Evolutionary economic geography and its implications for regional innovation policy

Ron Boschma

University of Utrecht
Faculty of Geosciences
Department of Economic Geography
PO Box 80 115
3508 TC Utrecht
e-mail: r.boschma @ geo.uu.nl
homepage: http://econ.geog.uu.nl/boschma/boschma.html

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Abstract

Related variety is important to regional growth because it induces knowledge transfer between complementary sectors at the regional level. This is accomplished through three mechanisms: spinoff dynamics, labor mobility and network formation. They transfer knowledge across related sectors, which contributes to industrial renewal and economic branching in regions. Since these mechanisms of knowledge transfer are basically taking place at the regional level, and because they make regions move into new growth paths while building on their existing assets, regional innovation policy should encourage spinoff activity, labor mobility and network formation. Doing so, policy builds on region-specific assets that provides opportunities but also sets limits to what can be achieved by policy. Public

intervention should neither apply 'one-size-fits-all' approaches nor adopt 'picking-the-winner' strategies, but should aim to connect complementary sectors and exploit related variety as a source of regional diversification.

Key words: related variety, evolutionary economic geography, regional innovation systems, regional growth

1. Introduction

Why do some regions grow more than others? Till the late 1980s, neo-classical theory argued that technology is a key determinant of regional growth. However, technology was treated as an exogenous factor and, therefore, the geography of innovation was left unexplained (Alcouffe and Kuhn, 2004). Inspired by Schumpeter's work, economic geographers played a prominent role in criticizing this neo-classical framework. From the early 1980s onwards, they focus attention on the explanation of the geography of innovation. Some regions are more innovative than others, and region-specific characteristics like institutions may be underlying forces. This even led to the claim that regions are drivers of innovation and economic growth. Concepts like industrial districts (Becattini, 1987), clusters (Porter, 1990), innovative milieux (Camagni, 1991), technology districts (Storper, 1992), regional innovation systems (Cooke, 2001) and learning regions (Asheim, 1996) have been launched in the last decades to incorporate this view.

Many of these regional concepts have drawn inspiration from evolutionary economics (Nelson and Winter, 1982; Dosi et al., 1988). This chapter aims to outline the drivers of regional growth, as proposed by evolutionary economic geographers (Boschma and Lambooy, 1999; Boschma and Martin, 2007). We claim that regional growth is based primarily on exploiting intangible assets such as tacit knowledge and institutions, rather than static cost advantages. More in particular, we will argue that related variety may be a key source of economic diversification of regions. The objective of this chapter is to set out how these insights taken from evolutionary economic geography may be incorporated in regional innovation policy. This is anything but easy. Wegner and Pelikan (2003) state that evolutionary economics consists of two distinctive strands of thought, that is, the neo-Schumpeterian (Nelson and Winter) and the Austrian approach (Hayek), which hold quite diverging views on policy. While the former advocates active government intervention, the latter does not. Another problem is that the empirical literature on regional policy tends to be

rather fragmented and inconclusive (see e.g. Brons, et al., 2000; Nijkamp and Stough, 2000). An obvious reason is that we do not know what would have happened if policy had not been installed. Notwithstanding these difficulties, we come up with some policy recommendations that incorporate recent thinking in evolutionary economic geography.

The chapter consists of two parts. The first part deals in a brief manner with the drivers of regional growth. A brief and selective literature review is given in Section 2, providing a background for the second part of the paper that discusses policy implications. Instead of relying on market failure arguments, we claim in Section 3 that system failures should be taken as a point of departure to underpin regional innovation policy. Section 4 explains how the regional context provides opportunities but also sets limits to the degrees of freedom governments may have to pursue effective policy. What is essential to recognise is that regional history determines available options and probable outcomes of regional innovation policy. In Section 5, we sketch out some policy options that might effectively impact on the drivers of regional growth. We provide examples of how policy may direct regional economies into new directions when building on related variety. In doing so, we direct attention to three mechanisms (spinoff process, networks, labour mobility) through which knowledge is effectively transferred between organizations at the regional level, and we explain how policy might facilitate these mechanisms. Section 6 draws the conclusions.

2. Variety, related variety and regional development

Our starting point is a fundamental departure from how conventional neo-classical economics treats knowledge. Knowledge is not a public good that is characterized by diminishing returns to scale. On the contrary, knowledge evolves: it is not reduced when it is used, but it accumulates through processes of learning-by-doing (Arrow, 1962). This cumulative and irreversible nature of knowledge development is embodied in individuals (skills) and in firms (routines): they develop different cognitive capacities over time (Nelson and Winter, 1982; Dosi et al., 1988). Due to its tacit and cumulative nature, knowledge is actor-specific and difficult, if not impossible, to copy or imitate by other actors. This implies that a firm can at least capture some benefits of its own investments in Research and Development (Romer, 1990; Aghion and Howitt, 1992). Consequently, variety in an economy is the rule, and knowledge accumulation at the level of individuals and firms is its prime mover.

There is increasing awareness that variety of knowledge may be a key driver of economic growth (Saviotti, 1996). In urbanized regions, one can observe a high degree of variety. Following Adam Smith, a huge market size enables firms to specialize in activities they can do best, enhancing their productivity levels. As a result, the economies of urbanized regions are often characterized by a sharp division of labor between specialized firms that sustains urban growth (Pred, 1966; Scott, 1983). Intra-urban variety may also induce knowledge spillovers between local firms and trigger new ideas, providing additional growth in cities. Jacobs (1969) claimed that diversified urban economies provide fertile environments in which different pieces of knowledge are recombined in novel ways, leading to new ideas and innovations. Neffke et al. (2009) have demonstrated that diversified regions support young and rejuvenating industries that are in a stage of experimentation.

Knowledge also tends to accumulate in space, leading to inter-regional variety of knowledge. There are many examples of regions and countries that specialize in a particular knowledge field, and which continue to do so for a long time. Many industries tend to concentrate in space, like the film industry in Hollywood, the financial sector in the city of London, and the American car industry in Detroit[1]. There are also huge differences between countries and regions as far as investments in R&D and human capital are concerned, leading to persistent income differentials between countries over time (Grossman and Helpman, 1991). Research and Development is extremely spatially concentrated, favoring only a small number of regions, and empirical studies show this pattern is quite stable over time (Feldman and Audretsch, 1999). Many studies have found strong relationships between regional stocks of knowledge (as embodied in university research and private R&D) and economic performance (e.g. Anselin, Varga and Acs, 2000).

However, it is not necessarily the case that places of knowledge creation and places of innovation overlap. The European paradox is often mentioned as a prime example. While Europe excels in basic research (i.e. R&D levels and patenting activity are quite high), Europe has problems to exploit new knowledge economically and turn it into innovations, in contrast to the US. So, the geography of knowledge creation and innovation may be characterized by an extensive spatial division of labor, with some places specializing in knowledge creation, other places turning new knowledge into innovations, and again other places focusing on the manufacturing of new products. For instance, R&D in the Dutch electronic industry is quite

[1] In the early twentieth century, Marshall attributed the spatial clustering of industries to specialized labour markets, local access to specialized suppliers and large markets, and the presence of local knowledge spillovers.

heavily concentrated in the Eindhoven region, while the outputs of the R&D (i.e. new electronic products) are produced all over the world.

Previously, we stated that knowledge tends to accumulate in individuals and firms, so why in regions? One reason is that knowledge will spill over to other firms now and then. When it does, it tends not to travel over very large geographical distances. This means that not only the firm itself, but other firms may benefit from the accumulation of knowledge and human capital. This may result in increasing returns to scale that is external to the firm (Shaw, 1992). Empirical studies confirm that knowledge spillovers are often geographically localized: spillover effects become weaker the higher the distance from the knowledge source (Audretsch and Feldman, 1996).

This is not to say that geographical proximity is a prerequisite for knowledge diffusion and innovation. Boschma (2005a) claims that geographical proximity is neither a necessary nor a sufficient condition for interactive learning and innovation. This happens only when other barriers of knowledge diffusion are overcome, such as cognitive, social and institutional distance. These forms of proximity need to be secured between actors in order to make them connected, and to enable effective knowledge transfer. These other forms of proximity may even act as a substitute for geographical proximity. For instance, social proximity may provide a vehicle to connect agents and enable knowledge flows over large distances, because these agents share a past as former schoolmates or former colleagues working for the same organization (Agrawal et al, 2006). Nevertheless, effective knowledge transfer may still be geographically localized when geographical proximity indirectly impacts on the establishment of the other forms of proximity. For instance, geographical proximity may encourage the creation of trust-based relationships that facilitate knowledge transfer between local agents (Maskell, 2001).

Due to the tacit nature of knowledge, firms can only understand, absorb and implement external knowledge that is close to their own knowledge base (Cohen and Levinthal, 1990). Effective transfer of knowledge requires absorptive capacity of firms and cognitive proximity, that is, firms need to share similar knowledge and expertise to enable effective communication (Nooteboom, 2000). This implies, for instance, that it is not sufficient to have local access to information through the provision of ICT infrastructure: a firm needs to be in a position to take advantage of the opportunity new knowledge is providing (Perez and Soete, 1988). In combination with geographical proximity, the need for cognitive proximity may

well explain the spatial concentration of tacit knowledge[2]. Once a region specializes in a particular knowledge and competence base, this will act as an incentive, offering opportunities to local firms for further improvements in familiar fields of knowledge on the one hand, and as a selection mechanism, discouraging knowledge creation that does not fit into the regional knowledge base on the other hand (Boschma, 2004). As a result, the regional accumulation of tacit knowledge provides an intangible asset for local firms that is hard to grasp for non-local firms, because spatial distance forms a barrier for the transfer of tacit knowledge (Gertler, 2003). There are various mechanisms through which knowledge spills over from one local firm to the other, and which contribute further to knowledge accumulation at the regional level. These are the spinoff process, labor mobility and networks.

The spinoff process is an effective mechanism through which knowledge is effectively transferred between firms through entrepreneurship. In this case, the newly formed spinoff firm exploits the knowledge the founder had acquired as a former employee of an incumbent firm in the same sector. Crucial is that these new entrants do not start from scratch. Empirical studies systematically show that this type of entrants perform best, that is, they demonstrate the highest survival rates. Many sectors are characterized by a high degree of spinoff dynamics during their years of formation, and the most successful firms in those emerging industries tend to be spinoff companies (Klepper, 2007; Wenting, 2008; Boschma and Ledder, 2009). Because most spinoff companies locate in the immediate surroundings of their parent organization, this knowledge transfer mechanism contributes to geographically localized knowledge formation. Some have argued that the spinoff process is one of the driving forces behind the spatial clustering of industries (Arthur, 1994; Klepper, 2007).

Besides entrepreneurs, new employees may also bring valuable knowledge into the firm. Since labor is the main carrier of knowledge, employees moving from one firm to the other will contribute to knowledge diffusion. In science-based industries, the mobility of star scientists and key engineers act as a key mechanism through which knowledge diffuses among firms (Saxenian, 1994; Pinch and Henry, 1999). Since labor mobility largely takes place at the local level, this implies it contributes to knowledge formation at the regional level. Lindgren and Eriksson (2007) found evidence that clusters are characterized by a degree of local labor

[2] The relevance of geographical proximity for knowledge exchange is associated with *tacit*, as opposed to *codified* knowledge (Brown and Duguid, 2000). Codified knowledge consists of information that can be written down and, consequently, can be exchanged over long distances. Tacit knowledge is more difficult to express in an explicit form. Tacit knowledge is acquired through experience, demonstration and practice which require personal physical interactions (Johnson et al., 2002). There is increasing awareness, however, that the need for face-to-face contacts to exchange tacit knowledge does not automatically mean that individuals have to be located close to one another (Rallet and Torre, 2000). In many cases, face-to-face contacts can be arranged on a temporary basis, for example through business travels, conferences or fairs (Gallaud and Torre, 2005).

mobility that is higher than elsewhere in the economy. Almeida and Kogut (1999) demonstrated that knowledge spillovers in regions like Silicon Valley can be mainly attributed to inter-firm mobility of engineers in semiconductors.

The third knowledge transfer mechanism is networks. Knowledge effectively circulates in networks, like technological alliances and epistemological communities. Social proximity is often considered a driving force of network formation, like inventors' networks (Breschi and Lissoni, 2003; Ter Wal, 2009). Because social proximity is enhanced by geographical proximity, networks are often geographically localized, and so is the process of knowledge creation and diffusion. Thus, a network is a mechanism of knowledge transfer that tends to favor geographically localized learning. This is further reinforced by the two other knowledge transfer mechanisms outlined above. Through the spinoff process, close ties are established and maintained between the incumbent and the new firm, which form an additional channel through which knowledge is diffused at the regional scale. Labor mobility also creates linkages between firms because former colleagues maintain social ties. These social relationships favor knowledge flows between organizations (Breschi and Lissoni, 2003). Since most of the job moves are intra-regional, these social networks are formed locally, enhancing further knowledge accumulation at the regional level.

This is not to say that networks are favorable for innovation by definition, nor do we argue that local relationships are. Network ties may become too close and inward looking, leading to a reduced awareness of developments outside the network (Uzzi, 1997). Firms that are involved in embedded relationships tend to be more loyal to their partners, and may end up in less efficient ways of production. If firms do not connect to new firms now and then, and if their own network is not accessible to new partners, it is difficult to break this situation of cognitive lock-in (Glückler 2007). Firms that focus too much on local relationships may become less aware of technological and market-related developments outside their region (Grabher, 1993). Being exposed to extra-regional knowledge is considered crucial, because it brings new variety into the region (Asheim and Isaksen, 2002; Bathelt et al., 2004). So, firms with tight relationships that focus too much on their own region may not easily adapt to external changes. Non-local relations as such, however, do not guarantee effective knowledge transfer either: a certain level of social and cognitive proximity between firms is needed to make effective connections over large distances (Boschma, 2005a; Agrawal et al., 2006).

Related variety and regional dynamics

Regional growth is about qualitative change, not quantitative change. Long-term regional growth depends on the ability of regions to create new variety through entrepreneurship and innovation, in order to offset decline and destruction in other parts of the economy. Schumpeter claims this process of creative destruction being the driving force of economic development. This process makes the spatial system quite instable in the long run (Boschma and Lambooy, 1999). Newly emerging sectors do not necessarily favor leading regions, and they provide opportunities to backward regions to some degree. Since new industries are built on new knowledge, new types of skills and new institutions to some extent, it is rather unpredictable where new industries emerge in the economic landscape.

Economic history is replete of dramatic changes in the spatial system both at the national and international level (Hall and Preston, 1988). In the last two centuries, techno-industrial leadership shifted from Great Britain to the United States and Germany, and some countries in South-East Asia have recently joined the ranks of leading industrial countries. Countries are subject to similar dynamics, as the cases of Great Britain, Belgium and Germany demonstrate. Their core industrial areas have almost been overrun by a set of new growth regions in the South East of England, Flanders and the South of Germany, respectively (Scott, 1988).

In order to sustain long-term regional development, it is essential for regions to transform and renew their economic base (Pasinetti, 1981; Saviotti and Pyka, 2004; Martin and Sunley, 2006). One reason for this is that the regional knowledge base may become standardized (i.e. explicit and codified) and, therefore, may lose its unique value to local firms (Maskell and Malmberg, 1999). Another reason is that networks between (local) firms may become too close and inward looking, as explained above. Some claim that strong networks are beneficial for activities of exploitation, but may be less suited to exploration (Nooteboom et al., 2007).

Regions may have a number of options to restructure their economies in the long run. A sustainable option is to diversify regional economies into new fields while building on regional assets. The long-term development of regions may depend 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, and related variety may be a key source for that. Below, we explain how related variety may contribute to economic branching in regions, and how the three knowledge transfer mechanisms (spinoffs, labor mobility and networks) may play a key role in this process of regional diversification.

Henderson et al. (1995) and others claim that major innovations are triggered by knowledge spillovers between different sectors in a region: the more diversified the regional

economy is, the better. However, there is increasing awareness that knowledge will only be exchanged effectively when the cognitive distance between sectors in a region is not too large: sectors need to be related or complementary in cognitive terms (Nooteboom, 2000; Frenken et al., 2007). Therefore, regions need related variety, in order to enable effective knowledge transfer between different (but related) sectors, and to trigger recombinations of pieces of knowledge in entirely new ways. In other words, related variety fulfils two basic needs at the same time. Some degree of cognitive proximity (that is, relatedness between sectors) is required to ensure 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 to stimulate novelty (Nooteboom, 2000). It is neither regional diversity (which involves too large cognitive distance) nor regional specialization *per se* (resulting in too much cognitive proximity), but regional specialization in related variety that is more likely to induce effective interactive learning and economic renewal. So, regional diversification is more likely to occur when knowledge spills over between sectors, rather than within one sector, but only as long as the sectors are related.

Frenken et al. (2007) have assessed the impact of related variety on regional growth in the Netherlands. Making use of the standard industrial classification system, they defined sectors at the 5-digit level as related when they shared the same sector at a lower level of aggregation. A key outcome was that a high degree of related variety in a region had a positive and significant effect on regional employment growth rates in the Netherlands in the period 1996-2002. Boschma and Iammarino (2009) found similar findings in Italy investigating 103 regions. Related variety had a positive impact on regional growth in Italy in the period 1995-2003, no matter how regional growth was defined.

Economic history has repeatedly given evidence of a high intensity of technology feedback between a set of industries for a period of time (Carlsson and Stankiewicz, 1991; Boschma, 1999). Major innovations in one industry often depend on complementary advances in technology in other industries before they can be exploited (Rosenberg, 1982). Sectors may be technically connected when they originate from a core technology. In the nineteenth century, the invention of synthetic dyestuffs gave birth to new industries, like pharmaceutics, explosives, plastics, synthetic fibres and photography. The economy of the Emilia Romagna region in Italy has witnessed a similar branching process in the last 50 years or so. Many successful sectors like ceramic tiles, the packaging industry and robotics emerged out of a pervasive regional knowledge base in engineering. These sectors not only built and expanded on this extensive knowledge base, they also renewed and broadened the regional economy of

Emilia Romagna. These examples give insights in how related variety enhances knowledge spillovers and sparks of radical innovations across industries, how new growth sectors come into being, and how regional economies branch in new directions over time.

However, so far, we have left unanswered the question how related variety favours economic branching in regions. Below, we explain that the effects of related variety may become manifest through spinoff dynamics, labor mobility and networks. As explained before, these may be considered key mechanisms that transfer knowledge effectively between sectors mainly at the regional level. Here we will argue that they may also contribute to a successful process of regional diversification.

We explained earlier that the spinoff process is a crucial mechanism that transfers knowledge effectively from one firm to another through entrepreneurship. Some studies explaining the spatial evolution of a new industry have observed that experienced entrants (that is, entrepreneurs with a pre-entry background in a related sector) also did well economically, comparable to the performance levels of spinoff entrants (i.e. entrepreneurs with a background in the same sector). The reason is that experienced entrepreneurs in the new sector do not start from scratch either: they can exploit the knowledge and skills acquired as an employee or entrepreneur in another sector because it involves related (but not similar) knowledge. As a result, experienced entrepreneurs reflect a successful branching process. They make old sectors giving birth to new sectors (Klepper and Simons, 2000). And because relatedness (i.e. some degree of cognitive proximity) is involved between the old and the new sector, as relevant knowledge and experience is transferred from the old sector and exploited in the new sector, it increases the probability of survival of the new industry. Klepper (2007) has demonstrated that prior experience in related industries like coach and cycle making increased the life chances of new entrants in the US automobile sector. Boschma and Wenting (2007) found evidence that new automobile firms in Great Britain had a higher survival rate during the first stage of the industry's life cycle when the entrepreneur had a background in these related sectors (in contrast to a background in the same automobile sector), and when the firm had been founded in a place that was well endowed with related sectors. So, when diversifying into the new automobile sector, these types of new entrants could exploit related competences and skills, which improved their life chances in the new automobile industry significantly, as compared to other types of start-ups.

The same line of reasoning can be applied to labor mobility. Besides entrepreneurship, a new industry can also exploit knowledge and experience in related industries when recruiting new employees. However, empirical evidence is still lacking here. There is little to no

understanding of what types of labor new industries need when they emerge and develop. However, it is plausible to assume that employees drawn from related sectors may bring in relevant skills and experience into the new firms, and this may positively impact on their survival rate during the first stage of the life cycle of the new industry. In a recent study on labor mobility in Sweden, Boschma, Eriksson and Lindgren (2009) found evidence that the hiring of employees with skills that are related to the existing knowledge base of the plant had a positive effect on plant performance. This finding is completely in line with the logic of related variety. When employees with unrelated skills were recruited, the plant cannot understand and integrate these new skills (there is too much cognitive distance), and therefore, no impact on plant performance was found. When it concerned new employees with skills that were already present in the plant (i.e. there is too much cognitive proximity), this type of labor mobility had even a negative impact on productivity growth of the plant.

When discussing the role of networks, we pointed out that non-local relationships may be crucial because new variety may be brought into the region through linkages with other regions (Boschma, 2004). However, a study on regional growth in Italy that made use of trade data demonstrated that the inflow of knowledge *per se* does not affect economic growth in regions. It is not sufficient to attract large and diversified flows of extra-regional knowledge (Boschma and Iammarino, 2009). The same is true when the extra-regional knowledge is similar to the knowledge base of the region. It does not add anything to the existing knowledge base of the region, and therefore, does not contribute to regional growth. However, a crucial finding was that the more related the knowledge base of the region and its import profile was, the more it contributed to employment growth in the region. Thus, 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. In those circumstances, cognitive proximity between the extra-regional knowledge and the knowledge base of the region is not too small (enhancing real learning across related sectors in different regions), but also not too large (enabling the absorption of the extra-regional knowledge).

The need for dynamic innovation systems

However, inter-firm knowledge transfers based on proximity and related variety alone will not lead to innovations. The innovation system literature claims that the innovation process should be seen as the outcome of interaction between actors within firms, between firms, and between firms and other organizations like universities, educational facilities, financial organizations and government agencies (Freeman, 1987). So, being innovative is not just a

matter of having access to related variety or to local or non-local knowledge, but whether interaction takes place at all these levels.

According to this literature, a number of organizations (such as research institutes, educational facilities, financial organizations) provides complementary inputs essential to the innovation process (Edquist, 1997). Besides absorptive capacity, a firm can exploit its innovation only when it is able to get access to (venture) capital, when it is able to hire workers with the required new skills, when it can find a new market, etc. In other words, firms need the presence of a critical mass of organizations that can provide these needs. In many peripheral regions, this critical mass is missing, resulting in low innovative performance. When it is also accompanied with low R&D levels, the absorptive capacity might be just too low to absorb inflow of (both public and private) knowledge from outside.

Besides a critical mass, it is crucial that these organizations are connected and form a system. The innovation process requires organizations to connect in order to enable flows of knowledge, capital and labor. The key issue is that this is far from self-evident to occur (Boschma, 2004). Capital suppliers are almost by definition reluctant to invest in innovative projects: radical and more complex innovations are a risky business with uncertain outcomes, and financial organizations have built up routines in established markets and technologies. Although the number of inter-firm technology alliances is on the increase (Nooteboom et.al,, 2007), firms tend to be reluctant to share their core competences with others, because there is a serious risk that knowledge will leak to competitors. Public research institutes such as universities have often difficulties to meet demand of innovative firms, because of differences in culture and incentive mechanisms (Metcalfe, 1994)[3]. And when innovations require labor with new skills, it may take long before the education system is restructured and will deliver the people with the right set of skills.

Besides the fact that it is not self-evident that interactions occur between organizations, it is also unlikely that organizations are sufficiently flexible to implement innovations. In reality, almost by nature, organizations are not flexible and responsive, due to routines and path dependency (Nelson and Winter, 1982). Thus, regions will reap the benefits from entrepreneurial activities of firms only when the actions of these key organizations are coordinated and form a system of innovation, and when regions have local organizations that respond quickly and smoothly to new developments. This is crucial for the long-term

[3] Because collaboration between different types of organizations (e.g. between firms and universities) is not self-evident, it tends to take place at a lower spatial scale, as compared to collaborations between similar organizations (e.g. between firms) (Ponds et al., 2007). This suggests that geographical proximity may be helpful in overcoming cultural and other barriers between different types of organizations.

competitiveness of regions: some regions are more capable of making these connections and have more responsive organizations than other regions. This is a key systemic asset of a region that is almost impossible to copy by other regions.

Institutions play a crucial role (Nelson, 1995). Apart from basic institutions like democracy and markets that support entrepreneurship and innovation, institutions also regulate and coordinate actions between organizations (Hodgson, 1996). This task is fulfilled by formal institutions (such as laws) and informal institutions (like norms) (Edquist and Johnson, 1997). An example of a formal institution is a patent law that protects inventors for some time while making information public. An example of an informal institution is a culture of shared trust, which is a local capability that supports inter-firm learning (Maskell, 1999). Countries and regions accumulate different institutions over time, which is quite similar to the way the regional knowledge base accumulates. They are the outcome of a long history in a specific regional context that cannot easily be copied by public policy in other regions. Like the innovation process itself, institutions have a systemic dimension: they form systems that are territory-specific (Hall and Soskice, 2001). At the international level, there are 'exit-based' and 'voice-based' institutional models (Ergas, 1984). At the regional level, Iammarino and McCann (2009) distinguish between regional innovation systems that differ in terms of industrial structure and dominant sources of knowledge. Consequently, regions follow different institutional paths that yield comparable levels of economic development: there is more than one way regions can accomplish economic development.

Because institutions tend to be durable and resistant to change, they not only support but may also constrain new developments. When new institutions are formed and created alongside new economic activities, they fulfill a specific need (Murmann, 2003), but once they are established, they may obstruct new developments. Powerful special-interest organizations may take over an economy, and slow down the capacity of regions to adopt new technologies and to reallocate resources to new activities (Olson, 1982). What matters thus is whether institutions are flexible and responsive to change, in order to avoid regional lock-in (Freeman and Perez, 1988): regions need a capacity to upgrade and transform institutions required for the development of new activities. This dynamic capability of organizations and institutions impacts on the long-term competitiveness of regions (Boschma, 2004).

Conclusion

In a knowledge economy, regions depend on their ability to absorb, develop and apply new knowledge. Since knowledge tends to accumulate, new knowledge will not diffuse widely

between firms and between regions. It requires absorptive capacity and institutions that bring agents together. Both intangible assets provide incentives and constraints within which the innovation process in regions takes place. Knowledge will spill over more intensively when regions are endowed with related industries that share a knowledge base. Related variety favors economic branching in regions through spinoff dynamics, labor mobility and networks. Because these mechanisms transfer knowledge across sectors and between old and new sectors mainly (but not exclusively) at the regional level, they contribute to a successful process of regional diversification. Due to the systemic nature of innovation processes, regions also require a critical mass of organizations that meet the following conditions: (1) they have to be well connected, enabling flows of knowledge, capital and labor; (2) these ties should not be, however, too strong, and not too focused on the region, avoiding problems of lock-in; and (3) local organizations and institutions must be flexible and responsive to new circumstances, overcoming inertial tendencies due to habits, routines and path dependency.

3. System failures as basis for regional innovation policy

In the remaining sections, we briefly sketch some policy recommendations that might effectively impact on the drivers of regional growth described in Section 2. To begin with, we claim that system failures should provide the underpinning of regional innovation policy.

A conventional market failure argument is that knowledge is a semi-public good. Because of the non-appropriability problem, the government needs to take action to overcome underinvestment in new knowledge through the provision of R&D subsidies or the establishment of property rights. Another standard argument is that knowledge is characterized by increasing returns to scale. For that reason, investments in public R&D, technology transfer and education are expected to foster economic growth (Hall, 1994). As such, the government aims to encourage the dissemination of knowledge, through the public provision of infrastructure such as broadband Internet. This is conceived especially relevant for lagging regions and small-and-medium-sized firms that lack resources to invest in R&D.

These market failure arguments provide a basis for regional innovation policy, but they do not tell the whole story. Evolutionary economists argue that market imperfections are not necessarily a problem that needs to be corrected by public intervention. On the contrary, they state that market imperfections, such as knowledge asymmetries, knowledge spillovers and monopolies, are part and parcel of any regional economy, and can even be considered the

drivers of innovation and regional growth (Bryant, 2001). Because knowledge asymmetries limit knowledge transfer, they provide a strong incentive to invest in knowledge creation. As explained before, related variety is a key regional asset that provides a major source of economic renewal and regional branching, and therefore should be cherished as such.

The market failure argument is also based on a linear model of innovation policy that focuses on R&D infrastructure and technology transfer, as if these will automatically lead to innovation in regions. There is, for instance, still a strong belief in the EU that R&D policy will bring benefit to many regions. In reality, R&D-based policy favours only a few regions in Europe, that is, the ones that are already heavily specialised in R&D (Morgan, 1997; Simmie, 2003). In addition, much of the newly created knowledge is not exploited economically in Europe but leaks away to other countries such as the US. This means R&D policy in Europe is subsidising to some degree the exploitation of knowledge elsewhere. In other words, this linear model of innovation policy based on market failures will lead to poor results, if such policy does not account for the systemic nature of innovation and the importance of absorptive capacity and institutions for knowledge diffusion.

The main reason to intervene in a knowledge economy is therefore not so much market failures, but system failures (Asheim et al., 2006). Metcalfe (2003) argues that innovation system failure should be taken as starting point for policy intervention, instead of conventional policy that is preoccupied with market failure and optimal policy. This is not to say that the relevance of market failures for underpinning regional innovation policy is completely denied. Poor access to information, for instance, should be tackled by policy intervention, but this is never sufficient on its own. So, at best, policy based on market failure needs additional policy actions to be effective, at worst, it may seriously damage the driving forces of innovation and regional growth.

There are three types of system failures that may result in low levels of innovative performance in regions (see e.g. Edquist, 1997; Todtling and Trippl, 2005). First of all, there may be crucial parts of an innovation system that are found missing. This refers to the fact that key organizations in innovation systems, such as research institutes, educational facilities, venture capitalists, specialized suppliers but also key regulations are weakly developed. Such a situation of ‘organizational thinness’ is often present in peripheral regions where a critical mass of local demand is lacking (Camagni, 1995). The second type of system failure concerns a lack of relationships between the organizations in an innovation system. As explained in Section 2, relationships are not self-evident, but have to be constructed. Inter-organizational collaboration, for instance, is often risky and frequently fails. When missing or badly

managed, knowledge will not be exchanged, inter-firm learning will come to a halt, and investment opportunities will not be realized, due to shortages of capital and skilled labor.

The third type of system failure is associated with lock-in. Organizations and their relationships often tend to be subject to inertia, which undermines the ability of regions to adapt and to renew their economic base. As noticed before, local organizations may be too strongly oriented towards old routines and old specializations, as the experience of many old industrial regions illustrates (Grabher, 1993; Boschma and Lambooy, 1999b). Moreover, local organizations may have developed too strongly tied networks, which limit their access to new sources of information, and which makes it difficult to implement new changes. It is crucial to underline that public organizations may be part of such a regional deadlock: public agents may contribute to the formation of closed and inward-looking systems through their policy programs and their direct participation in such networks (Hassink, 2005).

4. Considerations for the design of regional innovation policy

When building regional innovation policy on system failures, a number of issues comes to mind that call for more clarification. For instance, should policy select and target particular sectors and regions? Should one adopt a 'one-size-fits-all' policy approach? Can policy makers make regional economies develop in new directions, and if so, how? And to what extent should innovation policy be regionally-based? These issues are addressed below.

Picking winners?

There is a tendency in policy to select particular sectors and regions *a priori* as targets at the national level. Policy makers are inclined to support relatively new sectors like biotech, nanotechnology or gaming, because these are expected to be the job-creators of the future. In a similar vein, some regions are identified as innovation hotspots or brain ports, because these are considered the drivers of national economic growth. However, one can question the usefulness and relevance of such 'picking-the-winner' policy.

First of all, such policy overlooks the fact that is impossible to predict which will be the new growth regions and the winning sectors. 'Picking-the-winners' policy at the national level is risky, as history shows, because one runs the risk of selecting the wrong ones. There is little understanding of how regions move into new directions or start up new growth paths (Iammarino and McCann 2006; Martin and Sunley, 2006). What has been observed is that

new industries are often the result of spontaneous processes, rather than the outcome of orchestrated policy interventions. (Lambooy and Boschma, 2001). This is even true for cases like Bangelore where popular belief suggests otherwise (Pack and Saggi, 2006). This is not to deny, however, that governments often play a key role, as in Silicon Valley, where huge defensive expenditures by the US government gave the region an enormous boost.

Secondly, 'picking-the-winner' policy often results in picking the same winners like biotech, no matter what country or region is involved. When all regions are targeting the same sectors, and it is likely that many of these industries will cluster in only a few regions in the world, one can easily predict that the overwhelming majority of regions will fail to develop these industries, with huge losses of public resources (Boschma, 2005b). An exception might be the public support of general purpose technologies (like the Internet): there is no doubt these will have long-term impacts, but it still remains uncertain which parts of the economy will be most strongly affected in the next decades.

Thirdly, 'picking-the-winner' policy at the national level denies the fact that, in principle, almost each region has growth potential in the knowledge economy. Growth or innovation potentials of regions can be measured in different ways. Indicators like R&D, creative workers, high-tech industries and knowledge-intensive services identify different dimensions of the knowledge economy, and reveal very different spatial patterns. A recent study of the Netherlands has shown that R&D is located in the more peripheral parts, while creative workers are more concentrated in the northern part of the country, especially in the northern part of the most densely populated area (Raspe et al., 2004). When all these maps would be put on top of each other, it is almost impossible to observe regions that lack innovation potential: most of the Dutch regions participate in the knowledge economy in one way or another. It would therefore be wrong to exclude some of these regions from policy intervention, or to focus innovation policy too narrowly on one of these indicators, such as R&D. Innovation policy based on R&D potentials suffers from two other shortcomings. It has its roots in a linear model of innovation that simply equates innovation with R&D, while it will most likely benefit only a very small number of regions that have already high concentrations of R&D activities (Oughton et al., 2002).

Regional innovation policy based on related variety may avoid such dangers of 'picking-the-winner' policy, because its objective is to broaden and diversify the regional economic base while building on region-specific resources and extra-regional connections. No particular regions need to be targeted. Each region can be made part of such a policy approach, no matter whether these regions are specialized or diversified, or whether these have a high or

low degree of related variety. Nor do specific sectors (low or high tech, creative or not) have to be excluded from such a policy approach. As policy aims to bring together activities with possible complementary pieces of knowledge, it leaves behind a narrow sector perspective. Having said that, there is no doubt that regional policy based on related variety needs focus to be effective: it needs to identify and target region-specific assets and extra-regional linkages that have obtained some critical mass in a region. However, the objective is not to make strong sectors even stronger, but the objective is to enhance interaction and exchange between different but related activities, in order to support new variety in the region.

'One-size-fits-all' policy?

To say that almost each region has innovation potential is not to say that all regions are equal. There is a need to account for a variety of innovation potentials between regions, because regions differ in terms of location, knowledge base and institutional structure. Italy is a prime example: the North of Italy is strong in science-based organizations and R&D, the Third Italy is characterized by large numbers of industrial districts that are home of small and medium-sized organizations that have more informal and loosely structured relationships, while the South of Italy is characterized by a weak indigenous learning capability and weak networks due to poor institutions (Iammarino, 2005). Because of such regional diversity, it would be wrong to apply a 'one-size-fits-all' policy, such as neo-liberal policies or best practices like Silicon Valley, which is often found practice in regional policy (Todtling and Trippl, 2005).

It would be wrong to start regional policy from scratch either. Effective policy making requires localized action attuned to the specific needs and available resources of regions. Available options and probable outcomes of policy are largely determined by the regional history (Lambooy and Boschma, 2001). It means that the regional knowledge and institutional base should be taken as starting point when stimulating new fields of application that give birth to new sectors. Accordingly, there is a need for differentiated, tailor-made policy strategies that are geared towards specific potentials, and that will focus on tackling specific bottlenecks in regions. According to Iammarino and McCann (2009), regional innovation can only be effectively promoted when it accounts for the type of regional innovation system. This means that a 'picking-the-winner' policy at the regional level (instead of the national level) is more valid, because it focuses on activities that show the highest potential but still face bottlenecks to develop fully. Regional policy needs to capitalise on region-specific assets, extending and renewing the economic base, rather than to select from a portfolio of policy models that owed their success in different environments (Asheim et al., 2006).

'One-size-fits-all' regional policy models do not work in a highly fragmented economy, if they ever did (Cooke and Morgan, 1998). This implies that copying of best practices, as identified by benchmarking studies, are bound to fail, as regional policies aimed at imitating success stories like Silicon Valley have demonstrated (Boschma, 2004). Howells (2005) points out that 'best practice policies' are hard to adapt to local situations and difficult to understand and implement. Moreover, copying of success stories in practice often focuses on the success factors, rather than it is based on a sound analysis of how public policy contributed to the success of that particular region. This is not to say that regions cannot learn from each other (Hassink and Lagendijk, 2001). There may be advantages of best practice policies: they have proven their success elsewhere, they are more or less ready to use, and they may break down closed local networks that serve vested interests (Howells, 2005). In other words, there may be disadvantages attached to region-specific policies. These are often unique, so it is not always clear whether they will work, and local vested interests may dominate the policy design, excluding outsiders and newcomers (Cheshire and Gordon, 1996; Fritsch and Stephan, 2005). Region-specific policies should tackle these potential problems.

Policy makers are adapters

The rejection of 'one-size-fits-all' policy is in line with the view that policy makers are not fully informed and omnipotent. Therefore, policy makers have few degrees of freedom (Lambooy and Boschma, 2001). As stated before, the trajectories regions followed in the past, as accumulated in a particular knowledge base and a set of institutions, determine to a large extent available options and probable outcomes of policy. Regional policy is likely to fail when local strategies deviate from their local context. The more the policy objectives are embedded in the surrounding environment, the larger the potential impact of policy. When adaptation to change is constrained by the spatial system, policy based on related variety may increase the probability of policy success, because it builds on existing structures, while its objective is to broaden or diversify the regional economy in new directions.

Such a policy approach takes a more contextualized view of how policy should intervene in a regional economy (Cooke, 2009). It implies that the degree and nature of policy intervention should be different in regions because their histories differ. As a consequence, the question whether governments should intervene in a regional economy should be based on the institutional history of a region and which type of intervention fits better a region's situation, rather than it should be based on theoretical or ideological accounts (Fromhold-Eisebith and Eisebith, 2005). One has to account for the fact that the state is only one among

many actors, although a key player, and its role differs between countries and regions (Kohler-Koch, 1998). Given the institutional context, governments can directly intervene (through regulations, public research and education), but also take a role as broker and intermediair, connecting actors at the regional level (Cooke and Morgan, 1998).

Policy should also account for the fact that policy makers, like firms, do not optimise (Metcalfe, 1994). In a world of full of uncertainty, policy failures will occur, just like it is a rule that firms will eventually fail in markets (Ormerod, 2005). Because policy makers cannot rely on 'one-size-fits-all' policies, regional innovation policy is necessarily based on trial-and-error, in which policy makers learn and adapt (Schwerin and Werker, 2003). To enhance learning, the policy system should leave room to newcomers and new experiments, and develop a system of constant policy evaluation at the same time (Wegner, 1997).

Regional dimension of regional innovation policy

Policy makers in many countries have embraced the view that innovation processes have a regional dimension, and have responded by adding a regional dimension to their innovation policy (Van Geenhuizen and Nijkamp, 2006)[4]. We stated earlier that diversity in regional innovation policy is something that should be encouraged. While it is essential to take the knowledge and institutional base of regions as starting point, one should be cautious, however, not to overestimate the role of the region as driver of innovation. This has implications for regional innovation policy.

First of all, knowledge relationships often cross regional boundaries. Non-local linkages are often found crucial for learning and innovation, in order to avoid cognitive lock-in (Bathelt et al., 2004). Amin and Cohendet (1999) claim that non-local networks are crucial for path-breaking innovations, while local learning results in more incremental innovations. For firms, being connected may be as important, or even more so, than simply being co-located (Giuliani and Bell, 2005). This means that policy intervention should not focus on the region alone, as if geographical proximity is sufficient for innovation (Boschma, 2005a). On the contrary, it should encourage geographical exposure by means of cross-regional knowledge collaboration, cross-regional mergers and acquisitions, and inflow of human capital, in order to avoid regional lock-in.

[4] It is important to realize that this regionalization of innovation policy has many dimensions and meanings, and concerns objectives, instruments and administration issues, among other things (Fritsch and Stephan, 2005). We view regionalization of innovation policy in a broad way, covering any policy action that accounts for region-specific features. So, it is not only about cluster promotion, which is now a popular policy objective, but which has also been criticized as such (see Martin and Sunley, 2003).

Secondly, policy should take in consideration that knowledge transfer between local firms is not just accomplished by bringing them together. Knowledge does not spill over automatically between firms, even when they are located in the same region. Network analysis demonstrates that the position of firms in knowledge networks depends on their absorptive capacity (Giuliani and Bell, 2005). The higher its absorptive capacity, the more a firm is connected locally, the more central its position in the knowledge network, and the higher the innovative performance. What is more, firms with a high absorptive capacity are also more connected to the outside world. They may even act as gatekeepers that bring new variety into the region. Whether this external knowledge will diffuse widely in the region depends, again, on the absorptive capacity of all other firms in the region (Boschma and Ter Wal, 2007; Morrison, 2008). In this respect, regional innovation policy could play a role, by enhancing the absorptive capacity of local firms through research and education schemes.

Conclusion

There are good reasons to avoid a 'picking-the-winner' policy that targets only a few sectors or regions. The idea that is possible to design 'one-size-fits-all' regional policies is no longer valid. Copying of best practices is almost impossible when it comes to intangible regional assets that are the result of long histories in particular contexts. Regions provide opportunities but also set limits to effective growth policies. Policy makers should be wary to simply imitate successful models. Instead, policy solutions need to be inspired by regional indigenous capacity, because this increases the probability of effective policy. To avoid regional lock-in, it is crucial that policy is open to newcomers, new ideas and new policy experiments.

5. Some policy options

Now, how could regional innovation policy tackle system failures? There are many policy options one could think of, too many to be mentioned here. Due to a lack of space, several policy options will discussed below.

The objective of regional innovation policy is to encourage and facilitate new ideas and innovation through the creation, diffusion and exploitation (or commercialization) of new knowledge. The government might directly intervene, through the supply of R&D, education and capital that match the need of local firms, and which increase the absorptive capacity and innovative capability of firms. Public policy can also stimulate the effective transfer of

knowledge through the three mechanisms (spinoff dynamics, labor mobility and collaborative networks)[5]. Below, we briefly direct attention to these three mechanisms of knowledge transfer, because they tend to take place at the regional level, and they may provide inputs for regional innovation policy based on related variety. This is basically in line with the platform policies based on related variety presented in this OECD report by Cooke (2009).

Studies have shed light on the importance of spinoff dynamics for knowledge diffusion, entrepreneurship and regional development (Helfat and Lieberman, 2002). As noted before, spinoffs are new firms that are founded by entrepreneurs that have acquired relevant experience as far as market and/or technical knowledge is concerned. Empirical studies tend to show that spinoff companies often perform better than other types of entrants because they can build on relevant knowledge and experience acquired in parent organizations in the same or related industries (Klepper, 2007). Since spinoffs tend to locate near their parents almost as a rule, it may provide a basis for regional innovation policy. Because the spinoff process has also played a crucial role in the emergence of many new sectors, it may be seen as a mechanism that makes regional economics diversify into new sectors, while building on knowledge and competences available in existing sectors (Boschma and Wenting, 2007). A policy option is to target potential entrepreneurs (and not just supporting any new firm), by taking into consideration what kind of knowledge the founder brings into the new firm. Another policy option is to encourage spinoff policies in academic organizations that may contribute to the growth potential of spinoff ventures (Lockett et al., 2005).

Regional innovation policy could also play a role in encouraging labor mobility. As noted before, it is a crucial mechanism through which skills and experience are transferred from one local company to the other (Camagni, 1991). Since most labor mobility takes place at the regional level, policy promoting labor mobility may enhance knowledge transfer and innovation at the regional level. Since labor mobility may take away the incentive of firms to invest in their personnel, public policy should invest heavily in education and life-long learning. Aghion et al. (2006) argue that flexible labor markets are required to lower the costs of the process of creative destruction. It should, however, be complemented by a policy of life-long-learning. If not, individuals do not have the capability to confront new changes and to move from one job to the other.

[5] Dosi et al. (2006) claim that Europe should shift its policy approach from a networking type (emphasis on interactions with local environment) to an actor type of approach (strengthening high quality basic research and the innovative capacity of corporate actors).

Another crucial policy measure is to encourage the immigration of skilled labor because it may bring new ideas and related knowledge into the region. One way to achieve this is through international exchange programmes for students. Incoming students bring in new talents and skills from abroad, and combine these with new skills that are acquired in high education institutes in the host country. If the host country is capable of maintaining this group of high-skilled students after graduation (policy can most certainly play a role here), they will contribute to the economy as skilled employees or as founders of new firms. Outgoing students will acquire new skills in research and education institutes abroad, and may return to their home region after a while, where they will exploit their newly acquired skills in an environment they are familiar with (Saxenian, 2006). Policy could target those outgoing groups and provide incentives to return to their home region.

Another policy option is to stimulate networks as effective settings through which knowledge circulates and interactive learning takes place. As stated before, policy makers may act as intermediairs or knowledge brokers, or establish policy platforms that facilitate knowledge to spill over and diffuse from sectors to related ones. In doing so, policy should avoid that vested interests of established firms take over and dominate these networks, and deny access to small firms and newcomers. In a similar vein, competition policy could aim at stimulating the establishment of network alliances or mergers between related industries as a way of diversifying regional economies into new but complementary fields of activity.

This type of network policy should acknowledge that knowledge networks frequently cross boundaries of regions (Gertler and Levitte, 2005; Giuliani, 2005). It is crucial that regional innovation policy stimulates extra-regional networks, because it brings new knowledge into the region. Besides new infrastructure and international exchange programs, a way to accomplish this is to encourage foreign investments. Dachs et.al. (2007) found that foreign-owned companies in some small European countries tend to show a higher innovation output and higher labor productivity, as compared to domestically-owned companies. What is more, affiliates of foreign multinationals were quite strongly embedded in the national innovation system, may of them even showing a higher propensity to cooperate with domestic partners, as compared to domestically-owned companies.

Universities may also play a crucial role in exploiting inter-regional linkages, because they are extremely well connected to international networks. After their graduation, students will exploit and diffuse this knowledge in the regional economy. Academic spinoff policy and other policy measures may be implemented to ensure that the knowledge of universities will be further exploited economically at the regional level (Feldman and Desrochers, 2003). What

would be risky though is that public policy specifies in detail which knowledge fields will be targeted (e.g. through the allocation of R&D subsidies). As outlined before, this would mean a picking the winners policy that denies the crucial role of variety as a source of novelty.

6. Conclusions

We have built on insights drawn from evolutionary economic geography to present some recommendations for effective regional innovation policy. Since knowledge tends to accumulate mainly at the firm level, variety is the rule, and the more diversified a regional economy is, the higher regional growth. However, knowledge may also diffuse between firms, having an additional impact on regional development. If knowledge externalities are geographically bounded, knowledge will also accumulate at the regional level. In addition, knowledge will spill over more intensively when regions are endowed with related industries that share a common knowledge base. Related variety favors economic branching in regions through spinoff dynamics, labor mobility and networks. Because these mechanisms transfer knowledge across related sectors mainly at the regional level, they contribute to a successful process of regional diversification, which is crucial for long-term regional development.

However, knowledge creation and knowledge spillovers alone will not lead to innovation. Regions require a critical mass of organizations that provide necessary inputs to the innovation process, such as knowledge, skills and capital. Besides a critical mass, these organizations need to connect and interact, to enable flows of knowledge, capital and labor. In addition, organizations and institutions need to be flexible and responsive to implement change. In reality, almost by nature, organizations and institutions are not, because they suffer from lock-in, due to routines, sunk costs and path dependency.

We have used these insights as key inputs and underpinnings for effective regional innovation policy. Following system failure arguments, public policy has the task to establish key organizations of innovation systems in regions where these are found missing, or public policy has to ensure that these missing inputs to the innovation process will flow into the region. Once available, public intervention should encourage key organizations to connect, for example, firms need to be linked with research institutes and capital suppliers. In addition, public policy can make organizations more flexible and innovative, for instance, by upgrading their routines through the supply of new knowledge and skills. Finally, regional innovation policy can stimulate the effective transfer of knowledge at the regional level by means of

spinoff activity, labor mobility and networks. Since these mechanisms of knowledge transfer are basically taking place at the regional level, and because they make regions move into new growth paths while building on existing assets, these policy actions put in practice the idea that related variety may contribute to long-term regional development.

To increase the probability of policy success, regional innovation policy needs to account for the region-specific context that provides opportunities but also sets limits to what can be achieved by policy. Doing so, public intervention should neither apply 'one-size-fits-all' frameworks nor adopt 'picking-the-winner' policies. This is the main message that transcends this OECD report (Cooke, 2009; Iammarino and McCann, 2009). Instead of copying best practice models or selecting winners, policy should take the history of each region as a starting point, and identify regional potentials and bottlenecks accordingly. To avoid regional lock-in, it is crucial that policy is open to newcomers and policy experiments.

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