They are increasingly aware that knowledge networks, and their spatial configuration, play a crucial role in the innovation process, and therefore may be considered a driving force of the evolution of the economic landscape. However, network analysis is still very much underdeveloped in the geography of innovation, and this is certainly true for an evolutionary approach to this topic, though work is beginning to emerge (see, for example, Giuliani, 2007; Glückler, 2007; and some of contributions to this Handbook, such as Breschi et al., Cantner and Graf, Giuliani, and Glückler).

In Chapter 5, Boschma and Frenken take up this challenge by proposing an evolutionary perspective on the spatial evolution of innovation networks. They draw on insights from the proximity literature (Boschma, 2005; Torre and Rallet, 2005) to explain the evolution of the structure and performance of networks. Boschma and Frenken conceive different forms of proximity as alternative driving forces of network formation, geographical proximity being one of them. They propose an evolutionary perspective on the geography of network formation that is firmly embedded in a proximity framework (see also Sorenson et al., Chapter 15). Boschma and Frenken claim that proximity may be considered a prerequisite for agents to connect with and to enhance knowledge spillovers, but proximity between agents does not necessarily increase their innovative performance, and may possibly even hinder it. The authors refer to this as the 'proximity paradox'. Boschma and Frenken then turn to the long-term dynamics of networks, and discuss how such dynamics may be related to the changing role of proximity in the formation and performance of innovation networks. In this respect, crucial questions are how far and in what ways different proximities induce path dependence in the spatial evolution of networks (see e.g. Glückler, 2007; Ter Wal, 2009), and how this process depends on spatial context. This is an area of research that is still strongly underdeveloped, though considered crucial for the further development of an evolutionary perspective on the spatial evolution of networks. According to Boschma and Frenken, the ultimate goal is to develop a dynamic network approach that also accounts for that fact that the spatial evolution of network structures may, in turn, affect the degree of the different forms of proximity. That would really contribute to our understanding of the spatial evolution of networks as a truly endogenous process.

3. Firm Dynamics, Industrial Dynamics and Spatial Clustering

In Part Two of the book, the focus shifts from broad conceptual issues to the specific case of firm dynamics and industrial dynamics in space. Here, we start from the micro-level, focusing on the locational behaviour of firms, and how firms compete and learn on the basis of their routines in time and space. This leads to firm dynamics in the economic landscape: new firms will enter the market, some firms will do well and increase their market share in an industry, while other firms will stagnate and exit the market. Moving to the meso-level, one can investigate how these firm dynamics lead industries to evolve through different stages of development in time and space. The contributions in Part Two of the book explore how such an evolutionary framework can be fruitfully applied to topics in economic geography at the micro-level of firms (like the geography of entrepreneurship) and the meso-level of industries (like spatial clustering). More particularly, the contributions examine how firms behave, compete and learn in space, whether firm dynamics at the industry level lead to spatial clustering, and whether spatial clustering brings positive or negative externalities to cluster firms along the life-cycle of an industry.

According to Boschma and Frenken (2006), evolutionary economic geography examines how the spatial structure of the economy emerges from the micro-behaviour of individuals and firms.[3] Instead of describing the behaviour of individuals and firms as if they optimise, they follow Simon's (1955) concept of bounded rationality to claim that firms are subject to cognitive constraints (Nelson and Winter, 1982; Dosi et al., 1988). In order to reduce uncertainty, firm behaviour is guided and constrained by routines. Due to their tacit and cumulative nature, routines are not easy to change, and very difficult to imitate for other firms (Heiner, 1983). Evolutionary theory predicts that most firms innovate incrementally, exploiting the knowledge they have built up in the past. Nelson and Winter (1982) have described this as a 'local search process'. And when firms diversify and grow, they tend to expand into related products, that is, into those products that are technologically related to their current products (Penrose, 1959).

Taking such a micro-perspective, an evolutionary approach to economic geography can describe the evolution of the economic landscape as changes in the time-space distribution of routines over time (Boschma and Frenken, 2003), that is, how new routines come into existence, and how they diffuse in time and space. The economic landscape (as it manifests itself in the spatial clustering of industries, for instance) is

[3] This echoes recent calls from economic geographers to advocate approaches in which prime attention is given to the firm rather than the region (e.g. Taylor and Asheim 2001; Boschma 2004; Malmberg and Maskell, this volume). After having reviewed a number of theories of the firm, including agency theory and transaction cost economics, Maskell (2001a) claims that evolutionary economics is especially useful to economic geographers because of its emphasis on learning and innovation, and because of the possibility to analyse territorial aggregates of firms in regional and national innovation systems (see also Maskell, 2001b).

then result of an evolutionary sequence in which some variations of routines were selected because, for some reason, they were better adapted than others. As mentioned above, selection occurs at the micro-level of the firm (through its routines), but also at the macro-level of markets and institutions. Market competition acts on variety as a selection device, which determines which (old and new) routines survive and prosper, and which ones decline and go out of business (Ormerod, 2005). In a dynamic economy, fitter routines become more dominant over time through selection, enabling more efficient firms with fitter routines to expand their production capacity and market shares at the expense of less efficient firms. The selection environment not only includes markets but also institutions, whose effects become especially visible when a major institutional change occurs and the 'playing field' on which firms compete changes dramatically. Thus, understanding the fitness of routines requires an analysis not only of firms and markets but also of institutions as relevant enabling and constraining contexts.

More importantly, fitter routines also expand in an economy through learning and routine replication within and between firms. Crucial in an evolutionary account is the idea that replication and reproduction of routines are imperfect (Winter and Szulanski, 2001). The processes by which routines are replicated, diffused, and further replicated in successive populations of firms often work ineffectively, which explains the existence and persistence of variation. This is not, however, a random process: these routines spread or disappear in a context that is biased cognitively, socially - and also geographically. So some variations can be learned and passed on, though this depends on the extent to which agents are proximate in various dimensions (spatially, relationally or cognitively - see Boschma, 2005). As Cohen and Levinthal (1990) have argued, firms can understand, absorb and implement external knowledge only when it is close to their own knowledge base. In other words, effective knowledge transfer between firms requires absorptive capacity and cognitive proximity (Nooteboom, 2000). While evolutionary economics has focused almost exclusively on the cognitive dimension, one can think of other forms of proximity that affect the successful replication and diffusion of routines within and between firms across space. So the evolution of the economic landscape is mediated by cognitive, social, geographical and institutional processes that warrants attention in evolutionary economic geography. As Boschma and Frenken in Chapter 5 argue, this opens up a new research agenda in which the proximity framework becomes embedded in an evolutionary approach to economic geography.

Putting emphasis on selection forces and constraints does not necessarily mean that human agency does not play a role in evolutionary economic geography (see e.g. Staber, 1997; Boschma and Frenken, 2006). On the contrary, the role of entrepreneurs is crucial. How new routines are created by entrepreneurs in space, how they transform the economic landscape, and how the economic landscape itself impacts on the geography of entrepreneurship are the topics that are taken up by Erik Stam in Chapter 6. The

study of the location of new firms from a micro-evolutionary perspective goes back to Pred (1967) who also made use of the concept of bounded rationality. There is overwhelming evidence that new firms do not opt for optimal locations in terms of cost-minimization. Instead, they are affected by local structures laid down in the past, like the place of residence of the entrepreneur (many firms start from the entrepreneur's home), the location of the parent firm (spinoffs typically locate in the vicinity of their parent), the social networks of the entrepreneur (which are very local, and provide access to resources), and the regional knowledge base (new firms typically exploit local knowledge and skills). Critically surveying the geography of entrepreneurship literature, Erik Stam notices that entrepreneurship not only tends to be a geographically localized phenomenon, but it is also a spatially uneven process that tends to persist over time. This implies regional entrepreneurship tends to be a path-dependent process (see also Martin and Sunley, Chapter 3). For example, as most entrepreneurs start their venture from home, it may be expected that the current spatial distribution of people will explain to a considerable degree regional entrepreneurship rates, and as many successful entrepreneurs originate from existing firms, the current distribution of firms is most likely to affect the geography of successful entrepreneurship to some extent. These questions, among others, are crucial to develop an evolutionary economic geography framework that is embedded in a dynamic view on entrepreneurship.

Besides the question where entrepreneurs create new routines in space, an evolutionary approach in economic geography is also concerned with how routines develop further within firms, and in relation to their regional environment. In Chapter 7, Cristiano Antonelli addresses the importance of pecuniary knowledge externalities for localized learning and cluster development. While technological knowledge externalities have gained most attention and are often assumed to be 'in the air' (to use Marshall's phrase), Antonelli assigns pecuniary externalities a central role in the generation and exploitation of knowledge. He explains why technological learning is spatially biased, and firms will use idiosyncratic production factors that are locally abundant. This provides a theoretical explanation for the development of distinctive competences within firms, for the phenomenon of localized learning, and the spatial clustering of firms.

When an evolutionary approach in economic geography is used to deal with the spatial evolution of routines, interest focuses especially on how firms employ and develop spatial strategies over time (see e.g. Brouwer, 2005). Routines are diffused across the economic landscape through organizational practices like the relocation of firms (Knoben, 2007; Stam, 2007), merger and acquisition activity of firms located in different places, and the establishment of new plants by incumbent firms in other locations (Wintjens, 2001). Analyzing the evolution of spatial strategies of firms, evolutionary economic geography has the potential to contribute to a better understanding of the process of globalization through the spatial diffusion of routines within and between firms.

In Chapter 8, Simona Iammarino and Phil McCann provide an explanation for why the strategies of Multi-National Entreprises (MNEs) result in a pattern of 'concentrated dispersion' worldwide. They claim that firms accumulate different competences in time and space, which impacts on their incentives to co-locate and tap into complementary knowledge bases in different locations. This brings up a range of issues that are very relevant to an evolutionary approach in economic geography, for example: what kind of strategies do MNEs follow to overcome geographical and other barriers in order to access distant knowledge bases, and how can host regions successfully benefit from incoming MNEs in terms of knowledge transfer (see e.g. Morgan, 1997; Cantwell and Santangelo, 2002; Morrison, 2008)? And crucial for an evolutionary approach, what are the dynamics in the relationship between MNEs and the host regions (e.g. Cantwell and Iammarino, 2003). Research suggests that, under certain circumstances, the multinational firm may become more embedded in the host region over time, and will transform the local environment of the host region accordingly (see e.g. Dunning, 1994; Peng, 1995; Storper, 1997; Wintjens, 2001).

As Iammarino and McCann also point out in their contribution, an evolutionary approach provides a powerful framework to explain the tendency of economic activities to agglomerate and of industries to cluster spatially (see Malmberg and Maskell, 1997; Malmberg and Maskell, 2002). Because routine replication and processes of learning are often subject to failure, it helps to be co-located. What is more, routine replication and knowledge accumulation tend to operate at the regional level because the mechanisms through which they operate (like spinoff activity, firm diversification, labor mobility and social networking) tend to have a regional bias (Boschma and Frenken, 2009b): spinoffs tend to locate near their parent firm, new divisions of firms are frequently created inside established plants in the same location, employees change jobs primarily within the same labor market area, and social networks through which knowledge flows tend to be geographically localized. According to Boschma and Frenken (2009b), this implies that the lineage structure between routines is spatially dependent: once particular routines become dominant in certain regions, the subsequent evolution of these routines into the same and related industries will occur primarily in the same region.

There is a long tradition in economic geography that explains the spatial clustering of an industry from a sector lifecycle approach (e.g. Norton, 1979; Markusen, 1985; Scott and Storper, 1987; Scott, 1988; Storper and Walker, 1989; Chapman, 1991). Only more recently, this topic has been studied more systematically by investigating the (spatial) dynamics of the whole population of firms at the industry level through its different lifecycle stages (Boschma and Frenken, 2003). These industry lifecycle approaches analyse the spatial evolution of an industry in terms of entry, growth and exit of firms over time (Arthur, 1994; Klepper, 1997; for a critical review, see Boschma, 2007). Since firms' relations at the sector level are mainly of a competitive nature, entry-and-exit models and survival analysis are techniques that are often employed. The

core models on the spatial evolution of industry are the organizational ecology framework as developed by Hannan and colleagues (Hannan and Freeman 1989; Hannan et al. 1995; Carroll and Hannan 2000; Wenting and Frenken, 2008; Wezel, 2005) and Klepper's industry lifecycle model (Klepper 2007). These approaches provide additional insights to the extensive but rather descriptive literature on clusters. Instead of taking a static view on clusters, they provide a dynamic view on how clusters emerge and develop. Especially Klepper's industry lifecycle model has attracted attention, because it explains clustering from spinoff dynamics. Doing so, it provides a new, alternative explanation for clustering as the outcome of a spin-off process through which routines are passed on from incumbents (parent organizations) to new entrants (offspring). The Klepper model shows that such a process may lead to spatial clustering even in the absence of agglomeration economies. Interesting as that may be, evolutionary economic geography is not only concerned with the question how evolutionary processes (such as spinoff dynamics) impact on the geography of industries, but also how the economic landscape impacts on these evolutionary processes (Martin, 1999; Boschma and Frenken, 2003; Martin and Sunley, 2006; Boschma, 2007).

There is a growing number of studies that explain the spatial clustering of an industry from such an evolutionary framework. In Chapter 9, Michael Dahl, Christian Ostergaard and Bent Dalum provide a clear example. Their contribution departs from the conventional literature that often takes a static approach to clusters, and which tends to focus on explaining dynamics of clusters *ex post*, referring to location-specific advantages, such as knowledge spillovers, networks and labor market pooling (for a critique of that approach, see, for example, Storper and Walker, 1989; Boschma and Lambooy, 1999; Martin and Sunley, 2003). Instead, they argue there is a need to view possible advantages of clusters more as an outcome of, rather than a precondition for the formation and early growth of clusters. But even so, their case study shows that the wireless communication cluster in Northern Denmark was the outcome of the initial success of some pioneering firms that gave birth to successful spinoff companies in the region. This 'success breeds success' story is in line with findings in other studies (Klepper, 2007; Boschma and Wenting, 2007; Buenstorf and Klepper, 2009), which show that spinoffs are often successful because they can exploit knowledge acquired in very successful parent organizations.

This literature on industrial dynamics focuses on the mechanisms that drive the evolution of a population of firm-specific routines in an industry, and which make fitter routines more dominant in an industry. A key issue concerns the mechanisms through which successful routines diffuse across firms and cluster spatially when a new industry emerges. As noted above, spinoff dynamics and agglomeration economies may act as vehicles through which knowledge and routines are created and diffused among a growing population of firms within a territory. As noted above, spinoff dynamics is considered a driving force behind the spatial formation of an industry, because it

diffuses relevant knowledge from incumbents (parents) to new firms (spinoffs) at the local level. Moreover, agglomeration effects may become manifest, once spatial clustering occurs. For instance, local knowledge spillovers may become increasingly available, which then cause a further spatial concentration of the industry. As such, spinoff dynamics and agglomeration economies provide alternative explanations for the spatial clustering of an industry. However, these may also be complementary, since spinoff activity in a region may strengthen agglomeration forces, which, in turn, may enhance the creation and survival rate of spinoffs (Boschma and Frenken, 2003).

In a study of the long-run evolution of the British automobile industry, Boschma and Wenting (2007) found that both effects play a role, but in different stages of the industry lifecycle. Spinoff companies did not show a higher survival rate during the first stage of the lifecycle, because there is still not much to be learnt from a parent in the same industry, since a dominant design is still lacking. By contrast, new entrants with working experience in related industries did well at this stage. Spinoffs performed better only in a later stage of the industry lifecycle, because pre-entry working experience in the same industry then appeared to be of much higher value. The effect of the location on firm's survival also differed along the industry lifecycle. Start-ups in the British car industry that were founded in regions with related industries had a higher survival rate during the first stage (see also Buenstorf and Klepper, 2009). While one would expect a positive effect of localization economies on firm's survival, Boschma and Wenting (2007) found no effect in the first stage of the industry lifecycle, and even a negative effect at a later stage. The more spatially concentrated the automobile industry became, the harder it was for new entrants to survive in clusters, probably due to more local competition (see for similar results Staber, 2001; Otto and Kohler, 2008). This provides an alternative view on clusters than the more conventional one, in which clusters are supposed to deliver what they ought to do, that is, bring benefits to local firms (see Staber's contribution in Chapter 10). This is in line with recent studies that show that clusters not only stimulate entries (being an attractor for new firms) but also enhance exits (clusters being a tough selection environment at the same time) (Wenting, 2008).

This is not to deny that spatial clustering in certain industries may be attributed to traditional cost factors, as resource intensive industries locate in the vicinity of natural resources or near transport nodes, and many service sectors locate close to the market. However, for many industries, there may be no obvious location in which to cluster, as their main input is knowledge from people (Lambooy, 2002). This knowledge – for the most part – has to be created alongside the development of the industry itself. The location of these knowledge-intensive industries may then be understood from evolutionary processes through which the industry gradually emerged and developed. This is not, however, to deny that location-specific characteristics may matter (see e.g. Boschma and Lambooy, 1999; Bathelt and Boggs, 2003; Brenner, 2004; Glaeser, 2005; Martin and Sunley, 2006). On the contrary, the pre-existing localized presence of knowledge, skills and creativity may still be a good reason why knowledge-

intensive industries cluster in certain areas, and not in others, as the example of the spatial clustering of the British automobile industry demonstrated. However, instead of saying that locations matter in a deterministic manner (as propagated by neoclassical thinking), an evolutionary approach to spatial clustering accounts for dynamic processes through which routines are created and diffused (e.g. through the spinoff process, the formation of a specialized local labour market, or the establishment of institutions), and pre-existing structures in regions are expected to condition, but not determine their spatial outcome. This emphasis on contingency reflects the idea that locations may influence spatial clustering of industries to some extent, and it is up to empirical research to determine whether and to what extent this locational influence varies from industry to industry (Boschma and Frenken, 2003; Boschma, 2007). In order to determine the effect of pre-existing regional structures, it is crucial to assess the extent to which individual features of firms (i.e. their routines) matter for their survival. While many cluster studies tend to assume that clusters have a positive effect (why did the industry cluster otherwise?), this can only be concluded when one controls for the effect of firm-specific features. This is crucial, as Erik Stam observes in Chapter 6: entrepreneurship studies often show that personal attributes of entrepreneurs (like age, experience) provide a better explanation of entrepreneurial success than do regional features (see also e.g. Sternberg and Arndt, 2001).

Adopting a focus on individuals and firms could also contribute to a better understanding of the notion of routines, and how learning shapes and modifies routines (Hodgson, 2009). This could be accomplished by looking at how organizational routines, being a collective property of a firm (Nelson and Winter, 1982), are affected by entrepreneurial activities ('intrapreneurship') and the recruitment of new employees. Udo Staber explores in Chapter 10 how knowledge may be transmitted between firms, and how that affects the routines of firms. Staber suggest that we regard ideas in the form of meanings as the basic unit of transmission. Ideas are not isolated phenomena, but evolve as bundles. An evolutionary account could focus on how these bundles of ideas remain intact (like the set of skills in routines), but also how new ideas (through labour mobility or spinoff activity) may cause tension and incoherence in the existing set of ideas. In a similar context, Wenting (2008) has made an attempt to assess the effect of post-entry labour mobility on firm performance in the fashion industry. Boschma, Eriksson and Lindgren (2009) found that the hiring of new employees with skills the plant had already inhouse had a negative impact on plant performance. This may be due to the fact that the new skills could be quickly integrated into the routines of the plants, but they did not enhance overall productivity, and might even have caused conflict and rivalry with employees with identical skills. By contrast, the inflow of new employees with related (not similar) skills contributed positively to plant performance, possibly because it added new skills to the existing set of skills in the plant, and it formed no direct threat to employees with identical competences. The next step is to link this effect of post-entry labour mobility to the industrial lifecycle approach. This

concerns questions like: what kind of labour, and what sets of skills (diversified, related, specialized) are needed for firms to survive over the different stages of the industry lifecycle?

An evolutionary approach has the potential to bring a new perspective on the study of regional clusters, because it meets to a considerable degree the critique advanced by Martin and Sunley (2003) and Brenner (2004), especially the tendency to treat clusters in too static a manner. In Chapter 8, Simona Iammarino and Phil McCann describe the evolutionary aspects of clusters (see also e.g. Iammarino, 2005; Menzel and Fornahl, 2009; Ter Wal and Boschma, 2009), and stress the importance of path-dependent processes that shape cluster development, and which make clusters look very different over time (see also Iammarino and McCann, 2006). In Chapter 10, Udo Staber provides a thorough critique on the cluster literature from an evolutionary angle. Staber argues that the cluster literature has underestimated the origins and consequences of (new) variation in clusters. Consequently, clusters have been misconceived as coherent entities while, in practice, they consist of different levels (e.g. individuals, ideas, routines, organizations, networks) on which selection operates. According to Staber, evolution proceeds at a faster pace at lower levels of action and, thus, the fitness of ideas increases more rapidly that the fitness of a cluster as a whole. Thus, while at the level of individuals, there may be much turbulence (such as exits and new network relationships), this will not necessarily affect the survival of the cluster as a whole. Research should focus more on identifying the dynamics of selection mechanisms (such as competition and imitation) at various levels to explain stability and change in clusters. This would meet worries expressed in the literature that clusters are often treated as static, instead of dynamic entities (Maggioni, 2002; Carlsson, 2003; Martin and Sunley, 2003). And cluster research has to recognise that clusters can develop dysfunctional features that often give rise to diseconomies and negative economic effects, a point also made by Martin and Sunley (2003). Staber proposes an alternative evolutionary view on regional clusters. His basic line of argument is that, while evolution may unfold very differently across clusters, the general Darwinian processes (variation, selection, retention) operate in all units and at all levels of actions.

Another critique on the cluster literature is that it almost ignores the existence and effects of collaborative relationships amongst constituent firms. In Chapter 11, Phil Cooke and Carla de Laurentis begin by explaining how an evolutionary view fundamentally differs from a neoclassical approach. They then present the results of an empirical research project on collaborators and non-collaborators in cluster and non-cluster settings in the UK ICT industry. The data show that collaborators in clusters perform better than non-collaborators in clusters, suggesting a premium effect of local networking. There is also some evidence that collaborators in clusters perform better than collaborators in non-cluster settings. However, non-collaborators in clusters perform worse than non-collaborators in non-clusters, suggesting a diseconomies of scale-effect in clusters for non-collaborators. The study by Cooke and De Laurentis

shows how the analysis of networks of collaboration is important for understanding the dynamic performance of clusters, and links to the topic that is the focus of the next part of the book.

Part 3. Network Evolution and Geography

Part 3 of this book concentrates explicitly on the importance of networks in an evolutionary approach to economic geography. There is increasing awareness that networks play a crucial role in understanding the spatial uneven distribution of economic activity. Some have advocated the need for a relational turn in economic geography (Bathelt and Glückler 2003; Boggs and Rantisi 2003; for a critique, see Sunley 2008). As explained in Boschma and Frenken (2006), networks can also be incorporated and analyzed in an evolutionary framework. An evolutionary approach to networks can be applied to various types of spatial networks, like infrastructure networks and urban networks (Taylor et.al, 2007; Taylor and Aranya, 2008; Wall, 2009). In these latter cases, places are depicted as nodes in networks. In a seminal paper, Barabasi and Albert (1999) proposed that networks evolve as the result of an entry process of new nodes that connect with a certain probability to existing nodes, depending on the connectivity of the latter. This type of models can explain the emergence of 'hubs-and-spokes' structures in space, as found in airline networks, for example. Geographers are interested how location-specific characteristics and the geographical distance between new and existing nodes influence the formation of the network.

In this handbook, we limit our attention to inter-firm knowledge networks (Powell et al., 1996; Hagedoorn, 1992; Ozman 2009). Only recently, have geographers turned to the empirical study of the spatial dimensions of networks in innovation processes. These studies have spiralled out of the literature on national and regional innovation systems developed in the 1990s, which had strong evolutionary roots from the very start (Freeman 1987; Cooke, 1992; Nelson, 1993; Edquist, 1997; Breschi and Malerba, 1997; Asheim and Gertler, 2005). The objective of the innovation system literature was to uncover the institutional setting in a territory that affects the interaction patterns between a range of organizations involved in the innovation process. This led to the insight that countries and regions have different innovation systems, the nature of which can only be understood by looking at their history, that is, how these systems were shaped and transformed over time. Sectoral studies of innovation systems (eg. Malerba, 2002) have typically adopted such a dynamic perspective, setting out how institutions co-evolve with the emergence of a new sector (see e.g. Murmann, 2003; Consoli 2005). Another promising line of research has focused on whether sectoral shifts in innovation lead to institutional changes at the national level, due to evolutionary forces like selection, retention and imitation of sector-specific institutional models (see Hollingsworth, 2000; Strambach, this volume Chapter 19), a topic to which we return in Part 4 of the book.

An evolutionary approach to spatial networks could contribute to the field of economic geography in at least three ways. First, the study of networks promises to provide additional insights in the workings of clusters (Uzzi 1996; Giuliani 2007). In an influential paper, Giuliani and Bell (2005) have applied social network ideas to demonstrate that knowledge networks in a cluster are not pervasive, as is often assumed by the cluster literature, but selective. The micro-evolutionary view developed by these authors links the network positions of firms in a cluster to their absorptive capacity. Second, we still have little understanding of what are the main drivers of network formation. Boschma and Frenken (Chapter 5) and Sorenson et al. (Chapter 15) claim that a proximity framework is useful in this regard. Such a framework enables to isolate the effect of geographical proximity alongside other forms of proximity on network formation, because geographical proximity is just one potential driver, and not necessarily the most important one. This line of reasoning follows Boschma (2005) who claimed that geographical proximity is neither a sufficient nor a necessary condition for firms to engage in network relations and inter-firm learning. Third, the study of network dynamics and the role of geography is still in a premature stage, not least because of the limited availability of time series data on networks, and the embryonic methodological state of dynamic network analysis. Below, we will elaborate on each of these three potential contributions more in detail.

Recent network studies have contributed to a better understanding of clusters (see e.g. Staber, 2001; Giuliani and Bell, 2005; Cantner and Graf, 2006; Guiliani, 2007; Boschma and Ter Wal, 2007; Morrison, 2008; Visser, 2009). Using a micro-perspective on knowledge networks, these studies have questioned the conventional view that the economic well-being of cluster firms ultimately depends on extra-firm sources of knowledge, rather than intra-firm routines. These social network studies have also challenged the view that knowledge is 'in the air' in a cluster, from which all cluster firms can equally benefit. Without exception, these studies show that only a limited number of firms in a cluster are well connected to the local knowledge network, while many cluster firms are poorly connected, or not connected at all. As Elisa Giuliani demonstrates in her study of three wine clusters in Chapter 12, this is not a trivial issue: a knowledge linkage between two cluster firms increases the likelihood that both firms perform well. So, it is not the cluster *per se* that matters for firm performance, but being connected to the local knowledge network that counts. In addition, these network studies have shown that reliance on external knowledge relationships does not necessarily mean these are confined to the cluster. What these studies demonstrate is that the best performing firms tend to show a high connectivity to firms outside the cluster. A next question then is whether these leading firms might still act as gatekeepers for the cluster. Network studies show that this depends on their connectivity to other local firms, among other things (Morrison, 2008; Cantner and Graf, this volume Chapter 17).

Looking at the structure and nature of intra-cluster networks as a whole, in Chapter 12 Giuliani criticises the cluster literature for claiming that intra-cluster networks *per se* enhance economic development in the cluster as a whole. Her study on three wine clusters clearly shows that it depends on the structural properties of intra-cluster networks as to whether these will generate beneficial effects throughout the cluster. More specifically, her analyses show that this depends on how selective knowledge networks in cluster are, that is, how unevenly distributed these networks are among cluster firms. Giuliani also found that business networks (as opposed to knowledge networks) are more pervasive in clusters, but these do not spread positive spillovers throughout the cluster.

Concerning the firm level, network studies have recently taken up the question what explains the network position of firms in clusters. In their seminal paper, Giuliani and Bell (2005) pointed to the importance of firm-specific competences, like the absorptive capacity of firms. In Chapter 13, Stefano Denicolai, Antonella Zucchella and Gabriele Cioccarelli draw attention to the formation of different forms of reputation and trust between local firms, and how these affect the formation and dissolution of network linkages at the cluster level. Instead of referring to firm-specific competences, Denicolai et al. describe how firms with different forms of reputation may occupy different network positions in clusters. They illustrate this with a number of network studies they conducted in three Italian clusters.

Instead of focusing on clusters, network studies have also investigated the drivers of network formation at the level of firms. In Chapter 14, Johannes Glückler examines what drives the formation of sales partnerships in the stock photography sector in Germany. Based on a network survey of firms, Glückler explains the likelihood of establishing a sales partnership between two agents. Borrowing network measures from social network analysis, his findings suggest that the likelihood of forming a sales partnership in this sector is primarily shaped by multi-connectivity, rather than geographical proximity and homophily, for instance. In Chapter 15, Olav Sorenson, Jan Rivkin and Lee Fleming analyze US patent data and citation rates across inventors to determine which forms of proximity are important for knowledge flows, and relate these to the nature of knowledge (whether complex or not). Synthesizing a social network view with a perspective of knowledge transfer as a search process, they claim that the advantages of being proximate to some knowledge source depend crucially on the nature of the knowledge at hand. Their findings show that simple knowledge flows equally to actors near and far, while complex knowledge is unlikely to diffuse, no matter how proximate actors are. With knowledge of moderate complexity, however, the outcomes show that more close actors are in a better position to benefit from knowledge diffusion, in contrast to more distant recipients. Sorenson et al. conclude that an interesting line of research would be to investigate how the tendency of industries to agglomerate might depend on the complexity of knowledge.

Regional networks may be formed through the movement of labour. Labour mobility has the potential to provide effective channels of knowledge diffusion across countries and regions (Saxenian 2006). Agrawal et al. (2006) found that knowledge is transferred between firms across large geographical distances when their respective employees are socially linked due to a shared past in the same school or same company. In other words, knowledge networks are formed through social proximity between agents, irrespective of their geographical distance, although social networks are often geographically bounded (Breschi and Lissoni, 2003). In Chapter 16, Stefano Breschi, Camilla Lenzi, Francesco Lissoni and Andrea Vezzulli explore a large set of patent applications by US inventors registered at the European Patent Office in three high-technology fields in the period 1991-1999. They demonstrate that inventors who patent across firms do not diffuse their knowledge that much across space, firstly, because inter-regional mobility of inventors is rather limited, and secondly, because inventors create social networks at the regional level, not across regions. The few inventors who do move between regions, however, tend to maintain their ties with former co-inventors, providing a channel of knowledge diffusion to their prior location. In the latter case, knowledge diffuses across space through the professional networks of inventors.

Another issue is the effect of (regional) networks on economic performance. Studies often report a positive relationship (Ozman, 2009). However, this is not necessarily the case. This may depend on, among other things, the degree of proximity between the networks partners. While a high degree of any form of proximity might be considered a prerequisite to make agents interact, proximity between agents does not necessarily increase their innovative performance, and may possibly even harm it (Grabher and Stark, 1997; Boschma, 2005; Cantner and Meder, 2007; Nooteboom et al., 2007; Broekel and Meder, 2008). This is in line with what Gilsing et al. (2007) found when they assessed the impact of technological distance in high-tech alliance networks on the innovative performance of the partner firms. As expected, they found an inverse U-shaped function between technological distance and exploration (i.e. real breakthroughs), meaning that neither a very high nor a very low degree of technological proximity between partners resulted in exploration.

As Boschma and Frenken set out in Chapter 5, the study of dynamic spatial networks has thus far been limited, because of the limited availability of longitudinal data on networks and the poor methodological state of dynamic network analysis (see Ter Wal, 2009). Having said that, in the context of evolutionary economic geography, the main challenge is the study of the dynamics of network formation: how do networks of firms arise and develop in time and space, and what forms of proximity are important at what stage of the evolution of the network. In this context, the focus of attention is on the dynamics in the number of nodes and relations, and how the different forms of proximity impact on these network dynamics. What is interesting from an evolutionary perspective is to examine whether the different proximities induce path dependence in network evolution, and whether they cause retention in the local network (Glückler,

2007). Moreover, a dynamic network approach should account for that fact that the evolution of a network structure may, in turn, affect the degree of proximity in its various dimensions, like in the social and cognitive dimension (Menzel, 2008). However, this requires further refinements at the conceptual and methodological level before this can be applied empirically (see e.g. Glückler, Chapter 14).

In Chapter 17, Uwe Cantner and Holger Graf apply a dynamic perspective on regional innovation systems. Their contribution provides a study on the evolution of the Jena innovation network based on patent data. Behind the increase of the network size and the degree of connectedness, considerable dynamics are observed in terms of actors entering and exiting the network. They demonstrate that permanent innovators and new entrants show a tendency to concentrate more on the technological core competences of the network, while the network as a whole shows an increasing inward orientation to the local level. This chapter gives evidence of the enormous potential of analyzing network dynamics at the regional and local scales, a research field which is still underdeveloped.

Taking a dynamic perspective on network evolution, one can also theorise from the industry lifecycle concept about the role of inter-firm networking at different stages of the lifecycle (see Boschma and Frenken, chapter 5; Ter Wal, 2009). This is not to say that each industry is destined to follow such a lifecycle, and that each stage follows the other in a deterministic manner. Already in the 1980s, some economic geographers challenged the application of the industry lifecycle approach in such a stylized manner (see e.g. Taylor, 1986). Moreover, this would go against the nature of economic evolution as an open-ended process that is conditioned but not determined by its spatial context (Martin and Sunley, 2006). However, the main purpose of developing an endogenous model of network evolution along industry lifecycle lines is to derive some hypotheses that can be tested case by case, in order to determine the empirical veracity and applicability of the ideal type, especially in different spatial contexts. Ter Wal and Boschma (2009) have applied an industry lifecycle framework to the study of network dynamics. Following the lifecycle scheme of Abernathy and Utterback (1978), they expect that firms engage in network activity in the first phase to explore the possibilities of a new technology. As technologies are still competing and uncertainty is high, the network is unstable with firms often changing partners. In the second phase, firms developing dominant designs become the hubs while lagging firms try to maintain their position by networking with a hub (see Orsenigo et al. 1998). In the mature phase, the degree of embeddedness in networks is high as peripheral firms have exited. This can lead to over-embeddedness and ‘lock-in’ (Grabher, 1993). What is more, the repeated interactions in the past might have increased the cognitive proximity between firms, thereby reducing the potential for innovation by recombination. Under certain circumstances, this can lead to an endogenous decline of the cluster (see also Staber, 2007; Menzel and Fornahl, 2009). For a discussion of how positive lock-in can turn into negative lock-in, see also Martin and Sunley (2006) and Hassink (Chapter 21). Institutions also play a prominent part in this respect, a topic to which we turn now.

Part 4. Institutions, co-evolution and economic geography

Since its early development, institutions have been part and parcel of evolutionary economics. Veblen, one of its founding fathers, emphasized the importance of habits, conventions and norms in economics (1898). He laid the foundations of what is now called 'old' institutionalism, and which has affinities with evolutionary economics as this has developed since the 1980s. In the late 1970s, Nelson and Winter (1977) developed their concept of 'natural trajectories', which were described as heuristics that guide the innovation process (see also Rosenberg, 1976). These were often driven by the logic of mechanization and standardization of production, with the purpose of constraining wages by codifying the tacit knowledge of employees. In this way, Nelson and Winter gave their evolutionary theory a kind of Marxist flavour by referring to the overall importance of capital-labour conflicts. In the 1980s, the so-called regulation theory (Boyer, 1988) held a prominent place in the seminal contribution of Dosi et al. (1988) on the foundations of evolutionary economics. Moreover, eminent evolutionary scholars like Freeman and Perez (1988) developed the concept of structural crisis of adjustment, in which they claimed that institutions need to be transformed to enable new industries to develop fully and for old industries to be revived. And in the late 1980s, the innovation system literature was initiated and developed by prominent evolutionary economists like Freeman (1987), Lundvall (1992), Nelson (1992) and Malerba (2002; 2004) who likewise stressed the importance of national and sectoral institutions for the innovation process.

Economic geographers have been keen to apply these ideas to their own discipline. In the 1980s and 1990s, some adopted a regional approach to regulation theory, but this was never fully developed (Martin, 2000). More successful has been the adoption of the concept of innovation systems, which was explored in the early 1990s (see e.g. Cooke, 1992, 2001; Cooke et al., 1998; Asheim and Gertler, 2005), and to which economic geographers continue to contribute to this very day. Interestingly, evolutionary economists introduced the concept of innovation systems by linking it to a particular geographical scale right from the start, that is, the national dimension (Freeman, 1987; Nelson, 1993). What economic geographers have added in the meantime is the view that innovation processes are firmly rooted in region-specific institutions, most them of an informal nature (e.g. local culture) that are difficult to copy or imitate by actors in other regions. Due to these intangible assets, regions are considered important drivers of innovation, despite tendencies of globalization (Storper, 1992; Belussi and Sammarra, 2005).

In their attempt to delineate an evolutionary approach in economic geography, Boschma and Frenken (2006) made the observation that institutions have not always been treated by economic geographers in a truly evolutionary manner. Broadly speaking, they came to four lines of criticism: (1) institutions are often presented as pre-

given and fixed, as if these come from nowhere (a-historical) and do not change over time; (2) institutions are often depicted as factors that determine, instead of condition, the economic behavior of agents and the performance of regions; (3) institutional approaches in economic geography tend to employ case-study approaches while ignoring, if not rejecting altogether, the use of quantitative methodologies. Although case-studies have generated many valuable insights into processes of regional innovation, many institutional approaches have been reluctant to test any hypotheses that might be derived from these; (4) institutional approaches in economic geography tend to associate institutions with territories (at whatever spatial level) and, hence, spatial differences in economic activities are attributed to institutional differences among territories. This stands in contrast to those evolutionary approaches to economic geography which reason from organizational routines, and which view behaviour of firms mainly stemming from their routines, rather than from territorial institutions.

When taking such a firm-based, micro-perspective, one avoids running the risk of over-emphasizing the role of territorial institutions and violating a crucial ingredient of an evolutionary approach, that is, the heterogeneity of firms. The assumption that all agents act or perform the same when subject to the same regional institutions also contradicts empirical findings that suggest the opposite. As noticed above, Giuliani (2007), among others, has demonstrated that agents in clusters differ widely in terms of economic power, absorptive capacity and network position, despite the fact that clusters are associated with a particular set of institutions. This variety can only be understood from the fact that firms develop routines in a path-dependent and idiosyncratic manner, and territorial institutions are often so general such that specific effects at the firm level can still vary greatly (Boschma and Frenken, 2009a). The very fact that a variety of routines is found in a territory shows that territory-specific institutions do not determine the kinds of routines that develop and survive in a territory. As Gertler (2009) puts it, there is "a danger of 'reading off' individual behaviour from territorial institutions". Instead, there is a need to account for the role of contingency in regional development (see e.g. Bathelt and Gluckler, 2003). This implies taking the individual and firm level more seriously than institutional studies have tended in the past.

This is not to deny that territorial institutions may explain part of the inter-regional variety of routines, however. For example, production techniques of plants in a number of manufacturing industries have been found to be more similar within than across US regions, and that these regional differences are quite persistent over time (Rigby and Essletzbichler, 1997; Essletzbichler and Rigby, 2005). This may be attributable to region-specific institutions, but it may also be the result of routine replication among local firms through spinoff dynamics or labour mobility effects. Therefore, we have to be cautious about taking the impact of institutions for granted, and assess their relative importance on a case by case basis (Boschma and Frenken, 2009a).

To incorporate institutions more fully into an evolutionary economic geography framework, MacKinnon et al. (2009) claim there is a need to account for power and labor-capital conflicts. Boschma and Frenken (2009a) have argued that this can be accomplished when accounting for the political dimension of routines, as advocated by Nelson and Winter (1982). Besides the cognitive dimension of routines, which has drawn most attention among evolutionary scholars, Nelson and Winter (1982) have defined routines as a mechanism of internal control, more specifically to control potential labor-capital conflicts within the firm (see also Rosenberg 1969; Nelson and Winter 1977). Integrating the political aspect of routines in an evolutionary approach to economic geography would start from the study of how firms regulate or resolve conflicts of interests between capital and labor differently using different routines. A geographical perspective should aim then to explain the diffusion of such routines among firms within and across regions, and to determine under what conditions such a diffusion process leads to an institutionalization of particular routines at specific territorial levels (Boschma and Frenken, 2009a).

Quite recently, there has been increasing attention directed to how institutions can be incorporated in the explanatory framework of evolutionary economic geography (see e.g. Boschma and Frenken, 2009a; Essleztbichler, 2009; Grabher, 2009; Hodgson, 2009; MacKinnon et al., 2009). Part 4 of this volume brings together contributions of leading economic geographers that take up this major challenge. What they tend to criticize is that institutions are often treated as static entities that are left unexplained. In Chapter 18, Anders Malmberg and Peter Maskell combine a micro-perspective with a dynamic macro-view on institutions in economic geography. According to Malmberg and Maskell, there is a strong need to understand better how institutional dynamics form and shape particular paths at the aggregate level of regions and countries. Linking micro-behaviour to macro-level processes, they explore how these evolutionary insights might be applied to the analysis of the birth, growth and decline of clusters, a topic that has been largely ignored by the cluster literature. In this respect, they develop a stylized version of an evolutionary approach to the cluster lifecycle.

In Chapter 19, Simone Strambach focuses on how new technological development paths emerge within established institutional settings and create institutional change. She goes beyond the common use of the notion of path dependency that merely emphasizes the stabilizing and action-guiding functions of institutions. Interestingly, Strambach takes the view that institutional systems are not necessarily coherent themselves, but subject to institutional *plasticity*, meaning that a range of options for new development paths are open within the overall dominant institutional system. Creative agents can deviate from the established path in a deliberate and purposeful manner, creating new institutions but not necessarily breaking with the existing institutional system (see also Martin, 2010). Strambach takes the rise of the German customized business software industry as an example to demonstrate that a new path can be created within an unfavourable and incompatible institutional setting.

Despite the hostile German national innovation system, this sector succeeded to become a highly competitive sector on the world market, creating new supportive institutions and adapting established ones. In other words, Simone Strambach proposes an evolutionary approach that aims to endogenise the role of institutions, and makes institutions a more integral part of the explanation of the evolution of the economic landscape.

This echoes the view of Nelson (1995) who proposed that institutions should be thought of as co-evolving with technology and markets. There are some fine studies that focus on the interplay between industrial and institutional change, by describing how institutions co-evolve alongside new industries (Freeman and Perez 1988; Murmann, 2003). This literature emphasizes that supportive institutions are often an outgrowth of emerging industries, but once they become established, institutions may obstruct their further development due to inertia and hysteresis (Setterfield 1997; Martin and Sunley, 2006).4 Institutional change is therefore required not only to enable the emergence of new industries, but also to revive mature industries. We still have little understanding of the conditions under which regions or countries are more likely to adapt their institutions to seize opportunities provided by new sectors, and under what conditions institutional adaptation fails to take place (Maskell and Malmberg, 2007).

In Chapter 20, Eike Schamp takes up this issue but in a much broader sense. He explores how the notion of co-evolution may be fruitfully applied in evolutionary economic geography. According to Schamp, the notion of co-evolution has often been used in economic geography in a rather narrative and loose sense. Following Malerba's work, he argues there is a strong need to identify what is co-evolving, and to be more specific about the reciprocal causalities between the co-evolving entities that are analyzed. In this context, Schamp discusses several empirical topics that focus on co-evolutionary processes: the simultaneous growth of connected sectors, the co-evolution of sectors and institutions, and the creation of a region as a supporting environment.

In this context, Robert Hassink explores in Chapter 21 the relationship between lock-in and regional development. While studies in economic geography tend to stress the positive effects of geographical clustering on growth, Hassink elaborates on the idea that clusters may also end up in a state of negative lock-in (see also Hassink, 2005; Schamp, 2005; Hassink and Shin, 2005). In his contribution, Hassink makes the case that the emergence and persistence of these negative effects can be well explained by an evolutionary economic geography approach. Empirical cases of divergent experiences in old industrial regions in Germany and South Korea are discussed to show: (1) why in some old industrial regions strong lock-ins are found, and in other industrial areas weak

4 Though it should be noted that Setterfield (1997) argued for a model of path–dependent economic development (and cumulative causation) that endogenised the evolution of institutions. In his model, institutions are regarded as fixed (exogenous) in the short run (such stability being necessary for economic growth and accumulation to proceed in confidence), but as changeable (and endogenous) in the medium to longer run, responding to the changing imperatives and needs of the economy.

lock-ins; (2) how regional lock-ins may be caused by (institutional) structures at different spatial levels, including the national and supra-national level.

While many institutions are heavily influenced by the state, what is still missing though is a systematic view on the state that is well grounded in evolutionary thinking (see e.g. Metcalfe, 1994; Pelikan and Wegner, 2003). To an increasing extent, there are contributions that specify how evolutionary economic geography may inform regional innovation policy (see, among others, Lambooy and Boschma, 2001; Shapiro and Fuchs, 2005; Todtling and Trippl, 2005; Asheim et al., 2006; Raspe and Van Oort, 2006; Van Geenhuizen and Nijkamp, 2006; Nooteboom and Stam, 2008; Boschma, 2009). What these approaches tend to argue is that region-specific contexts provide opportunities but also set limits to what can be achieved by public policy. Consequently, policy action should avoid 'one-size-fits-all' and 'picking-the-winner' policies. Instead of copying best practices or selecting winners, policy should take the history of a region as a starting point, and identify regional potentials and bottlenecks accordingly. To avoid the problem of regional lock-in, Nooteboom and Stam (2008), among others, have argued that public policy should stimulate the entry of newcomers, encourage new policy experiments, and enhance the establishment of extra-regional linkages.

Another pending issue is how to incorporate institutions in a more quantitative evolutionary framework. Institutions have been mainly (though not entirely) examined in economic geography by using qualitative, descriptive case-studies. Boschma and Frenken (2009a) have expressed the need for studies on institutions and regional development that strive for generalizations that go beyond the unique. This would make empirical studies in evolutionary economic geography "more comparable, transparent and cumulative", without denying the importance of qualitative studies (see Markusen, 1999). Having said that, we are in need of more sophisticated methodologies that can cope with the explicit dynamic nature of evolutionary processes in economic geography (Boschma and Martin, 2007). Many approaches are being pursued to this end, ranging from case-study research and network analysis, to duration models, simulation methods and the use of spatial econometrics, depending on the research questions and the data available (Frenken, 2007). This methodological openness or pluralism may be considered a strength of evolutionary economic geography, as compared to neoclassical- and institutional-based approaches (Boschma and Frenken, 2006).

Part 5. Structural change, agglomeration externalities and regional branching

Schumpeter once stated that economic growth is not just about quantitative change, but also about qualitative change. Long-term economic growth depends on the ability of countries to create new variety through entrepreneurship and innovation, in order to offset decline in other parts of the economy. Schumpeter conceived this process of 'creative destruction' as the driving force of economic development. Since the reappraisal of Schumpeter's work in the late 1970s, economic geographers have applied

these Schumpeterian ideas on structural change and industrial dynamics to regional development in a variety of contexts (e.g. Norton, 1979; Norton and Rees, 1979; Van Duyn and Lambooy, 1982; Lambooy, 1984; Marshall, 1987; Hall and Preston, 1988). In the 1980s, there was an almost widespread consensus among economic geographers that 'new industries' do not emerge in 'old regions'. Empirical studies showed that new industries flourished in new growth regions like the Sunbelt states in the US, the South East in the UK and Bavaria in Germany, while old and declining sectors were mainly located in what were once the leading regions in the US (like the Rustbelt) and Europe (like the North in the UK, and the Ruhr area in Germany). Conventional approaches took a deterministic view on this, claiming that new sectors had different locational demands, like quality of life and low (labor) costs, as compared to old sectors. Other approaches took a more evolutionary perspective, emphasizing that it is unpredictable where new growth industries will emerge and change the economic landscape, because of chance events in combination with increasing returns (Storper and Walker, 1989; Boschma and Lambooy, 1999).

The spatial evolution of the economic system at the macro-level may be addressed in a framework of structural change, in which catching-up and falling-behind of regions is analysed not only in terms of the rise and fall of sectors but also in terms of the rise and decline of (infrastructure) networks. In this respect, the economic development of cities and regions can be analysed as an aggregate of sectoral change, and from their (changing) position in global networks of trade and knowledge. With respect to sectors, cities and regions that are capable of generating sectors at the start of a product life cycle will experience growth, while cities and regions that are locked into mature stages of life cycles will experience relative decline. There is no automatic economic or political mechanism that assures cities or regions will successfully renew themselves in this respect (Boschma and Frenken, 2006). With respect to networks, the growth of cities and regions also depends on a city's or region's inclusion in global networks of trade and commerce (Hohenberg and Lees 1995; Castells 1996). A central network position can be achieved by attracting corporate headquarters, developing specialised business services, and functioning as major transportation hubs. On the one hand, one might expect cities and regions in one historical era (e.g., based on railways) to be less successful in the next era (e.g., based on airlines), due to institutional rigidities and sunk costs associated with previous infrastructures. On the other hand, some major cities (like London and New York) seem to be capable of maintaining their leading positions in world-wide operating networks (Wall, 2009). 5

The fifth and final part of this volume focuses on the relationship between structural change and the evolution of the spatial system at the macro-level. Jan Lambooy, being one of the founding fathers of Evolutionary Economic Geography,

5 Glaeser's (2005) study of how Boston has repeatedly 'reinvented' itself over the past three hundred and fifty years provides a striking example of how a city can overcome institutional and sunk costs, and renew its growth dynamic, in Boston's case by drawing on and replenishing its skilled labour force.

takes up this issue in Chapter 22. He explores how an evolutionary approach in economic geography may deal with the inter-relationship between structural change and the evolution of the economic landscape. While the relation between technology and economic development has drawn a lot of attention, Lambooy argues that the impact of this relation on spatial structures, in particular urbanisation, has remained relatively unexplored. He claims that spatial structures tend to reflect technological and economic development in various ways, but often with a time lag, due to physical and institutional constraints that are engraved in space. More in particular, Lambooy discusses how General Purpose Technologies like ICT have impacted on spatial patterns, like the process of urbanisation and the spatial evolution of industries and networks.

Evolutionary economic geography deals with the uneven distribution of economic activity across space, and how that evolves over time. In Chapter 23, James Simmie takes up how new technological regimes impact on the evolution of the economic landscape. He examines the example of the rise of the service-based economy, and he addresses the need for an evolutionary perspective to investigate its spatial implications. Drawing on recent experiences in the evolution of the English urban system, Simmie investigates two recent phenomena in the rise of the information society, namely the rise of knowledge intensive business services and the importance of network ties between service sectors in the Greater South East region.

An evolutionary approach centres on historical processes that produce the uneven economic landscape. In this respect, spatial patterns emerge from economic growth processes that occurred in the past (Simmie and Carpenter, 2007). At the same time, spatial distributions affect subsequent patterns of growth due to the uneven spatial distribution of resources built up in the past giving rise to (positive and negative) externalities. Stochastic models of urban growth using time series on city size investigate sustained urban growth and decline, thus going beyond the logic of Gibrat's Law stating that urban growth rates are stochastic and independent of city size (Pumain and Moriconi-Ebrard 1997). This approach falls under evolutionary economic geography, since these models account for path dependence in which each event changes the probability of a next event to occur (David 1985; Arthur 1989). Such an evolutionary perspective differs from the core model in New Economic Geography (Krugman 1991) where changes in spatial distributions are explained from parametric changes, as in transport cost. The concept of path dependence in that model is different in that it refers to multiple equilibria that are sensitive to initial conditions only (Martin, 1999, 2009, 2010; Boschma and Frenken 2006). What unites evolutionary models is that the growth dynamics are path-dependent, and that this path dependence does not simply arise from the assumption of increasing returns as is the case in NEG models. That is not to say that increasing returns do not play a role. Rather, if included one should specify both positive and negative externalities.

In Chapter 24, Giulio Bottazzi and Pietro Dindo provide a fine example of how modelling may contribute to the further advancement of evolutionary economic

geography. These authors explain how different their evolutionary model of firm location is from the neo-classical Krugman model that laid the foundations of the New Economic Geography. They present the outlines of an evolutionary entry-exit model of firms' location that describes how the economic landscape evolves over time. As a starting point, they present a static framework in which a spillover drive scenario leads to agglomeration, while a market drive scenario may generate either an agglomeration or an even spatial distribution. The model further specifies how other variables (like transport costs) may enhance technological spillovers or market forces and thus agglomerative forces, or not. This static framework is complemented by an evolutionary entry-exit model, in which heterogeneous firms may change their locational preferences, due to previous decisions of other firms. In this dynamic setting, agglomeration is a less likely outcome, and when it occurs, the agglomeration may not always be stable.

Another promising line of research in evolutionary economic geography is to determine what kind of agglomeration externalities are needed to promote urban and regional growth (Jacobs, 1969; Glaeser et al., 1992; Henderson et al., 1995; Feldman and Audretsch, 1999). Frenken et al. (2007) have gone beyond the dichotomy of Marshall-Arrow-Romer (MAR)-type versus Jacobs-type externalities by introducing the notion of 'related variety' type externalities. This means that regions that are endowed with technologically related sectors might have higher growth rates, because this might affect positively the nature and scope of regional knowledge spillovers. That is, the extent to which the variety of technologies present in a region is related is expected to affect the scope for knowledge spillovers, as firms in different but related activities can profit more from mutual spillovers than can firms in unrelated activities (Boschma and Frenken, 2009b). In other words, related variety performs two tasks at the same time. Some degree of cognitive proximity (that is, relatedness between sectors) ensures that effective communication and interactive learning between sectors take place. But also some degree of cognitive distance (that is, variety between sectors) is needed, to avoid cognitive lock-in and stimulate novelty (Nooteboom, 2000). Frenken et al. (2007) could demonstrate empirically for the Netherlands that related variety has indeed a positive impact on regional growth. This result has been replicated in studies on other countries (Essletzbichler 2007; Bishop and Gripaios 2009; Boschma and Iammarino 2009).

The next step to take in these regional growth models is to account for the fact that new and related variety may also be brought into the region through inter-sectoral linkages with other regions. Boschma and Iammarino (2009) have made a first attempt to estimate the effects of inter-sectoral learning across regions on regional growth in Italy by means of trade data. Their analysis suggests that the inflow of a variety of knowledge *per se* did not affect economic growth of regions in the period 1995-2003. The same was true when the extra-regional knowledge was similar to the knowledge base of the region. However, the more related the knowledge base of the region and its import profile was, the more it contributed to regional employment growth. This might indicate that a region benefits especially from extra-regional knowledge when it

originates from sectors that are related or close, but not quite similar to the sectors present in the region. This type of analysis goes beyond the regional level, and sheds more light on the importance of inflows of extra-regional knowledge (is it just a matter of being globally connected, or is there more to say?). However, more refinement is needed to assess more systematically its importance for urban and regional growth.

This also concerns how to measure related variety. Recently, scholars have come up with more sophisticated indicators of relatedness on the basis of combinations of human skills or products that occur frequently in plants or firms (Breschi et al., 2003; Hausmann and Klinger 2007; Neffke and Svensson Henning 2009; see for a discussion Neffke 2009). Such studies provide a picture of which industries are related to one another, in order to capture better the knowledge spillover effects of related variety. Another advantage of these new indicators of relatedness is that they do not rely on predefined and static SIC codes. Since relatedness between industries may change in the long run because of technological developments, there is a need for a flexible indicator that accounts for shifts in technological relatedness and related variety over time.

The agglomeration economies literature (Henderson et al., 1995) has claimed that new (high tech) industries need Jacobs-type externalities (and thus inter-industry knowledge spillovers) to develop, while more mature industries benefit more from MAR-type externalities (i.e. intra-industry spillovers) in more specialized cities. From an evolutionary point of view, it is more interesting to investigate whether new industries need the local presence of related industries. Following the idea behind related variety, we would expect that a local diversity of sectors *per se* is less likely to lead to successful new combinations, because sectors will learn more from each other when they are technologically related. A research question that follows from this is whether related variety itself can be explained as an outcome of an historical process of regional development. As Boschma and Frenken (2009b) have explained, different time scales are involved. In the short run, related variety is a very stable property as the sectoral composition of a regional economy changes only slowly over time. Yet, on longer time-scales, related variety itself is subject to change and becomes a dependent variable. One can ask the question to what extent the technological relatedness between sectors in a regional economy as a whole can help us to understand the opportunities of each region to diversify into new and related industries. To the extent that new industries emerge from existing and related industries, the sectoral composition of a regional economy at one moment in time provides but also constrains diversification opportunities of regions in the near future.

Thus, from an evolutionary economic geography perspective, one would expect that a set of related industries in a region is rather persistent over time because regions are more likely to expand and diversify into sectors that are closely related to their existing activities (Hidalgo et al. 2007; Neffke and Svensson Henning 2009). This means that when firms diversify (but not many do so because of the risks involved), they will show a higher propensity to diversify into technologically related instead of

unrelated industries. Recent studies have indeed confirmed that regional branching occurs through related industries. Hausmann and Klinger (2007) found empirical evidence that there is a strong tendency of the export mix of countries to move from current products towards related products, rather than goods that are less related. In other words, a country's current position in the product space determines its opportunities for future diversification. Thus the process of structural change is very much conditioned by existing related activities in a territory, providing support for spatial path dependence. Neffke and Svensson Henning (2009) found evidence that unrelated sectors are more likely to exit the region than related sectors, while sectors that are related to other sectors in the regional portfolio are more likely to enter the region, as compared to unrelated sectors. So, regions might change their industrial profile over time, but they tend to do so in a slow manner, and when they diversify, this is rooted in their existing industrial profile (Neffke, 2009). However, this is not to say that every country or region has the same probability to diversify successfully into related activities. Hausmann and Klinger (2007) found in their study that rich countries that are specialised in the more dense parts of the product space, have much more opportunities to sustain economic growth, as compared to poorer countries which are positioned in the less dense parts. In conclusion, the historical trajectories of regions shape the rise and fall of sectors, but are also in turn shaped and transformed by this process of creative destruction.

More research is needed, but these outcomes suggest that the long-term development of regions depends on their ability to develop new sectors or new market niches that have their roots in the current regional knowledge base. It means that regional economies should branch into new directions rather than start from scratch when they diversify. Frenken and Boschma (2007) and Boschma and Frenken (2009b) have suggested that branching occurs at the regional level because it becomes manifest through knowledge transfer mechanisms such as spinoff activity, firm diversification, labor mobility and networking, all of which tend to be geographically bounded. This opens up a whole new research agenda. These and other research challenges mentioned earlier will contribute to the further advancement of evolutionary economic geography.

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