

What is the essence of geographic clustering?

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Abstract

The present paper put forward some basic arguments on the concept of geographic clustering. Before doing that the general idea behind this paper is to present the *new* approaches. Furthermore, we develop a framework as a tool in which it is easier to discuss the different *new* approaches of geographic agglomeration and clustering developed in the 1990s. The framework also makes it easy to get a clear overview of the different approaches and to see which of the older approaches they draw on.

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1 Introduction

In the time around the end of the 1980s, the element of geography started to get increased attention in the economic literature. This resurgence of geography was mainly started by the work of Paul Krugman, who created a lot of attention on this old concept. While the economists again started to think about geography as a factor in economics, economic and industrial geographers had of course not forgotten about this concept and continued their research in the period, where geography had been silent in economics. Krugman's efforts to promote geography created a lot of harm among the geographers. Discussion between Krugman and the geographers increased in *cruelty* in the following years. The harsh word flew from both sides and the geographers had no understanding towards Krugman's rediscovery of geography. The geographers did not acknowledge Krugman's model of geography, which is presented later in this paper. However, Krugman's effort increased the productivity in the field of economic geography, as it's researchers started to sharpen their arguments in order to meet Krugman's challenge.

The resurgence also increased the birth of other new approaches of studying geographic agglomeration and clustering. As we will show in this paper, all these new approaches reflect sort of a convergence of older literature in the sense that the new approaches all draw on elements from more than one of the main theoretical schools.

Thus the general idea behind this paper is to present the general idea of *new* approaches and to develop a framework as a tool in which it is easier to discuss the different *new* approaches of geographic agglomeration and clustering developed in the 1990s. The framework also makes it easy to get a clear overview of the different approaches and to see which of the older approaches they draw on.

The paper is structured as follows. The next section presents the four main theoretical approaches, which are main foundation of the *new* approaches. Section three describes the *new* approaches. The fourth sets up the framework and positions the *new* approaches inside the framework. The last section contains the concluding remarks on the theory of economic clustering.

2 The main theoretical approaches

We start here by briefly introducing the four main theoretical approaches, which together form the illustrative framework we are developing in this paper. The different approaches to geographic agglomeration exist and are further developed inside the interactions between these four fields.

2.1 Mainstream Economics

The mainstream theories of economic growth and especially the New Growth Theories (NGT) (Romer 1986; Lucas 1988; 1990; Grossman and Helpman 1991; Aghion and Howitt 1998) also concern geographic issues as well as focussing on macro-level growth and convergence. However these do not deal with clusters or agglomerations and are not intended to do so. The "new" element of NGT is to endogenise technological change in the models. This element was absent in the exogenous treatment of technology in neo-classical growth models (Solow 1956). The Solow model treated

technology, as a public good and changes in technology was determined exogenously as *Manna from Heaven*.¹

The problems of traditional neoclassical growth theory eventually led neoclassical economists to search for another model, which is more consistent with reality than the Solow model had proved to be and could explain reality better without having to revert to the assumption of exogenous technological change. Among these economists, Paul Romer was the central contributor. In two literature surveys, Fagerberg (1994; 1999) distinguishes between two generations of new growth models. The first-generation models (Romer 1986; Lucas 1988) had the idea that capital accumulation leads to technological change through *learning by doing*. However this could not be appropriated by the firms in which the learning takes place, but it is assumed to be external of the firm and to the beneficiary of all firms, who collectively can take advantage of this. Thus these models had constant returns to factor accumulation at the level of the firm and increasing returns to accumulation of all factors at the country-level.

The second-generation models (Romer 1990) suggested a framework more based on Schumpeterian ideas², where the first-generation models were based on more Kaldorian ideas (Fagerberg 1999). This generation of models changed the view on innovation as being just a pure externality to being the result of a deliberate effort of firms. Innovators will have a temporary monopoly as a result of imperfect competition at the level of the firm. New technology is only partly excludable in the models, so innovations have both a private and public component. This ensures that innovation and growth may go on and on, since decreasing returns to innovation is not possible in these models. The second-generation models thus move away from capital accumulation as the engine of economic growth. R&D investments and the degree of appropriability are now the main factors in mainstream growth theory (Fagerberg 1999).

Another part of mainstream economics, which deal more with geographic aspects than NGT, is the New Trade Theories (NTT) (Grossman & Helpman 19xx; Krugman 19xx). These theories have been far more influential in geographic literature especially in the New Economic Geography literature.³

To be extended...

2.2 Economics of Innovation (Evolutionary Economics)

Basically three central points distinguish economics of innovation with the neoclassical part of mainstream economics (Lundvall 1998). First of all, economics of innovation focuses on change. The agents are have limited rationality and asymmetric information. Their actions and their behaviour change over time as they continually learn from their experiences. In this tradition innovation is the most central aspect.

Secondly, institutions and history matters. The neo-classical approach has the ambition to become a theory of general validity in its own right. However, the economics of innovation is an open approach integrating economic, historical and sociological aspects in a united theory.

¹ The other rather crude assumption of the Solow growth models was perfect competition involving no possibility of returns to scale.

² Similar models have been developed by Grossman and Helpman (1991) as well as Aghion and Howitt (1998).

³ Further described below.

Finally, agents are very different, which together with the diversity of variables are very central to the understanding of dynamics of a system, where evolutionary mechanisms are fundamental.

The primary analogy behind this tradition is that innovations, which is central to growth and wealth of an economy, is a result of a complex interactive learning process depending on the above three central arguments. The innovations can either be path dependent incremental innovations or radical innovations, which represent large jumps in technological progress. But what is innovation basically?

2.2.1 Characterising innovation, knowledge and learning

A lot can be said about these three elements, so this section only briefly characterises three key elements of the economics of innovation. These are presented below.

Innovation is a very hard factor to measure. A part of the problem is that innovation has many dimensions covering various sorts of activities. People usually think of innovation as a new product, but innovation can also be (Kline and Rosenberg 1986):

- a new production process;
- the substitution to a cheaper material in the production process;
- the reorganisation of production, internal functions, or distribution arrangements leading to e.g. increased efficiency or lower cost;
- an improvement in instruments or methods of doing innovation.

Knowledge is characterised as having two different natures. Thus knowledge is often divided into two types, codified and tacit. Codified knowledge is formalised knowledge, which can be stored, copied and transmitted easily. It can be transmitted across large distances at low cost. Tacit knowledge, on the other hand, is non-formalised knowledge, which is hard to describe and transfer from person to person. An important form of tacit knowledge is skills. It is mainly created through experience or face-to-face contact between individuals. A direct transfer of this type of knowledge is only possible through social interaction between individuals. A large part of technological innovation represents an effort to codify this tacit knowledge (Foray and Lundvall 1996).

This conception of knowledge has strong implication towards a connection between innovation and geography, because social interaction is important to transfer tacit knowledge, which is perhaps the most important type of knowledge in the innovation process. Thus the access to tacit knowledge may be the main reason for firms to cluster in specific areas.

The knowledge creation process has two different aspects. Firstly, knowledge can be created through a planned resource-demanding effort in a separate *sector*, which is specialised in the production of new knowledge and the diffusion of knowledge and information. This *sector* includes the education system, universities, public research facilities and R&D departments in firms. Here knowledge is created through a more or less intended investment (Foray and Lundvall 1996).

Secondly and perhaps most importantly, knowledge is created through learning processes in firms (Maskell and Malmberg 1999). This second aspect of the creation and diffusion of knowledge evolves in the repetition activities in the economic life. This

can be thought a repetition of a working process (e.g. learning by doing or trial and error) (Foray and Lundvall 1996). This aspect is a learning process, which continuously enhances the knowledge base, but a part of this is the importance of unlearning and forgetting. Past learning experience or routines is necessary to be forgotten in order to open for new and better ways of doing things. This means that some existing knowledge can be the barrier, which keeps new and better knowledge to be developed (Lundvall and Johnson 1994).

2.2.2 Dosi's five stylised facts on innovation

Dosi's five stylised facts (1988) all involve aspects, which give arguments to the fact that, innovation is correlated with location. The stylised facts are: Innovation is a highly uncertain process. Innovation process relies heavily on contemporary research. Innovation is a complex process. Learning by doing is an important feature of the innovation process. Innovation is cumulative process. They are in turn presented below.

Innovation is a highly uncertain process. This uncertainty is connected with the limited information about the future events and technical problem with unknown solution procedures, which may influence the process. Another aspect is the impossibility of precisely knowing, what consequences the actions might have (what will happen, if I do this) (Dosi et al. 1988). If agents participate in networks or collaboration with external partners, they can minimise the uncertainty by engaging problem solving networks. The uncertainty in the innovation process may provide a clear incentive for firms to group together to enhance the possibility of participating in more or less formal interactive networks with other firms and agents (Lundvall 1988).

Innovation process relies heavily on contemporary research. Contemporary research from universities has continually influenced the innovation of firms in more than 100 years. Innovation in individual firms is depending on major new technological opportunities open by basic research. The existence of universities in the local environment of a firm has an important influence on the innovation processes in the local community, because the universities are seen as a free exchange of knowledge and vital source of information on frontier technology (Feldman 1993).

Innovation is a complex process. The complexity of research has increased, because the nature of the search activities leading to innovations has changed. This complexity moves the process of innovation away from individual innovators to formal research organisations (R&D laboratories in firms, universities, government research facilities etc.). Firms located in areas with access to these formal research organisations will have lower cost of acquiring information, which is needed in the search activities, because these organisations will be a source of this information, which ultimately will enhance the innovation process (Feldman 1993).

Learning by doing is an important feature of the innovation process. Large parts of the knowledge needed in the innovation process are tacit by nature. A significant amount of innovation and improvements rely on this type of knowledge, which come from the individual learning by doing or learning by using processes in firms or organisations. Since this type of knowledge is very hard to transfer, individuals need to get in face-to-face contact with each other in order to learn from each other's experience. This may result in firms locating next to its competitors and suppliers in order to access this information. Thus competitors or suppliers, who face the same obstacles and problems, can be valuable sources of this type of knowledge (Von Hippel 1988; Porter 1990).

Innovation is cumulative activity. The future direction of the innovation process are often defined by the state-of-the-art technologies today and the probability of making technological advances in firm or organisations (and perhaps countries) is a function of the innovations already achieved by them in the past. This makes innovation a cumulative process, because the firm, which has technological advantage today, has a high probability of having the technological advantage tomorrow (Nelson and Winter 1982) This cumulative nature implicates that areas with innovative success in the past will be best suited for innovative success in the future. The main implication of this is that innovation expects to exhibit pronounced geographic clustering (Feldman and Florida 1994).

2.2.3 Technological regimes

A technological regime (Nelson and Winter 1982) can best be defined as a combination of four different factors, which describe the environment in which firms operate. It is a description of the innovation pattern in a particular regime. The four factors are described below (Malerba and Orsenigo 1990; 1997).

Opportunity conditions. This factor reflects the profit opportunities behind innovation and the probability of a given investment to result in a successful innovation. High opportunities will give strong incentives to innovate, because they determine a high probability of success of innovating. This is sometimes associated with potentially high variety of technological solutions. This is particularly in the earlier stages of the product life cycle. Additionally, the opportunities can include high levels of pervasiveness, which mean that new knowledge is relevant for use in several products and markets. The source of the opportunity condition also varies across technologies and industries. In some industries the opportunities are related to major scientific breakthroughs (as shown by e.g. Freeman 1982), where as in others the opportunities of innovation are connected with advancements in R&D or learning.

Appropriability conditions are the possibilities of protecting an innovation from imitation and the possibilities of protecting the profits of innovative activities. High appropriability means that the possibilities of protection are high, whereas low conditions indicate an environment with a high level of spillovers.

Cumulative conditions. These conditions can be formally defined as the degree of serial correlation among innovations (Breschi 2000). More generally this captures the properties that current innovations form a starting point for tomorrow's innovations and that today's innovators are more likely to be innovators of the future in specific technologies and along a specific trajectory (Nelson and Winter 1982). The generation of new knowledge builds on what has been previously generated. The past knowledge not only constrains current research, but also generates new questions and knowledge (Malerba and Orsenigo 1997). Cumulativeness may be related to the *success breeds success* processes (known from Nelson and Winter models (1982)), which comes from the arguments that innovative success yield profits, which can be reinvested in R&D, which again increases the probability of innovation again.

Knowledge base. This condition refers to the properties, which the innovative activities are based on. The knowledge base involves various degrees of specificity, tacitness, complexity and interdependence. Simplified, the means of transmission of knowledge can either be formal or informal. The more knowledge is changing, tacit and complex, the more relevant are the informal means of transmission (e.g. face-to-face contact, training, and mobility of personnel). This will also increase the impor-

tance of distance between agents. On the other hand, the more knowledge is standardised, codified and simple, the more relevant are the formal means of transmission (e.g. publications, licences, and patents). This may not give importance to the role geographic proximity in the transmission of knowledge between agents (Malerba and Orsenigo 1997).

2.2.4 Systems of Innovation

The systems of innovation literature⁴ is widely recognised as being a central part of the economics of innovation literature. The concept was developed in the late 1980s in a national context. According to Christopher Freeman (1995), Bengt-Aake Lundvall used the expression 'national systems of innovation' for first time in the making of Dosi et al. (1988)⁵, but it was first used in published form by Christopher Freeman (1987). This work led to the publication of two major books on the concept in the beginning of the 1990s. The first is titled, *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning* (Lundvall 1992). The book contains theoretical chapter linking institutional aspects and interactive learning to the innovation process as well as empirical chapters. Complementary to the Lundvall book, Richard Nelson published a book entitled, *National Systems of Innovation: A Comparative Study* (1993). This book includes a series of case studies of the innovation systems of fifteen countries. Later in the 1990s research has developed concerning sectoral systems (Breschi and Malerba 1997; Malerba 2001), technology systems (Carlsson and Jacobsson 1997) taking its point of departure in the concept of national systems of innovation.⁶

According to Lundvall (1992, p. 12) national systems of innovation is explicitly defined as *all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring – the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place*. The concept cannot be sharply determined as the boundaries of national systems of innovation are hard to define more narrowly.

The systems of innovation literature has its theoretical origins in the above-described economics of innovation tradition and evolutionary economics. The common idea includes the perception that technological change and innovation are evolutionary processes, which are narrowly related to learning. Furthermore, this literature has a large emphasis on interaction between actors leading to conceptualisation of innovation and knowledge production as processes, which are often highly embedded in a given social context.

2.3 Economic and Industrial Geography

To be written...

2.3.1 Neo-marshallian Italian Industrial Districts

To be written...

2.4 Organisational economics

To be written...

⁴ For a good survey of this literature, see Edquist (1997).

⁵ Later used widely as a key term in this book, see also Lundvall (1988).

⁶ The literature is also the departure of the regional systems of innovation approach, which will be described further in detail below.

3 The new approaches

3.1 Krugman and the New Economic Geography

Coming from the heart of mainstream economics and the theory of international trade, Krugman has moved into the geographic discipline. By introducing some of the concepts of international theory he has been the main architect behind the approach developed in the 1990s called the *New Economic Geography* (Fujita et al. 1999; Krugman 2000). Besides being influenced by Krugman's history in trade theory, this approach is also built on some of the concepts from early theories of economic geography.

The general and short version of the idea behind Krugman's revitalisation of geography in mainstream economics is illustrated by this quote (Krugman 2000, p. 49):

"A man from Mars - or from the real world - would be surprised to find that economic geography and the theory of international trade are sharply distinct fields."

The standard international trade theory (e.g. the Hecksler-Ohlin-Samuelson model) is firmly based in a neo-classical world with formalised static equilibrium based model with constant returns and perfect competition. This has left no room for theoretical convergence with theories of economic geography based on imperfect competition, increasing returns and with a crucial role of history. However during the 1980s the so-called New Trade Theory accepted aspects like increasing returns and imperfect competition into the world of mainstream economics. Thus the two traditions have converged and made it possible to include geographical aspects in trade theory and vice versa (Krugman 2000). The result of this convergence has been called the New Economic Geography (NEG).

The goal of the NEG is to model agglomeration by including the interaction between centripetal and centrifugal forces simultaneously. The models should be able to tell stories about the geographical structure of the economy, which is shaped by the tensions between these underlying forces. Also the models should be able to explain the underlying micro decisions behind the forces (Fujita et al. 1999).

Building on the core-periphery model (Krugman 1991a), the core question of NEG is to ask how the interaction between increasing returns and transportation cost might lead to a particular geographical structure of production. The answer of this includes some of the older stories from the international trade theory about the home market effect. Under the assumption of immobile resources, production agglomerates near the largest market in order to minimise transportation cost and exploit the increasing returns. This story dates back to Krugman (Krugman 1980). Combining this with the possibility that the resources may be more or less mobile, the simple core-periphery model reflects the idea that there is a tension between forces, which enhances concentration (centripetal forces), and forces, which limits concentration (centrifugal forces). This idea is not new in the core periphery model, but it is simple formulation of a cumulative process, which Krugman himself dates back to Pred (1966) (Krugman 2000). This means that the contributions from Krugman in 1991 draw on some of the core contributions of economic geography from the middle of the 20th century.

Furthermore the NEG approach has opened a focus on geographical concentration of particular industries, which was not the initial core-periphery model. This opens the approach to vertical structures of production with the possibility of up- and downstream industries to concentrate. Again with the focus on increasing returns and

transportation cost (Krugman and Venables 1995; Venables 1996). This change in the focus has included the concept of external economies, which is one of the main traditional issues of the international trade theory. This issue is however a rather old element and still an important issue of the economic geography (see e.g. Storper 1997). But Krugman (2000) is aware of this link and dates the concept back to contributions in trade theory from Graham (1923). Graham considered the existence of increasing returns on the industry level and not just on the level of the individual firm or plant to lead to increase specialisation of production between countries. This idea has been particularly appealing to scholars of geographic aspects, because stories told with this concept often involve an element of location below the country level (see also Porter 1990).

The dynamics of the NEG lies in the arguments that the geographic pattern is more or less predictable. In an economy the geographical pattern will slowly evolve, if the centripetal forces are strong enough. Concentrations will evolve with a distance and pattern determined by scale effects and transportation costs. This process will be self-organising and qualitatively predictable. Despite having a model with multiple equilibria, there should be some predictable geographical patterns (Krugman 2000). The arguments presented here again provide a link back to some of the traditions from economic geography, which have presented these arguments, i.e. Christaller (1933) and Lösch (1954). But these ideas are actually also very close to the evolutionary location model of Arthur (1994) in the dynamics, but with a totally different theoretical background. However, Krugman does not quote this model.

Initially a location might have some kind of advantages, which will be attractive to particular firms and gradually, attract these firms. Once this location is established, the initial advantages may be more or less obsolete compared with the self-sustaining advantages of the concentration of the particular firms in this location (Krugman 2000).

3.2 Porter studies

These started in the late 1980s by Michael E. Porter with numerous case studies of the national competitiveness of several developed countries. The result was the well-known book (1990), "The Competitive Advantage of Nations". The book was strongly inspired by Porters background in strategic management and organisational economics, but also inspired by the thoughts from economics of innovation which led to the systems of innovation literature, which flourished in the late 1980s and start 1990s. The Porter approach is a descriptive non-formalised type of literature, which mainly focuses on the competitiveness of firms and organisations. However this is clearly linked to geography and clusters, because of these aspects importance for competitiveness in this approach. The main literature in this approach is Porter (e.g. Porter 1990; 1998; 1999; 2000) and his former PhD. Student during the writing of the 1990 book, Michael Enright (1999).

To be extended...

3.3 Localised capabilities approach

Closely connected to the disciplines economics of innovation and economic geography, Peter Maskell and Anders Malmberg are the main architects behind the localised capabilities approach to geographic clustering. The approach is based on the idea that firms build their competitiveness in interaction with localised capabilities, which are based on the following four factors (Maskell et al. 1998):

- The region's infrastructure and built environment;
- The natural resources accessible in the region;
- The region's specific institutional endowment;
- The knowledge and skills available in the region.

All these factors are built and moulded by historical processes. The infrastructure can often be traced back at least a century, while the natural resources are typically a much older factor. The natural resources of a region comprises of both the region's own natural resources and the resources, which are accessible from other places through imports. The access to resources is a key determinant of the firms' competitiveness (Maskell and Malmberg 1999). The institutional endowment is a broader concept, which should be defined as all the rules, practices, routines, habits and traditions associated with the regional supply of different factors, which characterises a region (Maskell et al. 1998). Maskell and Malmberg themselves highlight factors such as entrepreneurial spirit, moral beliefs, culture and political traditions as being important examples of elements of the institutional endowment, which are important for locational development (Maskell and Malmberg 1999).

More to come...

3.4 Localised Knowledge Spillovers Approach

This approach includes elements of all the four main theoretical schools, evolves around the central argument that innovation is expected to exhibit pronounced geographic clustering. The innovation clusters geographically in areas with concentrations of specialised resources, which eventually enhance and facilitate the innovation process (Feldman 1993). This line of literature is based on a series of empirical studies of the spatial patterns of innovation in the US and in Europe.

The theoretical framework of the work draws on a lot of the central literature in from all fields, but especially from the economics of innovation. The central arguments from this line of research mainly concern the innovation process and the complexity of knowledge. Building on the five stylised facts of the innovation process (Dosi et al. 1988; Feldman 1993; 1994; 1994) argue that innovation will cluster geographically, because the implications of each of the five stylised facts have spatial elements attached.

Since the transmission of new knowledge becomes more costly and complex with increased geographical distance, the transmission of new knowledge is more efficient in a local proximate area. This complex and spatial nature of new knowledge leads to an increased probability, that the economic activity based on innovations will cluster geographically (Audretsch 1998). This line of thinking draws on some of the more mainstream theories, which focus on the importance of knowledge spillovers for economic growth via increasing returns (e.g. Romer 1986; Grossman and Helpman 1991; Krugman 1991b). But the difference between this line and Krugman and others is the

nature of knowledge spillovers. Krugman etc. believes that knowledge spills over unlimitedly across geographic distance. This illustrates, what often have been referred to as "The Death of Distance" (The Economist, 30/09/95). Here it is some sort of a paradox that knowledge spillovers and geographical location should be linked together in world with Internet, e-mail, fax, etc. The cost of communication have diminished drastically in recent years, thus it may seem as paradox that location should still be linked with knowledge spillovers and communication. However, this is again explained by the complexity of knowledge and the distinction between knowledge and information, which again is inspired by the economics of innovation. Information is codified knowledge, which can be easily communicated at low cost. On the other hand, knowledge is difficult to codify and cannot be directly transmitted. The transmission of tacit knowledge involves some kind of face-to-face contact between individuals, which of course is very difficult across geographic distance. This also illustrates that the arguments used here by Audretsch are directly compatible with the literature, which have emerged under the heading of 'systems of innovation'.

Once a location is developed as a concentration of innovation, will it then be able to hold its position? Audretsch and Feldman (1996) put forward a possible answer to this question. Linking to the growing literature on the connection between innovation and industry life cycles⁷ (Klepper 1996) their answer lie in the idea that the agglomerative forces is shaped by the phase of the industry life cycle. They argue that key aspect to the evolution of innovative activity is where innovation takes place and as described above the propensity for innovation to cluster spatially will tend to be in industries where tacit knowledge plays an important role. The role of tacit knowledge is perhaps the largest during the earlier stages of the product life cycle (Audretsch 1998). Audretsch and Feldman (1996) tested this empirically and found considerable evidence suggesting that the propensity for innovative activity to cluster spatially is shaped by the stage of the cycle.

3.5 Other approaches

To be written ...

4 An Illustrative Framework

To get a better overview of these theories and empirical approaches, it can be very helpful to set up a graphical framework of these theories of geographic clustering. Based on the four large traditions of economics, some of which includes geographical approaches themselves, we draw a framework, which enables us to clearly see the differences of the new approaches developed in the last fifteen years.⁸ Below we have developed such a framework.

In the basic framework in figure 1, we see the four main economic schools of thought. With each of the schools, we have highlighted some of the approaches, which either represents the main literature of the school or an important approach to geographic clustering of economic activity. All together the four schools form a framework of common fields or areas, which open for approaches drawing on two or more of the schools. All the new approaches presented above fit into these areas.

⁷ This literature suggests that who innovates and how much innovative activity is undertaken is closely linked with to the phase of the industry life cycle (Klepper 1996).

Figure 2 shows how these new approaches are located in the framework. For understanding this framework it is important to know that if two approaches is located in the same common area, this does not necessarily mean that the approaches are very similar. They should be seen as two independent approaches drawing on the same schools in the theoretical background. Furthermore, if an approach is located in e.g. mainstream and economic geography, this does not mean that it is a mainstream approach, but only that the approach draws on elements of theory, which we consider to be part of the mainstream school.

⁸ Christian Pedersen originally developed the idea behind this framework in his master dissertation. However this has been further developed and extended in this paper.

Figure 1: The Basic Framework

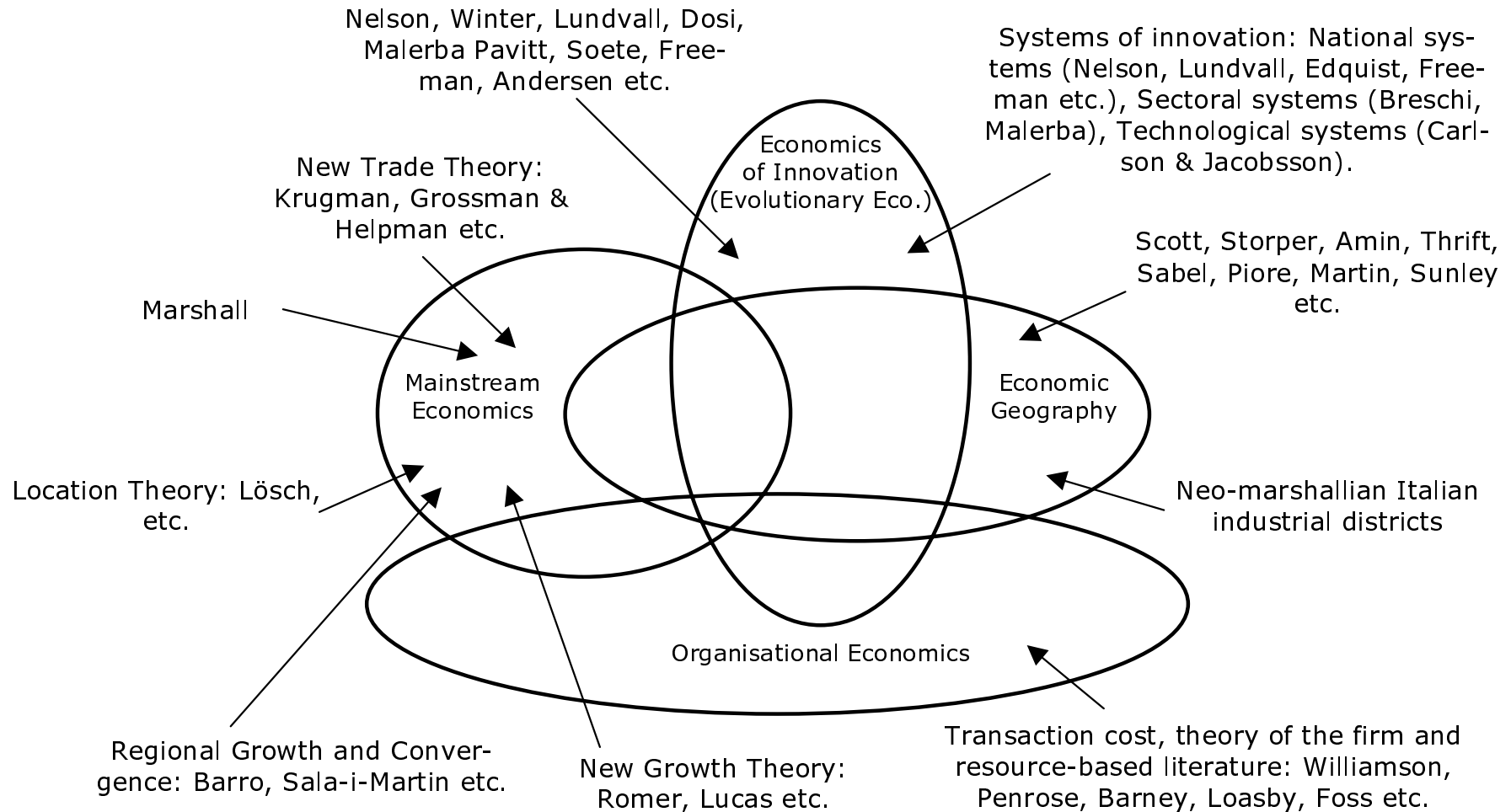
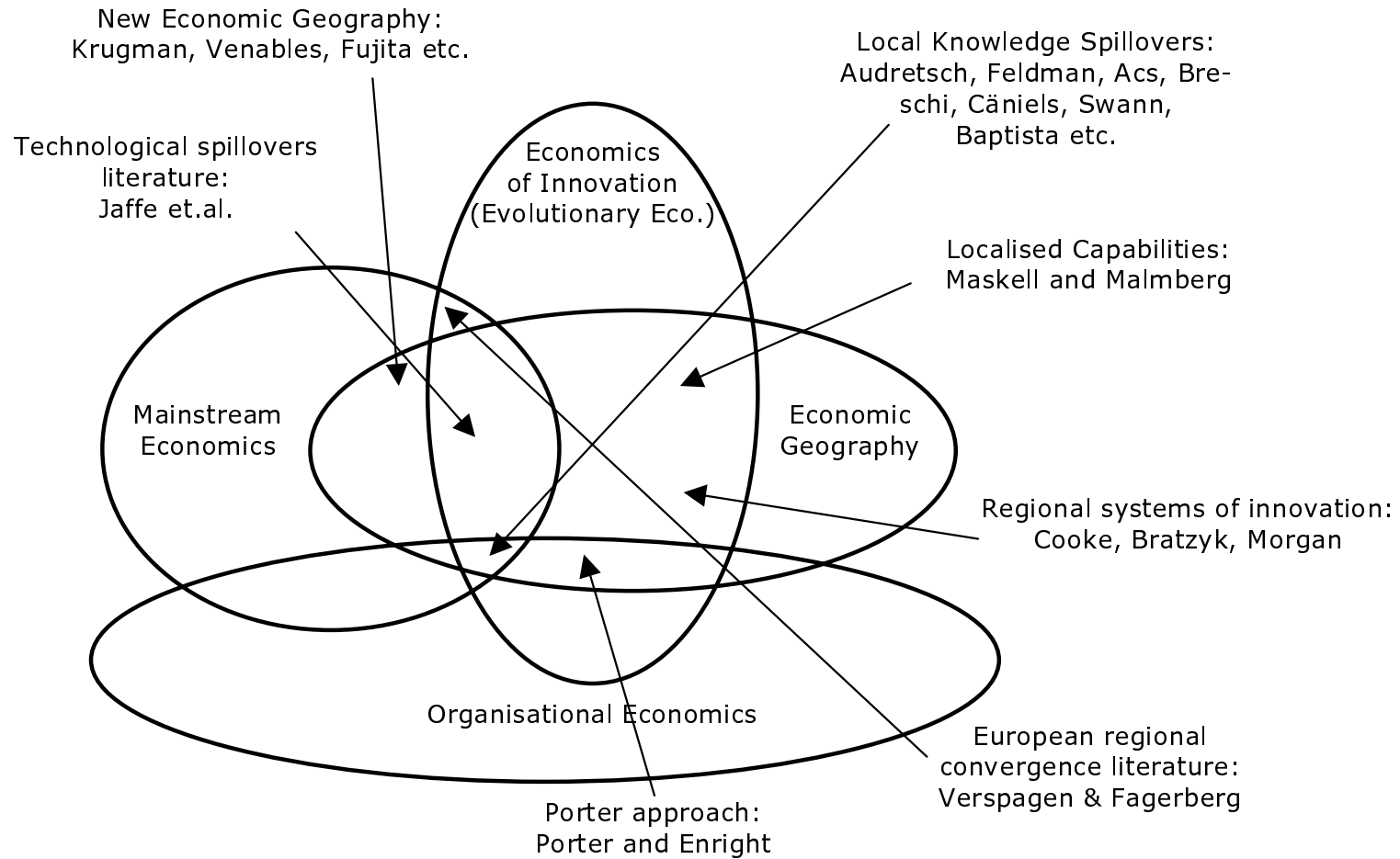


Figure 2: The overlapping framework



5 Concluding remarks

To be written ...

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