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From Specialisation to Diversification in Science and Technology Parks

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Abstract : Science and technology parks have been popular among policy-makers at several spatial levels to promote innovation and economic growth of certain localities. However, this mainly property-led policy tool has been criticised for two reasons. First, it often failed to successfully support regional networking and technology transfer to regional firms. Only unplanned science and technology parks, such as Silicon Valley, seem to have been successfully fostering regional networking and technology transfer which has led, in turn, to the development of competitive innovative clusters. Secondly, it has too often bet on the same horses and become too specialised in the same fields, such as in micro-electronics or in biotechnology. This specialisation has been theoretically supported by the cluster concept. It has led to both a zero sum game of competition between locations as well as potentially negative path dependence and lock-ins. This paper suggests increasingly supporting diversification in science and technology parks by bringing together hitherto unconnected technologies. Several recently discussed concepts could be used to support diversification, such as related variety (Frenken et al. 2007), regional branching (Boschma and Frenken 2011), regional innovation platforms (Harmaakorpi et al. 2011) and transversality (Cooke 2011).

Keyword : Science and technology parks, regional innovation policy, clusters, diversification concepts

1. INTRODUCTION

In the 1990s, science and technology parks, a land and property-led technology policy concept which aims at spatially clustering high-tech firms and R&D organisations, have been very popular among local, regional and national policy-makers to boost regional economic growth. No matter how they are called, be it science parks, technopoles, high-tech centres, incubator centres, technology parks, technoparks or science cities, they have given hopes to policy-makers in many countries to boost regional technology transfer, innovativeness and hence competitiveness. Many detailed studies have been done both on science and technology parks in individual countries such as the USA (Luger and Goldstein 1991), Japan (Bass 1998) and Germany (Sternberg et al. 1996) and on science and technology parks in an international comparative perspective in order to find some lessons that could be learned from successes and failures (Castells and Hall 1994) (for a good overview on Science and Technology Parks see OECD 2011, Chapter 6.1 (Table 1.)).

Although there are large variations among science and technology parks in different countries (Anttiroiko 2004), broadly speaking, they aim at achieving three goals. First, the most obvious goal is to foster economic development. High-tech and innovation-led growth is regarded as absolutely necessary for maintaining and increasing competitiveness of firms, regions and nations (Malecki 1997). Secondly, in some countries, particularly those with over-populated and congested urban areas, building an out-of-the-way science and technology park in the countryside is often seen as a way to reduce regional economic inequalities (see for instance Tsukuba in Japan, Daedeok in South Korea and technopoles in France). This kind of 'dirigiste' or mission-oriented regional policy is based on the growth pole concept and can only

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Table 1. Science cities: an international comparison.

	Science cities	Daedeok	Silicon Valley	Zhong-guancun Science Park	Hsinchu Science Park	Tsukuba	Kista	Oulu
	United Kingdom[1]	Korea	United States	China	Chinese Taipei	Japan	Sweden	Finland
Green-field Location		◉	○		◉	◉		
Regional development goals	◉	◉			◉	◉		◉
Dominant national role		◉		◉	◉	◉	◉	
Dedicated public investment		◉		◉	◉	◉	◉	
National programme	○				◉			
Major research institutions	◉	◉	◉	◉	◉	◉	◉	◉
National R&D leader			◉	◉		◉	◉	
Partnership models	◉		○		◉		◉	◉
Flexible network models	○		◉	○	○		○	○
Orientation to innovation	◉	◉	◉	◉	◉	○	◉	◉
"New Argonaut" links			◉	◉	◉			
Strong venture capital Presence			◉					
Public science education	◉							

Notes: 1) Northern England Science Cities of Manchester. Newcastle, York; 2) ◉ = Strongly present; ○ = partially present. More ◉s or ○s denotes that more factors are present, not that more factors lead directly to better outcomes.
Source: OECD 2011, 196.

be found in countries with powerful central governments (Cooke and Morgan 1998). Thirdly, science and technology parks aim at creating synergy between higher education institutes (HEIs), public research establishments (PREs) and firms in order to foster technology transfer, innovation and hence competitiveness. In the end, this should lead to creating an environment geared toward innovation.

Although creating synergy and fostering technology transfer and networking both among firms and between firms and HEIs and PREs in the region is an important goal of science and technology parks, the failure to achieve this goal is at the same time one of their largest weaknesses. The main reasons for this lack of technology transfer and networking are the following. First, because science and technology parks are a property-based initiative, a great deal of their management is property related and puts much emphasis on marketing and image instead of promoting networking on the spot. Secondly, since the technology-push philosophy (linear model of innovation) prevailed at many science and technology parks of the first generation, they often lack explicit technology transfer instruments. Thirdly, in some larger science and technology parks in peripheral areas, externally controlled branch plants dominate, which have few links with local suppliers and lack the R&D base necessary for collaboration with local HEIs and PREs. According to Castells and Hall (1994) it is not sufficient to simply provide the networks in a physical sense at science and technology parks, it is also necessary to take definite steps to open up the social networks and break down barriers to networking.

Another main weakness, particularly with science and technology parks planned by central governments, is that science and technology park plans are often over-ambitious and focus on a too broad range of technologies and industries. Planners often forget that different science and technology park policies are appropriate to different levels of regional development (Castells and Hall 1994). At lower development levels, relatively modest technology parks will be perfectly appropriate. Particularly in the latter case, it is necessary to concentrate on one or two target areas or niches that are best adapted to local needs and facilities such as regional HEIs, PREs, industrial traditions, entrepreneurial capacities and political leadership in the region.

Now at the beginning of the 21st century, there is a debate going on about whether the concept has reached some point of saturation, particularly in industrialised countries such as the USA (Luger and Goldstein 1991), Europe (Komninos 1997) and Japan. In these countries, therefore, science and technology parks are certainly in the maturity or even declining phase of their life cycle. Annerstedt (2006, 279), however, has a contrasting view, as he states that "over the last 10

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years, with the promotion by policy makers of specialized, local 'clusters' of firms and supporting institutions as strategic means for industrial policy, science parks have come back into the limelight of the centre stage for industrial policy deliberations." According to him, the current generation of science and technology parks can be regarded as the third generation (see also OECD 2011). The first generation of science and technology parks which was established in Europe in the early 1960s was mainly located in suburban areas and used the innovation philosophy of science push and the linear approach. The second generation remained an extension of a university (or other R&D facility) into a dedicated high-tech zone, but the innovation philosophy had more of a market pull character. The third and most recent generation of science and technology parks has, according to Annerstedt (2006), cluster-oriented interactive innovation as its innovation philosophy and is, much in contrast to the previous generations, embedded in the urban environment. Moreover, it has a wider range of stakeholders and is therefore more difficult to manage and to evaluate (OECD 2011).

This paper pleads for increasingly supporting diversification in science and technology parks with the help of several recently discussed concepts. In Section 2 the focus will first be on clusters, in Section 3 on science and technology parks seen in a broader framework of regional innovation policies and in Section 4 the focus will be on these newer concepts stressing the diversification and synergy effects that can be achieved in bringing hitherto unconnected industries and technologies together.

2. CLUSTERS

Much literature has been written about the positive sides of the geographical clustering of industries, such as in the work on the rise of new high-tech regions, industrial districts and regional production clusters in North America and Western Europe (Malecki 1997; Porter 1990, 2000). Most authors have tried to come up with explanations for the rise of these regions in order to contribute to regional economic development theories and to learn policy lessons from these success stories for other regions. Economists have been dealing with the question why internationally successful industries tend to concentrate in a few nations or regions (Porter 1990, 2000). More recently, the evolutionary school of technological change takes, unlike neoclassical theory, routines, history and geography seriously by recognizing the importance of place-specific elements and processes to explain broader spatial patterns of technology evolution. This school regards the mutual relations between innovations, firms and the political and socio-institutional forces as conditions for an optimal diffusion process and thus for economic growth. Closely related to the evolutionary school are the concepts of regional innovation systems and the learning region (Cooke et al. 2006), concepts stressing the importance of linkages between firms and other organisations in order to promote benefits from geographic clustering. They see regional 'governance' structures or institutions as an essential element for supporting innovation. These explanations share with each other the focus on the origin and development of innovation and the significance of industrial organisation and inter-firm linkages for regional competitiveness and regional innovation processes. Most of them belong to the family of so-called territorial innovation models (Moulaert and Sekia 2003).

Thus, geographical 'clustering' of firms in related industries and its implications for regional development have been debated for a long time now (Cumbers and MacKinnon 2004). There have been intensive discussions about the extent of clustering at a regional level and the potential economic benefits that might be generated by clustering. It is well-known that the spatial co-localisation or 'clustering' of firms and other organisations in related industrial sectors has potential for economic and innovation benefits. These benefits have been labelled variously as 'external economies of agglomeration,' which support the co-operative and competitive relationships between firms and enables the effectual development and manufacture of products. Storper (1997) argues that traded interdependencies may be based on upstream and downstream linkages between buyer and supplier firms, and untraded interdependencies include resource base, skills, technologies and governance agencies. Proximity is said to provide the social solidarity and trust, the face-to-face contact and the pool of skills and know-how.

Although many authors assume there are economic and innovation advantages from geographic clusters, there are also arguments which appear to run counter to the 'benefits from localisation' thesis (Enright 2003). Potential disadvantages lie in labour cost inflation, inflation of land and housing costs, widening of income disparities, local congestion, environmental pressure, over-specialisation and last but not least lock-ins (Martin and Sunley 2003). Among the potential lock-ins that might emerge in clusters are functional lock-ins (hierarchical inter-firm relationships), cognitive lock-ins (a collective mindset in a cluster that might confuse secular trends with cyclical downturns) and political lock-ins (thick institutional tissues aiming at preserving existing traditional industrial structures and therefore unnecessarily slowing down industrial restructuring and indirectly hampering the development of indigenous potential and creativity) (Hassink 2010).

There are other important spatial dimensions, including the national and international arenas, which may influence the extent to which geographical clustering occurs. The geographical pattern of local industrial innovation activity should be seen in the context of national and international forces. For example, the role of the 'national system of innovation,' in shaping firms' innovation activities and capabilities, has been discussed extensively. Economic and innovation benefits may arise for firms which belong to the same national system due to short geographical distance, common language and social organisation, and cultural proximity. There may be an important role for national 'governance' institutions such as national state structures and strategies, as well as other organisations such as networks of national research organisations and universities. This, indeed, may support and enhance local innovative activities and capabilities, but as part of the 'national system of innovation' (OECD 2001). In turn, increasing regionalisation tendencies are overlaid by an increasingly intensified global division of labour (Bathelt et al. 2004). Based on 'global' information and communication trends together with new forms of global governance, institutions and strategic alliances, spatial proximity may be unnecessary. There are authors who suggest that globalisation may, however, reinforce the presence of geographic clustering, where regional economies represent important areas of specialisation (Storper 1997).

Although there are many definitions of clusters (see for instance Martin and Sunley 2003) they boil down to a group of firms in one location (co-location) that have a competitive advantage in innovation due to co-operation, collaboration, competition, networking, trade associations and lobbying (Benneworth et al. 2003).

Martin and Sunley (2003) are very critical about the ambiguities and identification problems surrounding the cluster concept. In fact, the concept bears many characteristics of what Markusen (1999) has coined a fuzzy concept, which is characterised by both lacking conceptual clarity, rigour in the presentation of evidence and clear methodology and difficulties to operationalise. One, in our view useful, solution to solve these problems is to look at different dimensions of clusters and to use a typology of clusters based on development stages. By doing this we put the cluster in an evolutionary perspective.

Different dimensions of clusters include (Enright 2003): the geographical scope of clusters, the density (dense vs. sparse clusters), breadth of clusters (broad vs. narrow), the depth of clusters (shallow vs. deep clusters), the geographical span of sales (from local to global), the strength of competitive position, the innovative capacity, the ownership structure and last but not least the stage of development. The latter point refers to a life cycle of clusters, going from embryonic to emerging to mature and declining stages (see also Menzel and Fornahl 2009). Related to this typology of the stages of development, clusters also vary in terms of their level of activity and self-realisation (Enright 2003). Working clusters are those in which critical masses of local knowledge, personnel and resources create agglomeration economies from which local competitors, suppliers, customers and institutions benefit. Latent clusters have a critical mass of firms in related industries but have not yet developed the level of interaction necessary to benefit from co-location. Potential clusters have some elements, but they need to be deepened and broadened. Policy-driven and "wishful thinking" clusters clearly lack critical mass and have a very thin foundation on which a cluster should be built. Unfortunately, there are too many of these wishful thinking clusters, as well as wishful thinking science and technology parks, coined as Silicon Somewheres by Hospers (2006).

On the basis of theoretical thoughts on geographic clustering by Porter (2000) and Enright (2003), a rapidly increasing number of policy initiatives to support clustering of industries has been emerged in many countries of the world (see for instance Porter 2000; Fromhold-Eisebith and Eisebith 2005; Asheim et al. 2006). Cluster policy initiatives seem to be relevant to support and shape new forms of industrial organisations. Clusters, therefore, like regional innovation systems and learning regions, seem to be an empirical and theoretical basis for newly oriented regional innovation policies.

Given the fact that one can find cluster policies in nearly all industrialised countries, there is a large variety in these kinds of policy initiatives (Fromhold-Eisebith and Eisebith 2005). They differ in the type of government intervention from non-existent to catalytic (bringing interest parties together without much support and direction), to supportive (catalytic plus cluster-specific investments in infrastruc-

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ture, education and training), to directive (supportive plus more directive targeted programmes), to interventionist (government making the major decisions about the evolution of the cluster rather than the private actors) (Enright 2003). Fromhold-Eisebith and Eisebith (2005) distinguish between explicit top-down and implicit bottom-up cluster initiatives. There are also strong differences in the level of government that is involved, although in most large industrialised economies it is the local and regional governments that are mostly involved in cluster support (Enright 2003). A potential danger of regional cluster policy is that by supporting specialisation, negative lock-ins might emerge that hinder timely adaptation to changing external circumstances.

3. REGIONALISATION OF INNOVATION POLICY

Clusters and science and technology parks should clearly be understood as part of a larger array of regional innovation policy initiatives. According to Cooke (2001, 22): "··· there is emerging recognition that science parks are a valuable element but not the only or main objective of a localised or regionalised innovation strategy." The position of science and technology parks in these wider regional innovation policies, however, differs from country to country, depending on their relative importance compared with the other elements of these policies, that is technological financial aid schemes, the innovation support infrastructure and cluster support initiatives (Enright 2003). In Japan and South Korea, where we can find large-scale science and technology parks devised and partly financed by central government, they seem to have a more prominent position in regional innovation policies than in Germany and many other countries in Europe. In Europe, science and technology parks are not frequently mentioned neither in support programmes of the European Union nor in the theoretical development concepts which have been currently developed by Western European scholars (Cooke et al. 2006). Science and technology parks, however, can and should be integrated in these policy programmes and development concepts. However, no matter what position they have in wider regional policies, in all industrialised countries the dispersed networks of demand-oriented innovation support agencies (software) and the spatially constrained, property-led, supply-oriented science and technology parks (hardware) seem to be quite separated from each other.

Also the popularity of the concept of clusters is closely related to the surge in regional innovation policies in many industrialised countries of the world. This is due to the fact that the importance of the regional level is increasing with regard to diffusion-oriented innovation support policies (Amin 1999; Cooke and Morgan 1998; Asheim et al. 2003; Fritsch and Stephan 2005). Central governments, however, keep their key role in supporting basic, pre-competitive technologies, which have spill-over effects that go far beyond the borders of regions. Partly supported by national and supranational support programmes and encouraged by strong institutional set-ups found in successful regional economies such as Baden-Württemberg in Germany and Emilia-Romagna in Italy, many regions in industrialised countries have been setting up science and technology parks, technological financial aid schemes, innovation support agencies, community colleges and initiatives to support clustering of industries since the second half of the 1980s. The central aim of these policies is to support regional endogenous potential by encouraging the diffusion of new technologies both from universities and PREs to small and medium-sized enterprises (SMEs), between SMEs and large enterprises (vertical co-operation) and between SMEs themselves (horizontal co-operation). Intermediary innovation support agencies are considered to be the core of regional innovation policies.

This increasing importance of regions for innovation policy can be considered as the outcome of a converging of regional and technology policy since the early 1980s (Fritsch and Stephan 2005). These two policy fields converged into regional innovation policies since their aim became partly the same, namely supporting the innovative capabilities and thus competitiveness of SMEs. It also fits into what Amin (1999) observed as a shift from a firm-centred, incentive-based, state-driven and standardised regional economic development policies to bottom-up, region-specific, longer-term and plural-actor policies. These policy trends cannot only be seen in European countries, but also in North America and some countries in Asia (Cooke et al. 2004). Although we can therefore speak of a general phenomenon, there are of course large differences between individual regions and countries concerning the extent to which these trends take place. Generally, factors contributing to regional innovation policies are a federal political system, decentralisation, strong regional institutions and governance, a strong industrial specialisation in the region, socio-cultural homogeneity and thus relationships of trust, large economic restructuring problems and a strong commitment of regional political leaders.

One of the main strengths of the regional level for innovation support has been called the “garden argument” (Paquet 1998): if the economy is regarded as a garden with all kinds of trees and plants, for the gardener (government) there is no simple rule likely to apply to all plants. Growth is therefore best orchestrated from its sources at the level of cities and regions. At this level, rather than at the national level, policy makers can better tailor policy to demand (Nauwelaers and Wintjes 2003). Regionalisation, therefore, allows for differentiation in policies, which is necessary because of differing regional economic conditions and thus different support needs of industries and firms. Regionalisation also raises the enthusiasm and motivation of regional policy makers, as they are now able to devise “their own” policies. Moreover, because of the large variety of institutional set-ups and initiatives in Europe and North America, these laboratories of experimentation offer both national and regional policy makers plenty of institutional learning opportunities (Hassink and Lagendijk 2001).

Closely related to this “garden argument” is the positive relationship between institutional embeddedness in regions, entrepreneurial learning processes and competitiveness (Cooke and Morgan 1998). For their competitiveness firms depend on innovation processes. In order to come to such innovation processes firms have to exchange information and reproduce this information into knowledge, in other words they have to learn. Due to an increasing cut-throat competition and shorter product life cycles, firms, particularly SMEs, are increasingly dependent on information and knowledge sources that are only available outside the firm. Firm innovation processes therefore increasingly take place in interaction with other organisations, be it with other business partners, such as customers, suppliers or competitors or with public research establishments, higher education institutes, technology transfer agencies and regional development agencies. Innovation processes hardly ever take place in isolation any more. Innovations can thus be understood as manifest results of cumulative learning processes of firms. The spatial environment provides different institutional contexts for interactive learning. These contexts differ not only nationally, but also regionally and locally from each other. Firms are therefore institutionally embedded in different contexts for interactive learning. Spatial proximity stimulates communicative interaction between actors. However, it is not a sufficient condition. In order to achieve this interaction social proximity (equal or similar characteristics such as age, vocation, language and equal or similar views on values and norms) and organisational proximity (concern structure, intra- and inter-firm network structures) are necessary factors as well. The knowledge form determines to what extent proximity is necessary for learning by interacting. Typically, innovation-relevant information is not a publicly available, codified good, but private tacit knowledge - those parts of personal knowledge as well as personal skills that cannot be communicated in an impersonal way. Only through personal, communicative interaction between actors there are possibilities to exchange, understand and to apply this kind of information. In order to communicate, tacit, and to a lesser extent codified knowledge 'code keys' are needed, which are only understandable if (social) coherence and proximity are available. Thus institutional embeddedness in regions positively affects the communication of tacit knowledge in particular and learning by interacting in general, which in turn is positive for competitiveness. Collective learning processes and a collective tacit knowledge are linked to the location because of the coinciding of social, cultural and spatial proximity. At the same time, however, Bathelt (2003, 772) stresses that one should not forget the role of the non-local for competitiveness: “In addition to mobilizing internal resources, regional policies should also support agents in developing linkages and networks with external agents and markets … Caution should … be exercised in prioritizing the local capabilities over non-local opportunities.”

Since regional innovation policies have been emerging in the mid-1980s, several academics have started to develop theoretical and conceptual ideas on regional innovation strategies (Lagendijk and Cornford 2000). These concepts, which form an important part of the family of territorial innovation models (Moulaert and Sekia 2003; Cooke et al. 2006), that is regional innovation systems, the learning region and clusters have been partly developed for policy reasons, namely as a response to organisational and strategic weaknesses of regions. Scholars also wanted to derive conceptual policy lessons from successful regional economies and to clarify why the regional level is an important level as a source for learning and innovation.

Thus science and technology parks and clusters are part of a wider regional system of innovation, in which firms and other organisations, such as research institutes, universities, innovation support agencies, chambers of commerce, banks, government departments are systematically engaged in interactive learning through an institutional milieu characterised by embeddedness (Fig. 1.). In such a regional system of innovation one can often find more than one cluster and science and technology parks are regarded as part of the technology transfer infrastructure (in Fig. 1. science and technology parks are called technology parks). Even within one science and technology park, there can be several clusters; Komninos (2005) writes about multi-cluster technopoles in France, for instance.

Lester (2005), the leader of a large international research project on local innovation systems, has developed an inter-

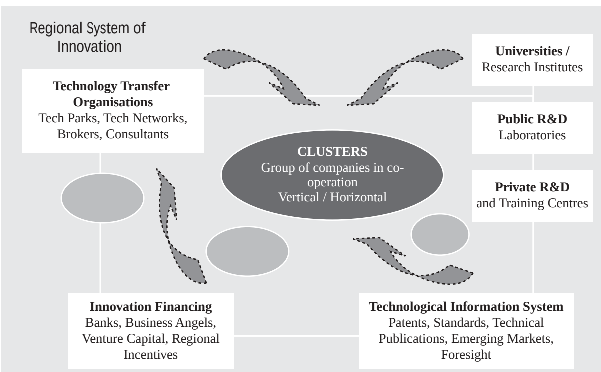

Fig. 1. Position of clusters in regional systems of innovation.
Source: Komninos 2005

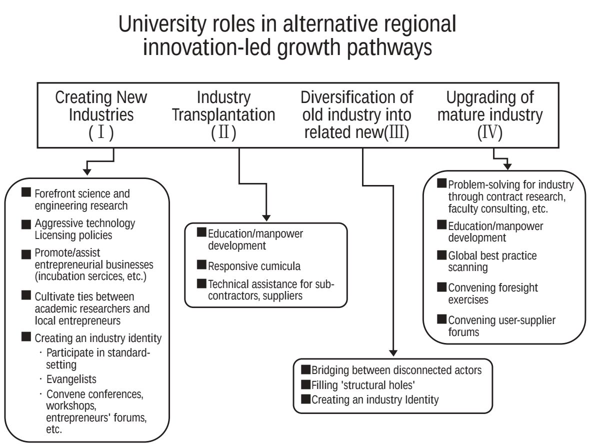

Fig. 2. Typology of industrial transformation and the role of universities.
Source: Lester 2005

esting typology of industrial transformation, consisting of creating new industries, industry transplantation, diversification of old industry into related new and upgrading mature industry (see Fig. 2.). This typology of industrial transformation is used to describe, analyse and compare the 23 case-studies in the USA, Finland, the UK, Taiwan, Japan and Norway. In most of the described cases, universities, cluster policy initiatives and science and technology parks played an important role in realising the transformations.

4. NEWER CONCEPTS EMPHASISING DIVERSIFICATION

Science and technology parks have too often bet on the same horses and become too specialised in the same fields, such as in micro-electronics or in biotechnology. This specialisation has led to both a zero sum game of competition between locations as well as potentially negative path dependence and lock-ins. Recently several concepts are discussed in the literature to point at the innovative potential of bringing together hitherto unconnected technologies. Examples are related variety (Frenken et al. 2007), regional branching (Boschma and Frenken 2011), regional innovation platforms (Harmaakorpi et al. 2011) and transversality (Cooke 2011). These concepts are potentially useful to foster synergy effects in science and technology parks.

First, variety is increasingly seen as a source of regional knowledge spill-overs, measured by related variety within sectors. On the other hand, in the case of unrelated variety, variety is seen as a portfolio protecting a region from external shocks (Frenken et al. 2007). According to Martin and Sunley (2006: 421) "there is a trade-off between specialization and a short-lived burst of fast regional growth on the one hand, and diversity and continual regional adaptability on the other." In most regional economies, however, the situation is rather complex, as "··· various networks and structures of interrelatedness can emerge between different sectors and activities within a region, thus suggesting the possibility of what we might call 'path-interdependence,' that is situations where the path-dependent trajectories of particular local industries are to some degree mutually reinforcing. The extent and significance of this interlinking path effect is a key issue for further research."

Secondly, in a very similar vein Boschma and Frenken (2011) refer to regional branching. Mechanisms through which this occurs include regional entrepreneurship, firm diversification, spin-offs and labour mobility. According to Boschma and Frenken (2011, 191) "countries and regions have a different capacity to diversify successfully into related activities, depending on the degree of related variety: the higher the number of related industries in a region, the higher the number of possible recombinations, and thus the higher the probability that regions will diversify successfully into related products (Boschma and Frenken 2011, 191). "

Thirdly, also closely linked to the concept of related variety are regional innovation platforms (Harmaakorpi et al. 2011). According to Harmaakorpi et al. (2011, 563) "the dynamic of regional development or innovation platforms lies in the logic of urbanization economies that emphasizes the power of related variety" and "platforms often emerge from very unorthodox combinations that exploit related variety" (Harmaakorpi et al. 2011, 564). It is much more focused on future trajectories than the cluster model. In many other ways the related variety-oriented regional innovation platform model is opposed to the agglomeration- and specialisation-oriented cluster model, such as concerning the network morphology, the role of social capital, knowledge creation, modes of innovation and location and urbanisation economies.

Fourthly, transversality, in turn, has close relations to regional innovation platforms (see Cooke 2011). According to Cooke (2011, 303) "leading exponent innovation policy agencies [such as Bayern Innovativ in Germany] can be found investing in 'transversality' between industries in pursuit of innovative cross-fertilization or cross-pollination that support business and other kinds of institutional innovation." Cooke (2011, 309) sees some clear shift from cluster to new kind of policies stressing related variety: "traditional sector and cluster policies reached a point in their evolution where significant growth or employment gains were less forthcoming that previously thought likely or experienced … accordingly, some innovative regional policy regimes … began exploring the innovative potential of horizontal interactions among different regional and extraregional sectors or clusters."

5. CONCLUSION

This aim of this paper was to critically analyse whether the cluster concepts as well as newly developed theoretical concepts can bring success to the third generation of science and technology parks and whether they can help to tackle the problem of lacking technology transfer and networking. Cluster policy planned and implemented in a realistic way can upgrade science and technology parks and cities in such as way, that they can become important contributors to industrial transformation. Intelligent and realistic cluster policies therefore are an absolute must for policy-makers aiming at upgrading their science and technology parks into the third generation (Annerstedt 2006). With the help of these policies science and technology parks can also avoid to be stuck in the first and second generation, with the danger to end up as a Silicon Somewhere (Hospers 2006). Intelligent and realistic cluster policies involve sound assessments of network and cluster potential in the local and regional economy surrounding science and technology parks, as well as careful monitoring of the international competitive environment of the cluster activities by the cluster policy-makers. Using a typology of clusters is useful in monitoring the development of the cluster over time and in devising cluster support policies that are appropriate to the given stage of development.

Moreover, the policy combination of science and technology parks and cluster policies needs to be integrated in wider regional innovation policies and strategies. These strategies should be based both on thorough and in-depth studies of the strengths, weaknesses, opportunities and threats of the regional economy and firms' production environment and on the national and supra-national institutional framework. Only if the establishment of science and technology parks are based on these kind of studies, they are able to focus both on the demand for technologies among local firms and on cluster niches in the regional production structure. In this way the development of supply-oriented science and technology parks based on the linear model of innovation can be avoided. Therefore, this paper strongly endorses the argument for a differentiated regional innovation policy put forward by Tödtling & Trippl (2005). They (2005, 1203) state that "there is no "ideal model" for innovation policy as innovation activities differ strongly between central, peripheral and old industrial areas." Careful design of innovation support systems guarantees a good fit between the development stage of science and technology parks and the innovation support system in which they are embedded. Since each country is at a different development stage, science and technology parks will accordingly be at different positions in their policy life cycle (and thus of different generations, as well): at the end of their life cycle in Japan, Germany and for instance Finland, at earlier stages in emerging economies. Science and technology parks in industrialised countries, therefore, need to be embedded in other regional innovation support systems than science and technology parks in emerging economies. Realistically planned and successfully implemented cluster policy can upgrade science and technology parks and cities in such as way, that they can become important contributors to industrial transformation at the local and regional level. In such a way intelligent and well-thought-through cluster policies aimed at industrial transformation can extend the life cycle of science and technology parks in industrialized countries into the third generation.

However, the recently developed theoretical concepts (related variety, regional branching, regional innovation platforms and transversality) stressing the need for diversification in order to achieve synergy effects at the local and regional level show even more promising post-cluster avenues for the future of science and technology parks. Since these concepts are not yet investigated in the framework of science and technology parks yet, future empirical research is needed in a quantitative and qualitative way in order to both test these concepts in that context and to give sound policy recommendations on how to diversify science and technology parks.

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