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Development Strategies of Urban Innovation Systems

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ABSTRACT

The present study is going to make a description in the approach of urban innovation systems, and in the policies that we may follow in order to develop an innovation ecosystem at city level. We will try to combine the systems of innovation approach with the urban framework in order to provide a conceptual framework about the development of an urban innovation system. In the quest of new ways of economic development and growth, urban innovation systems could play a crucial role in the establishment of a sustainable development system based on the comparative advantages of a city and on its human and social capital. Also the current dissertation aspires to become a tool of innovation strategy for policy makers.

Key words: *urban innovation systems, urban innovation strategy, actors, networks, urban enviroment*

ΠΕΡΙΛΗΨΗ

Η παρούσα διπλωματική εργασία πρόκειται να κάνει μια περιγραφή της των αστικών συστημάτων καινοτομίας, και των πολιτικές που μπορούν να ακολουθηθούν προκειμένου να αναπτυχθεί ένα οικοσύστημα καινοτομίας σε επίπεδο πόλης. Θα προσπαθήσουμε να συνδυάσουμε την εννοια των συστημάτων καινοομίας με το αστικό πλαίσιο, προκειμένου να παρουσιάσουμε ένα εννοιολογικό πλαίσιο για την ανάπτυξη των αστικών συστημάτων καινοτομίας. Στα πλαίσια της αναζήτησης νέων τρόπων οικονομικής ανάπτυξης και μεγέθυνσης, τα αστικά συστήματα καινοτομίας θα μπορούσαν να διαδραματίσουν κρίσιμο ρόλο στη δημιουργία ενός συστήματος βιώσιμης ανάπτυξης βασιζόμενο στα συγκριτικά πλεονεκτήματα της πόλης και στο ανθρώπινο και κοινωνικό κεφάλαιο της. Επίσης, η παρούσα διπλωματική εργασία φιλοδοξεί να γίνει εργαλείο στρατηγικής για την καινοτομία, για τους υπεύθυνους χάραξης πολιτικής.

Λέξεις κλειδιά: *αστικά συστήματα καινοτομίας, στρατηγικές αστικής καινοτομίας,δρώντες, δίκτυα, αστικό περιβάλλον*

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1. Introduction

Each city possesses a unique cultural and natural quality, forces of creativity and development, knowledge bases that diversify each city from another and comparative advantages that may enhance its innovation and entrepreneurial activity. Moreover cities play a key role in economic growth with their concentration of consumers, workers and businesses, together with the formal and informal institutions that make an agglomeration thick and cohesive with the potential to produce externalities and increasing returns to scale.

Also the last decades in innovation literature, the approach of systems of innovation has become the main tool of innovation strategy for policy makers. According to these trends we will try at this dissertation to combine the systems of innovation approach with the urban level in order to provide a conceptual framework about the development of an urban innovation system. In the quest of new ways of economic development and growth, urban innovation systems could play a crucial role in the establishment of a sustainable development system based on the comparative advantages of a city and on its human and social capital.

At the next chapter we will investigate the meanings and interpretations of innovation, of system of innovation. Our literature review focuses at the national, regional and mainly at the urban level of systems of innovation. We conclude the chapter mentioning the main components of systems of innovation which will help us in the next chapters to define the critical factors that contribute to the emergence of urban innovation systems.

In chapter 3 we provide an analytic description of the innovation systems from Eindhoven, Shanghai and Vancouver and we describe the key elements and good practices that are leading to the successful performance of their innovation systems. Also we mention certain general information about each city and we conclude with the policies that they follow to improve their innovation performance or to face their particular weakness.

In chapter 4 we focus on key factors that we have drawn from our case studies, and we try to present the similarities and differences between the particular urban innovation systems. Also we mention certain factors that appear to be, key elements leading to the

success of an urban innovation system and other functions that seem to have more local characteristics. In this chapter we stress that we can't apply a particular set of policies in every city to develop an innovation system, but we must take into consideration the particular characteristics of each city separately.

In the last chapter we provide an analytic conceptual framework which is the result of our literature review, is based on the three case studies and includes policy interventions from current policy guidance on innovation systems. Finally we approach the strategy which will favor the innovation performance at city level.

2. Innovation Systems Analysis

2.1 The concept of innovation

Innovation as conceived by Nelson and Rosenberg (Nelson, 1993) is narrow in the sense that it is restricted to technical innovations. They write: "This book is about national systems of technical innovation. The studies have been carefully designed, developed, and written to illuminate the institutions and mechanisms, supporting technical innovation in the various countries" (Nelson and Rosenberg, 1993). This is certainly an accurate description of the content of the Nelson book, for none of the contributing authors discuss organizational, institutional, or social innovations in any detail, although a few address such innovations in an ad hoc manner.

The innovation concept is, however, not always restricted to technical innovations. Schumpeter, for example, conceived of innovation in a much broader way. In his own words, he preferred to define innovation more rigorously by means of the production function, a function that describes the way in which quantity of product varies if quantities of factors vary. If, instead of quantities of factors, we vary the form of the function, we have an innovation (Schumpeter, 1939). (Carlsson & Stankiewicz, 1995)

Moreover we could define innovation as the setting up of a new production function. This covers the case of a new commodity as well as those of a new form of organization such as a merger of the opening up of new markets. (Schumpeter 1939). According to the previous, Schumpeter expressed innovation by saying that innovation combines factors in a new way or that it consists in carrying out new combinations(Schumpeter,1939).

As Nelson and Rosenberg state, they interpret innovation rather broadly, to encompass the processes by which firms master and get into practice product designs and manufacturing processes that are new to them, whether or not they are new to the universe, or even to the nation' (Nelson and Rosenberg,1993). Hence their innovation concept includes not only the first introduction of a technology but also its diffusion. As with the Nelson and Rosenberg concept of innovation, the 'technological systems' approach of Carlsson and Stankiewicz focuses mainly upon technologies, their generation, diffusion, and utilization (Carlsson & Stankiewicz, 1995)

In technological innovation Carlsson, however, includes both know-how and artefacts (Carlsson, 1995). Product as well as process technologies are also included in the Carlsson and Stankiewicz notion of technology. Hence their innovation concept is similar to that of Nelson and Rosenberg. Lundvall deviates here in mentioning 'new forms of organization' and 'institutional innovations' (Lundvall, 1992), in addition to technological process and product innovations.

2.2 Contemporary interpretations and meanings of innovation

Moreover, according to OECD's definition, innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD, 2005).

Innovation plays a key role in the economy and society by contributing to growth and jobs and helping address social and environmental challenges. Innovation is important for growth at all stages of development, specifically by creating and diffusing new technologies. Different types of innovation play different roles at various developmental stages.

Innovation may be characterized by several dimensions including, the degree of novelty, the type of innovation (product and process innovation), the impacts of radical and incremental innovation and the source of innovation (technological and non-technological innovation).

In more recent interpretations the concept of innovation is quite diverse, depending mainly on its application. For example, innovation is the successful exploitation of new ideas. And companies' success, for example, means increased revenues, access to new markets, increased profit margins, among other benefits.

Among the different possibilities to innovate, those related to product or process innovations are known as technological innovations. Other types of innovations can relate to new markets, new business models, new processes and organizational methods. Or even new sources of supply. Many people often confuse innovation and innovation processes with continuous improvement and processes. For an innovation to be

characterized as such, it must cause a significant impact on the pricing structure, in the market share, in the company's revenue, etc.

Continuous improvements are not usually able to create competitive advantages of medium to long term, but they are able to maintain the competitiveness of the products in terms of cost.

To conclude, different authors mean different things by the term innovation. This is not necessarily problematic, since definitions and analytical distinctions are not right or wrong. However, for certain purposes specific definitions may be good or bad, useful or not. This pragmatic view of conceptual matters simply implies that the object of study should influence the conceptual specification. The conceptual tools used should, for example, be influenced by whether we want to study only technological process innovations or include product innovations and/or organizational innovations as well.

2.3 The concept of systems of innovation

2.3.1 Innovation Systems

An innovation system may be seen as a pragmatic tool for systematic description and mapping of innovation activities and agencies at the level of regions and nations. The basic idea is that innovation comes neither out of the blue nor out of the mind of the individual entrepreneur. Innovation reflects cumulative processes of interaction where different organizations and individuals combine efforts in creating, diffusing, and using knowledge. The division of labor as well as the pattern of collaboration will reflect the distribution of specific competences among agents and organizations as well as the institutions that shape competition, communication, and cooperation. Analysts can therefore understand the rate and direction of innovation by mapping competences and institutional set-ups under the heading of "innovation system."

But innovation systems may also be seen as the outcome of a process of abstraction quite different from the one made by neo-classical economics. The most basic difference is a double shift of focus from allocation to innovation and from rational choice to learning. In the modern economy, innovation is fundamental for economic performance at the level of both firms and regions. Units that allocate efficiently but keep producing the same product with the same process technology year after year do not survive. It is therefore as legitimate to focus on innovation as it is to focus on allocation.

The most important insight that has dominated the field of innovation studies in recent decades is the fact that innovation is a collective activity. It takes place within the context of a wider system. This wider system is coined 'the innovation system' or 'the innovation ecosystem'. The success of innovations is to a large extent determined by how the innovation system is build up and how it functions, (Bergek & al, 2008)) (Hekkert & al, 2007; Rantisi, 2002). The concept of the innovation system stresses that the flow of technology and information among people, enterprises and institutions is key to an innovative process. It stresses the interaction between actors who are needed in order to turn an idea into a successful process, product or service in the marketplace.

All innovation systems can be characterized by the same basic building blocks or components. These are actors, institutions, networks and technology. Examples of actors are:

- *organizations responsible for education*
- *R&D*
- *industrial activities*
- *consumers*

Examples of institutions are:

- *supportive legislation*
- *technology standards*

Examples of networks are:

- *linkages between organizations in research projects*
- *advocacy coalitions*

The Systems of Innovation (SI) approach has existed the last years after the seminal work by Freeman (1987), Lundvall (1992) and Nelson (1993). The SI approach has become very established in a very short period of time. It is widely used in academic contexts and also as a framework for innovation policy-making. (Saxenian, 1994)

Edquist(1997) defined a system of innovation as "all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations (Edquist 1997). This means that the SI approach is about the determinants of innovations, not about their consequences.

The SI approach does not deserve the status of a ’theory’ of innovation, but must rather be called a conceptual framework. (Edquist 1997)

As a basis for understanding discussions about various kinds of systems of innovation, it is useful to go into more depth in describing what such a system actually is.

2.3.2 National Systems of Innovation

Christopher Freeman (1987) defines a national system of innovation as 'the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies (Freeman, 1987).

Lundvall explicitly defines the concept of a national system of innovation in a 'broad' sense, including all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place (Lundvall. 1992). Lundvall suggests that the boundaries of a national system of innovation cannot be sharply determined, and indeed it might be an impossible task to do so in detail.

Systems of innovation other than national ones can be, should be, and are being identified and studied. An innovation system can be 'supranational' in several senses, it can be truly global, or it can include only part of the world (e.g., an integrated Europe). It can also be 'regional' within a country, an example being the Silicon Valley area in California or Route 128 in Massachusetts (Saxenian, 1994). An innovation system can also be supranational and regional within a country at the same time, as are parts of Germany, France, and the UK. Continuing along the spatial path one may distinguish between a supranational system at the European Union level, the national level, the regional level and the local level.

2.3.3 Sectoral Systems of Innovation

Also we could talk about sectoral systems of innovation (i.e., systems that include only a part of a regional, a national, or an international system). The technological systems approach is a sectoral one in this sense. In contrast to the national approach represented by Nelson and Lundvall, Carlsson et al. (1992) talk about technological systems in specific technology fields. In other words, their approach is sectoral in the sense that it

is determined by generic technologies. They can be, but are not necessarily restricted to one industrial branch. Carlsson and Stankiewicz state that the nation-state constitutes a natural boundary of many technological systems. Sometimes, however, it may make sense to talk about a regional or local technological system. In yet other cases the technological systems are international, even global. Where the boundaries are drawn depends on the circumstances, e.g., the technological and market requirements, the capabilities of various agents, the degree of interdependence among agents, etc. (Carlsson and Stankiewicz, 1995: 49)

Hence, technological systems may be national, regional, as well as international. From the point of view of a transnational corporation, the relevant system of innovation may be similar to a sectoral one but international or global at the same time. Since it is active in many countries, it may also be important for the firm, in its strategy, to take differences between national systems into account - in order to exploit them. At the same time 'technological systems' constitute elements of national as well as regional systems of innovation.

Systems of innovation may be supranational, national, or subnational (regional, local) and at the same time they may be sectoral within any of these geographical demarcations. There are many potential permutations. Whether a system of innovation should be spatially or sectorally delimited depends on the object of study. All the approaches mentioned above may be fruitful - but for various purposes or objects of study.

Sometimes a national approach to systems of innovation is most appropriate and sometimes a sectoral or regional one is more useful. The approaches complement rather than exclude each other. Sometimes one angle is useful, sometimes another.

2.3.4 Regional Innovation Systems

The RIS is defined as a social system that features systematic relationships between different groups of actors, from both private and public sectors, for purposes of increasing and improving the learning capacities localized in a particular region (Doloreux 2002).

However certain studies examining the definition of RIS identify that the region could be a geographic entity too small or alternatively too large to host an innovation system. Some authors propose an enlargement of the concept of the regional innovation system

to also include the extra-regional relationships that influence the innovative process (Bunnell & Coe, 2001). Other studies instead illustrate that the region is an entity too large for the consideration of innovation systems that are in fact often localized in a more restricted area (Rantisi, 2002).

Regional Innovation systems emphasize the spatial organization of industrial activity, and stressing the role of inter-firm relationships. In this view, the non-business actors taking part in regional development, such as supporting institutions, are only secondary.

2.3.5 Urban Innovation Systems

Describing an innovation system at urban level, first we have to mention the actors (institutions / organizations) that play an important role in its shaping, the networks they developed together to interact with each other and the environment on which the innovative activity is favored. We should also describe the market forces that influence innovation activities, the critical components that play a catalytic role in the development of the innovation system, and the institutional arrangements of each city.

The challenge is how each city can draw its own innovation ecosystem. We have to find the ingredients of success and the way in order to facilitate the innovative performance in an urban framework. We must find the appropriate policies to implement, that fit in each city and will improve the innovation performance. Such policies could include the utilization of the scientific and labor force, the mobilization of necessary funds and the supporting of R&D. Later in this chapter we will mention more accurately which are the necessary and specific policies that cities should follow. We will use elements from the three previous case studies and from the contemporary literature in order to come up with a comprehensive plan for the development of an urban innovation system.

Actors

Urban Innovation Systems need particular combinations of actors which depend on the profile of the city. With the term actors we mean both the institutions and the organizations that consciously play an important role on the city innovation ecosystem. Examples of actors are firms, suppliers, start-ups, research institutes, venture capital investors, universities, local government and business/industry associations. Also we should mention the important role of incubators, accelerators, shared working spaces and job training firms which cultivate the innovation performance of the ecosystem.

Networks

Besides the mix of actors and their individual characteristics, the innovation capacity of an urban innovation system also depends on the interactions and linkages between actors. Different types of networks can be distinguished, ranging from formal, institutionalized, and business-oriented networks (supply chains, strategic alliances) to more informal, people-oriented networks. Most networks stretch beyond the region, but in a strong urban innovation system, the city is a focal point with high network intensity. Networks can produce concrete innovative partnerships, alliances, and new ventures, which ultimately churn out innovative products for which there is a market and that produce economic value.

An important force of innovation is the occurrence of unexpected cross fertilizations between people from different trades and backgrounds, resulting in new ideas and initiatives. Cities offer a dense and rich variety of innovative actors commercially oriented, and also artists and counter-movements which their networks at the intersection of sectors can lead to innovations.

Urban networks facilitate the flow of ideas, skills, knowledge and deals. They underpin the supply of innovation, and demand for it. Cities support their own strong networks, and enable firms to access wider networks and flows in the regional, national and international economy.

Some types of networks include:

- *Local networks:* Feature formal and informal business-to-business collaboration between firms, and also between firms and public research institutions. Business-to business collaborations occur at both formal and informal levels. Informal networks are also important in identifying business opportunities, acquiring knowledge and developing ideas.
- *University-business links:* These occur across many cities and are mainly concerned with co-operation and the use of university innovation, technological and scientific expertise.
- *Public-private networks:* These foster business engagement with government programs and universities. For example innovative cities, exhibit strong networks between public sector actors, and between the public sector and the business sector.

Certain advantages of networks are that, they are important sources of new or critical information for new discoveries, they encourage experimentation and are a testing ground for ideas, they help firms acquire resources, they strengthen trust and collaboration within and across sectors, and they help firms enter new markets, including global markets.

Cities attempting to cultivate networks are driven by experimentation, creativity, and even a sociological understanding of how networks function. (Granovetter, 1973), differentiates networks as either having "strong ties" or "weak ties," which are determined by factors such as the frequency of contact, the emotional intensity of the relationship, and the reciprocity of commitments between the actors.

Strong ties occur between people or firms with a working or professional history, higher levels of trust, willing to share more detailed information, and more apt to participate in joint problem solving. Weak ties occur between people or firms working within a different economic cluster or context where there is infrequent contact. Weak ties provide access to new information, even novel industry information, new contacts, and new information on business leads that are outside of existing networks.

Environment

With the term environment we mean both the spatial and the institutional dimensions of the ecosystem that facilitate the innovation activity in a city.

According to the spatial dimension, we mean the location and the accessibility of the city and also the range and quality of amenities that make it an attractive location for skilled labor, entrepreneurs, and firms. Different amenities exert an attraction effect on different types of actors, and broad categories like skilled labor can be broken down into subcategories such as, young talents, international knowledge workers, highly specialized workers and creative class, which may respond to different kinds of amenities. Besides actual conditions on the ground, another important factor is the perception or reputation of the city in the minds of potential inhabitants, visitors, and incumbent firms. A developing urban innovation system can benefit if its city has a strong brand name, while at the same time the presence of well-developed clusters and knowledge locations, can enable a city to develop a powerful brand name it did not previously possess. Besides attracting labor, entrepreneurs, and firms, the spatial

environment may also allow those workers and firms already present in the city or region to become more productive or creative.

At the institutional level we could describe the factors that provide a base for innovation activity. With the term institutional environment we mean the rules of the game and the business cultures and attitudes which have a deep impact in innovation processes. It includes formal rule systems like laws and regulations and enforcement mechanisms sanctioned by the state. But there is also a cultural-cognitive aspect, including accepted beliefs and values shared among individuals through social interactions that guide behavior. Culture reflects the ideas, values, norms, and meanings shared by members of a society and perpetuated through families and communities. Values consist of global beliefs or abstract ideas that transcendentally guide actions and judgments across specific objects and situations (Hofstede, 1980). To a large extent, the institutional environment is a national phenomenon, related to national laws, traditions, and culture. But there are city aspects as well. Cities may differ in their business cultures, norms and values, and degree of openness and tolerance.

Critical Features

Moreover we should consider and other critical features that shape the urban innovation system and play catalyst role in the establishment of the innovative entrepreneurial activity. Some certain factors affecting business location and therefore the innovation performance in a city are connectivity-accessibility, availability of qualified staff, communication, access to markets and quality of life. Below we describe some types of critical features and their role in innovation:

- *Connectivity-Accessibility:* Roads, hub airports, ports and rail links increase cities' effective reach and improve firms' innovation potential. Good transport links and services mean that firms and institutions are closer in time and distance, facilitating collaboration, market transactions and networks. Such links also increase the potential size of markets for services, products and labor. Urban areas still possess a major advantage in terms of the density of communication infrastructures and IT networks, and are also able to provide faster and larger connections in international communications networks.
- *Availability of qualified staff*: The availability of highly skilled workers is a major factor for the location and retention of innovative firms in a city. The

diversity of skills and ability of large urban labor markets to support specialist skills are also important for innovation.

- *Quality of life:* Factors such as amenities and cultural diversity help underpin urban growth and innovation. They are important for the attraction and retention of firms and skilled labor.

Also local demand can be a crucial factor for allowing growth to take off and in particular the presence of lead users who quickly adopt new products and provide valuable feedback to their developers. Besides private firms and individual consumers, the government or the military can also take this role. (Katz & Wagner, 2014)

Moreover, neighborhood amenities provide important services to residents and workers in the district. This includes medical offices, grocery stores, restaurants, coffee bars, hotels, and local retail such as bookstores, clothing stores, and sports shops. Beyond the usual role of these amenities, restaurants, coffee shops, and bars reflect not only contemporary urban consumption patterns but also complement the intensive social interactions of the new economy. Amenities activate city streets and public spaces, inviting a mix of people to shop, browse, and mingle.

2.4 Concluding remarks. The Main Components of Systems of Innovation

We know that different organizations and institutions are important for innovation processes. There is also general agreement on this in the Systems Innovation literature, although this is sometimes not expressed in a clear and direct manner.

Systems of Innovation can be quite different from each other, e.g., with regard to specialization of production, resources spent on R&D, etc. For example, industrial production in the United States is much more specialized in the production of R&D intensive products than is industrial production in the EU (Fagerberg 2001, Edquist and Texier 1996). Further, within the EU, R&D intensities vary greatly between countries. In addition, organizations and institutions constituting components of the systems may be different. For example, research institutes and company-based research departments may be important organizations in one country, while research universities may perform a similar function in another.

Institutions such as laws, norms, and values also differ considerably between systems. In summary, there seems to be general agreement that the main components in SIs are organizations and institutions. However, the specification of these components certainly varies between systems.

Between the components of the systems of innovation there exist relations that contribute to the establishment of the system. Interactions between different organizations are crucial in those learning processes that are normally the basis for the development of innovations. These relations may be of a market and or a non-market kind. Also it could be mentioned that markets only coordinate transactions, i.e. items sold and bought. They do not deal with other kinds of relations. Learning processes, that are interactive between organizations, concern exchange of knowledge elements and collaborations that are not easily handled, through market transactions.

Finally we conclude that innovation and innovation process are absolutely a collective process which requires the existence of different actors and organizations under an institutional infrastructure in which the networking and interrelations facilitate the innovation process.

3. Case studies from Urban Innovation Systems

3.1 Eindhoven

Eindhoven is a municipality and a city located in the province of North Brabant in the south of the Netherlands, originally at the confluence of the Dommel and Gender streams. The Gender was dammed short of the city center in the 1950s but the Dommel still runs through the city. The city had a population of 221,402 in 2014, making it the fifth-largest city of the Netherlands and the largest of North Brabant.

Neighboring cities and towns include Son en Breugel, Nuenen, Geldrop-Mierlo, Heeze-Leende, Waalre, Veldhoven, Eersel, Oirschot and Best. The agglomeration has a population of 337,487. The metropolitan area consists of 419,045 inhabitants. The city region has a population of 749,841. Also, Eindhoven is part of Brabant Stad, a combined metropolitan area with more than 2 million inhabitants.

Figure 1: Map of Netherlands

Source: Wikipedia

3.1.1 Eindhoven's Innovation System: Historical roots and sources of strength

Eindhoven, with its strong specialization in high-tech systems and materials, design, life-tech, and the automotive industry, is one of the leading European regions in research and development. Its strong performance in innovation can be traced back to its historical development trajectory, with particular importance of the region's leader firms Philips (micro-electronics) and to a lesser extent DAF (automotive industry), which laid down much of the region's physical, human, and social capital and through spin-off created many of the currently dominant firms of the region.

During the 1990s, the region had to deeply restructure itself during a crisis before reaching its current level of innovation performance. This restructuring process had an especially strong impact on the region's system of governance, triggering stakeholders to set up a strong regional government layer, eventually culminating in the creation of a public–private organization for economic development (Brainport Foundation).

Besides the deep historical roots of its innovation performance, several key features explain the region's performance and present challenges to safeguard its future growth prospects. A major source of strength underpinning the innovation performance of the Eindhoven system is the fact that its key firms are strongly embedded in the region. They feel a strong attachment to the region and are willing to make a contribution to addressing challenges facing the region. Strong local embeddedness explains why Philips was willing to invest as deeply as it did in the region, as were young firms such as the semiconductor giant ASML. But also, for example, the fast-growing ICT firm Sioux aspires to become one of the new anchors of the regional economy. (Winden & al, 2014)

The key benefit of having strongly committed leader firms is their positive effect on the region's supply chain. Eindhoven OEMs are highly demanding but at the same time generous to their suppliers in terms of knowledge sharing and building healthy long-term relations rather than squeezing supplier's profit margins for short-term cost advantage. In this way, they help their suppliers continually upgrade themselves and become able to carry out their own R&D.

First, he development of the High-Tech Campus and the Brainport Innovation Campus, with key roles for Philips and ASML, respectively, illustrates another way leader firms

can contribute to the strengthening of the regional value chain. However, the kind of region building Philips used to engage in is now a thing of the past, and an over-reliance on a few key leader firms could turn this source of strength into a threat to the sustainability of the region's competitiveness.

Second, the effort to rejuvenate the regional economy in the 1990s left the region with a strong governance network of pro-active public and private stakeholders. Through their regional cooperation organization and the public– private organization for regional development (Brainport Foundation), a wide network of local actors has developed effective ways to collectively address the region's challenges. This public private governance model seems very suitable to cope with the complex and fast-changing opportunities and threats facing urban innovation systems. The working style of Brainport Foundation illustrates the need to set up such intermediary organizations with care, providing sufficient funds and legitimacy to be an effective partner for local firms and research institutions but without making it too independent (with an overly generous budget) or dominant (with too far-reaching a mandate).

Third, a strong research infrastructure is an essential asset of the innovation system, first and foremost as a source of new talent. The region's technical university, TU/E, is especially strong in cooperation with local industry, a crucial task many universities in other regions still struggle to perform well. But historically, its bonds with local industry have been so strong that it made the TU/E overly dependent on a few key private partners for funding and direction. Its recent development strategy, illustrated by the redevelopment of the TU/E Science Park, is an interesting case in how a university can reform itself into a more independent and central actor in the system while keeping its traditionally close bonds with industry. Moreover, the TNO and Holst Centre are interesting cases in public– private cooperation in research and development.

A fourth source of strength for the Eindhoven system is the widespread adoption of open innovation among its firms and other stakeholders. This umbrella of innovation strategies promises to enable the system to sustain its high innovation performance even if firms are no longer able to fund the kind of large internal R&D labs like the NatLab that first brought the Eindhoven system to prominence. But the successful application of open innovation puts high requirements on a system, most notably the ability of local actors to carry out R&D cooperation based on trust rather than contracts, and the ability to quickly establish and nurture start-up and spin-off firms. The Eindhoven region

shows an exceptional ability for the former but performs relatively weakly on new firm creation.

Finally, the Eindhoven system has benefited from an effective regional branding strategy, which is the fifth source of strength identified for its innovation performance. It went from a relatively obscure and underestimated region to a globally recognized one in just a decade, presenting itself to the world with a focused brand image (rather than trying to be perceived as 'good at everything') agreed on by a wide coalition of local stakeholders. While this strong branding is a relatively recent asset for the Eindhoven region, it can help attract more leading firms to the region and strengthen its position in the global network of innovative regions.

Figure 2: View of Eindhoven

Source: website

3.1.2 Conclusion. Key challenges for the future

Besides these five sources of strength of the region, four key challenges face the region's stakeholders if they are to sustain their competitiveness in the future.

The first and most urgent challenge that Eindhoven faces is in addressing its shortage of skilled technical labor, making it an interesting case for any innovative region facing the need to attract substantial numbers of international knowledge workers. The Eindhoven region benefits from its attractive environment and open character and above all from the cutting-edge research opportunities at its firms and research institutions, which form the most important attraction factor for international knowledge workers. Innovative living concepts at StrijpS also form an interesting potential element in a strategy for attracting international knowledge workers.

Second, the region is over-specialized in the high-tech systems and materials sector, which is highly innovative but also very vulnerable to cyclical ups and downs. Moreover, this sector has a tendency to produce a small number of large firms at the top of extensive value chains, increasing the vulnerability of the region. If any of these leader firms were to offshore their R&D or relocate out of the region altogether, the repercussions of this would ripple through the region's value chains and potentially create a new crisis like the one the region faced in the 1990s. The rapid emergence of the design sector holds promise to help the region diversify into a more recession-proof industry, and the Strijp S redevelopment project may play a key role in this. Also, the leader firms themselves are strengthening their position in sectors such as healthcare, energy, and mobility, which are likely to enjoy steady demand in the near future owing to, among others, trends of population ageing and the need for energy transition.

The third challenge facing Eindhoven is its relative weakness in new firm creation. Since this challenge seems to be caused by both, a paucity of entrepreneurial spirit and skills among the region's knowledge workers and a weakly developed network of venture capital investors, an integrated solution is needed to address this weakness. Start-up and spin-off incubation is a generally accepted policy instrument for providing such an integrated solution. While both examples of success and failure have been identified, start-up incubation remains a complex challenge to the many Eindhoven stakeholders involved in it.

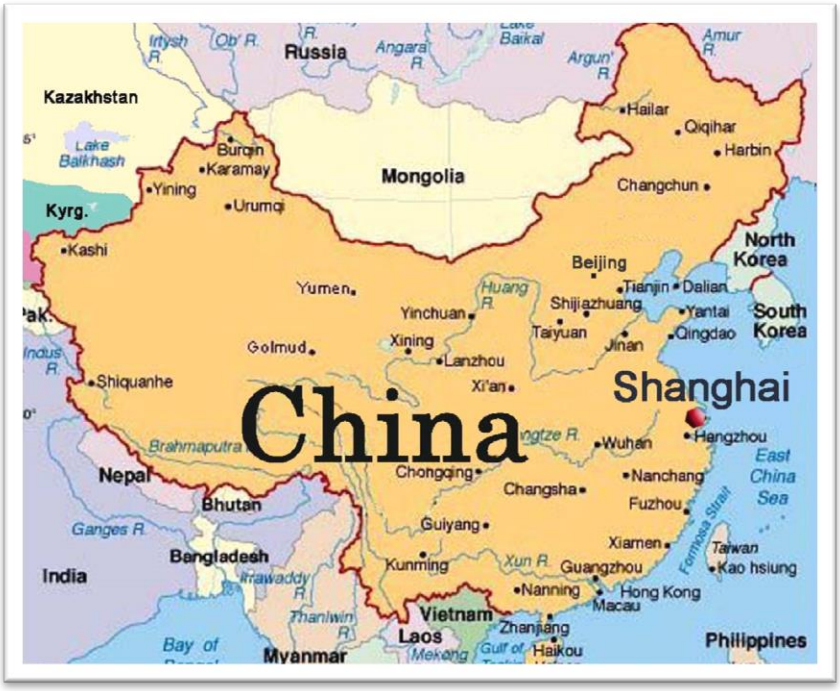
And finally, the region faced the challenge of a shortage of public investment in R&D, making the region's research infrastructure highly dependent on the willingness of local

firms to make increased investments. In general, a dependence of private rather than public R&D does not have to be a weakness for an urban innovation system, but at turning points in its development, a lack of public funding sources can threaten the sustainability of its innovation performance. (Winden & al, 2014)

3.2 Shanghai

Shanghai is the largest Chinese city by population. It is one of the four direct-controlled municipalities of the People's Republic of China, with a population of more than 24 million as of 2013. It is a global financial center, and a transport hub with one of the world's busiest container ports. Located in the Yangtze River Delta in East China, Shanghai sits on the south edge of the mouth of the Yangtze in the middle portion of the Chinese coast. The municipality borders the provinces of Jiangsu and Zhejiang to the north, south and west, and is bounded to the east by the East China Sea.

Figure 3: Map of China



Source: Website

The area's GDP constitutes 18 percent of the national total. Shanghai is the largest city of the YRD and is identified as the leading city and promoter of the YRD's growth. Also, in order to speak of a regional innovation system, it is required for a region to

possess governance competences, that is political and, ideally, financial autonomy. Whereas Shanghai largely meets these criteria, the YRD does not: it is an economically integrated region that is coordinated by a committee with members from different cities in the YRD, but is not governed by a distinct regional authority.

Shanghai is an autonomous municipality, combining governmental features of both a city and a miniature province. The government of Shanghai mirrors the central government, as the mayor of Shanghai presides over the same type of ministries and commissions that exist at the central level. Technically, authorities in Shanghai merely implement the central government's directives.

3.2.1 Shanghai's development path

The Shanghai Development Path and Current Policies until the founding of the PRC in 1949, Shanghai was the economic hub of China in the areas trade, finance and light industries. However, after the Chinese Communist Party took power, private industry disappeared. Simultaneously, the ratio of light to heavy industry in the city fell from 71:29 in 1957 to 49:51 in 1978. Shanghai lost its economic autonomy and had to remit the majority of its revenues to the center. (Stenberg & Muller, 2005)

Among others, the resource outflow resulted in a chronic underfunding of the local infrastructure (Lin 1998, p. 50). Economic reforms were initiated in 1978, but during the first few years, Shanghai was left out of the reform process, as the central government was reluctant to allow experimentation that might threaten its revenues. Excluding Shanghai from reforms seriously damaged its economy. In 1978, the city topped the list of all provinces and regions in contributions to national income. By 1986, Shanghai had fallen to number six, in 1990 to number 10 (Segal, 2003).

Shanghai's recovery was initiated by the development plan of February 1985, which arranged for the city to regain its national lead in commerce, trade, science and technology (Segal 2003). The main goal of this policy was to revitalize Shanghai by granting Shanghai a status similar to that of the special economic zones (Han, 2000). Another important step for Shanghai's comeback was the urban 10th five-year plan (2001-05), which proposes that the future role of Shanghai should be as a high-tech hub and business center of China. To support such a strategic transformation, the traditional six pillar industries of the 1990s (e.g. automobiles) are to be replaced by new ones, including high-tech industries (Segal 2003).

Of the six high-tech parks in Shanghai, Zhangjiang in the Pudong New Area is the locus of new investments in high-tech-industries, in particular semiconductors, software and biotechnology. The park administration and the municipal government have aggressively pursued investment, e.g. by offering subsidized loans and generous tax exemptions. As a result, Zhangjiang is emerging as one of the major biopharmaceutical parks in China. Since 1994, more than 30 R&D institutions have been built in close proximity to each other, and a number of multinational pharmaceutical companies have set up branches in Shanghai. Roche is one of the first multinational companies to set up an R&D center in China (Wang 2004).

Figure 4: View of Shanghai

Source: Website

More recently, Shanghai began to pay more attention to the role of entrepreneurship for the development of high-tech industries. At the beginning of the reform process, there was doubt about whether Shanghai should rely on small-scale enterprises to achieve its economic goals. High-tech-parks were established mainly in order to attract foreign direct investment (FDI) and to induce the creation of joint venture firms that would be the vanguard of technological development, but not in order to promote entrepreneurship.

However, because of the success of non-governmental enterprises, officials in Shanghai began to realize that the city needed to rely less on SOEs to promote a regional innovation system. The city began to create innovation centers and incubators for

private enterprises within the zones and near major universities (Segal 2003). By the end of 2004, there were 28 incubators in total. Additionally, Shanghai established several organizations that finance research and development activities of private companies.

3.2.2 Innovation and Entrepreneurship policies

Policies fostering (high-tech) entrepreneurship focus on two types of entrepreneurs. First, universities in Shanghai have started to formulate incentive policies in order to encourage faculty members to commercialize their R&D achievements. Secondly, the city supports entrepreneurship by Chinese who are returning home after years of study and work abroad. Attracting returnees has become an ever more important element of Shanghai's high-tech strategy. Among other measures, the city has established "Overseas Student Parks" within the high-tech development zones. These parks are reserved exclusively for companies started by returnees. They offer low rent, tax breaks etc. like other science parks in China, but they also address the special needs of returnees, such as accelerating the bureaucratic process involved with establishing residency and ensuring access to housing (Zweig, 2005).

Partly a result of these policies, the trend for Chinese overseas students to return to China and found a high-tech company has been accelerating. The number of companies founded by "returnees" in Shanghai has increased at the rate of one per day since 2002, reaching 3,000 and amounting to a total investment of € 330 million by the end of 2004 (China Economic Information Service 2004). In 2003, in Zhangjiang High-tech Park, the most popular site in Shanghai for entrepreneurs in high-tech sectors, there were approximately 500 companies founded by "returnees", among them 50 biotech companies.

Shanghai has largely regained the autonomy to implement its own innovation policy, a prerequisite for creating a regional innovation system. There are visible outcomes of Shanghai’s diverse policies to improve its innovative capability. Shanghai now has the second highest number of research institutes affiliated to the prestigious Chinese Academy of Science (Chinese Academy 2005).

Additionally, two of 100 premium universities are located in Shanghai. Of the two, Fudan University ranks number six in China concerning the number of key state laboratories where research of strategic importance or high technology is carried out (Liu & Jiang, 2001).

Shanghai is among the top five regions concerning the number of patent applications granted (National Bureau of Statistics 2003, p. 769). Beijing outpaces Shanghai in the number of high-tech firms and employees, their revenues as well as their exports, but Shanghai leads Beijing in the average size of firms, and with regard to the revenue and exports either per firm or per employee.

Shanghai has been developing rapidly, but is still in transition from a site of heavy industry to a metropolitan region comprising a range of industries (including high-tech) and services. Therefore, it exhibits some of the weaknesses typical of old industrial regions, such as the dominance of large firms, the concentration of firms in traditional industries and a political lock-in.

3.2.3 Conclusion and the role of Returned Entrepreneurs

To summarize, although Shanghai has undertaken many steps to create an innovation system and has started to recognize the role of entrepreneurship for innovation, deficits prevail. Most notably, the majority of SOEs does not innovate. At the same time, the prominence of SOEs in the economy constrains the development of private entrepreneurs, potentially important innovation actors, thus resulting in a lock-in.

High-tech companies started-up by Chinese returning from overseas can therefore be expected to make a significant contribution to the Shanghai innovation system. Entrepreneurial return migrants may contribute significantly to regional innovation systems in return migrants' home countries, for two main reasons:

- If they start up NKBFs, this increases the number of innovation actors based in the region.
- Return migrants tend to maintain extra-regional linkages or networks, thus facilitating the flow of knowledge into the respective regional innovation system. This can help to overcome regional innovation deficits.

Shanghai can be considered a regional innovation system, albeit one that is still in transition from a manufacturing site and hampered by a dominance of SOEs. Returning entrepreneurs mainly engage in product development activities in the medium range of high-tech. For this type of activity, the regional framework conditions, a combination of first-world infrastructure and third-world labor costs (including qualified labor) are rather good.

However, insufficient framework conditions such as a lack of property rights require that return migrants bring back the core technology or knowledge from abroad. Additionally, they rely on formal and informal international networks for further innovation activities. This facilitates a continuous flow of new knowledge into the region.

Returning entrepreneurs integrate in regional networks for two main reasons.

1. Regional cooperation is determined by the necessity to "survive" in a difficult and unpredictable environment. Although conditions for private companies in Shanghai have improved, entrepreneurs are still facing many constraints and have to secure government support. Returning entrepreneurs therefore cooperate with and talk to government agencies in order to establish guanxi (connections or relationships). As a side effect, knowledge spillovers occur.
2. Regional cooperation is also motivated by the need for resources which are mainly provided by universities and research institutions. However, whereas in industrialized countries, the flow of knowledge runs from universities to companies, in Shanghai it is the other way round.

Returned entrepreneurs are uniquely positioned to utilize location-specific advantages in two parts of the world by dividing the innovation process into two phases. Knowledge production (phase 1) is located in more advanced innovation systems abroad, and commercialization (phase 2) in Shanghai. However, their strategy is a response to the weaknesses of the Shanghai innovation system, as different from (successful) regional innovation systems in industrialized countries, international rather than regional R&D cooperation’s and face-to-face contacts are important for the companies’ innovation base.

To conclude, returned entrepreneurs can be regarded as a factor contributing to the development of the Shanghai innovation system. Nevertheless, founding a high-tech start-up in China is still a challenge with high risks involved that only experienced returnees can master.

3.3 Vancouver

Vancouver officially the City of Vancouver, is a coastal seaport city on the mainland of British Columbia, Canada. The 2011 census recorded 603,502 people in the city, making it the eighth largest Canadian municipality. The Greater Vancouver area of around 2.4 million inhabitants is the third most populous metropolitan area in the country and the most populous in Western Canada. Vancouver is one of the most ethnically and linguistically diverse cities in Canada, 52% of its residents have a first language other than English. The City of Vancouver encompasses a land area of about 114 square kilometers, giving it a population density of about 5,249 people per square kilometer (13,590 per square mile). Vancouver is the most densely populated Canadian municipality, and the fourth most densely populated city over 250,000 residents in North America, behind New York City, San Francisco, and Mexico City.

Statistics Canada (2003) report that Vancouver has an industrial diversity very similar to Toronto although having a significantly smaller population. The key question to be addressed is whether the clusters started early and grew more or less autonomously via say the inheritance model of cluster development or whether their development has been greatly influenced by external events or even transplanted from elsewhere

Figure 5: Map of Canada

Source: Website

3.3.1 Vancouver's Innovation Clusters

Vancouver is a major center of innovation in Canada. More particularly it hosts a number of human-capital intensive clusters. Vancouver is based on human capital based economic activities that are important to the region, albeit that is mostly a little unexpected in a city so far from other major population centers. (Wixted & Holbrook, 2012) These activities are:

- fuel cells (predominantly based on hydrogen technologies)
- bio-pharma (a range of firms creating human health oriented biotechnologies or traditional pharmaceuticals)
- motion pictures based
- new media (mainly the electronic games sector)
- wireless technologies

Fuel Cells.

Of all the human capital intensive activities, fuel cells are the smallest and most specialized in terms of spillovers. Although it has benefits from R&D capital from outside the region, it is significantly an undiversified cluster as it relies on local R&D facilities and access to near-local talent at the University of Victoria (Holbrook et.al. 2010).

Bio/Pharma.

The prime characteristic of the bio/pharma cluster in Vancouver is one largely of IP rent seeking. For example it doesn't have the critical mass of important centers east and south, but companies do have strategies for managing the construction of value in Vancouver. In response to the question 'how does your firm benefit from being located in this particular urban region with its mix of firms/institutions' the answer is that, to a limited extent the company does benefit from ideas generated in the local milieu and the skilled people that reside there.

Another interesting insight is that mainly collaborate with Australia, New Zealand, California, Montreal and North Carolina. So in Bio-Pharma the specific location of Vancouver has helped it survive but has been a barrier to its development beyond a certain size.

Wireless

The wireless cluster has had a long and varied path in Vancouver relying on investment from outside the region as well as, for a time, an innovative, provincially owned telephone company. Today the cluster has close ties with the new media cluster. This closeness is highlighted by the very recent amalgamation of the two industry associations WinBC (for Wireless) and New Media BC into DigiBC, an organization representing approximately 22,000 employees and 1300 companies.

Motion Pictures

What is interesting about the story of Vancouver and motion pictures is there has been a very traditional split between foreign film development in Vancouver and Canadian film industry activities in Toronto (Coe 2001). This trend has been weakening in more recent years. The dependency of Vancouver on external interaction is seen by the need to continually reassess the tax credit status of foreign films (primarily out of the USA).

As a location, Vancouver was extremely well placed to benefit from the opportunities being created by the on-going vertical disintegration of the Hollywood studios. The city is close to Los Angeles (2.5 hours' flying time), provides an enviable 'west coast' quality of life, is in the same time-zone thereby allowing easy co-ordination of activities between the two centers, has a mild climate which allows all-year-round filming and offers a large range of different scenic locations within 1–2 hours' drive of central Vancouver. (Wixted & Holbrook, 2012) (O'Connor & Scott, 1992)

In 2009 this industry in Vancouver experienced significant economic turbulence during the global financial crisis, but seems to have nevertheless attracted significant investment.

New Media

The new media specialization and diversity pattern is summed up excellently by the following. Vancouver is a beautiful city, a draw for recruits. Sea to sky has a lot of amenities, great place to make video games because there are lots of companies that make video games. Hollywood at the North helps, strong film and television, cross fertilization, they use those professionals. Also there exist great educational institutions that produce high caliber potential hires. Lastly Vancouver is a Pacific Rim gateway, including to the east. It is cheaper to develop here than in the US.

The advantage for Vancouver is simultaneously local, diverse (interactions with motion picture industry) and translocation (given references to being on the Pacific Rim as well being a gateway to the East,Toronto and Montreal). The reference to cross-fertilization is important. This is an explicit acknowledgement of the value of clustering among both competitors and similar, but not necessarily competitor industries (i.e. new media and motion pictures).

Figure 6: View of Vancouver

Source: Website

3.3.2 Evidence from Vancouver's Innovation Clusters

Three phenomena should stand out. First, apart from the example of motion pictures, the Vancouver cluster started early globally, in one case, fuel cells, leading the world to re-examine the technology. It would suggest that mostly these are not spin-out clusters but have their own independent trajectories. Second, apart from fuel cells all the clusters rely on a diversity of spillovers for inputs that at the very least are local but in many cases stretch across the North American continent both east and south. The outputs of these clusters are marketed globally. Lastly, we can suggest that there something west coast about many of these activities which have a distinctly mid to late 20th century origins in comparison to east coast US manufacturing or business services, which in Canada are based in Toronto and Calgary but not Vancouver.

While there is some evidence for cross industry spillovers the strongest evidence is for multi-spatial spillovers in terms of inputs and for a global outlook in terms of sales. Agglomeration, the lifecycle evidence suggests that all the clusters are mostly of long standing in the Vancouver region and with the exception of the major motion picture

activity all clusters have indigenous roots, suggesting that they are not spin-outs from more innovation intensive regions.

3.3.3 Vancouver's Innovation System on the Pacific

A dominant factor in the emergence and continuance of Vancouver is its position on the west coast of North America, as well as being the most accessible Canadian airport to Asia and being in the same time zone as California.

In contrast to the current regional science philosophy, it was previously argued that transport systems were vital. The development of cities and regions has generally been associated with the development of transport. A good description of this association has been provided by Anderson's (1985) overview of European urban history where the fortunes of places have been shaped primarily by their position in a transport system. (O'Connor and Scott 1992:240).

Prior to the arrival of the Boeing 707, Vancouver was where the trans-Canada rail line had placed it, literally and figuratively at the end of the line. It was simply an intermodal (rail/sea) transfer point and the northwest edge of the North American continent. At that time, Calgary was a bigger destination for air passengers in the early 1950s (Natural Resources Canada, 1957). This changed with the introduction of the first mid-sized long haul aircraft and today the Boeing 777 and the Airbus 340 are specifically designed to fly the ''thin'' routes and thus continue to change hub positioning. The change in aircraft has been assisted by changes in navigation and air route administration involving trans-polar routes which has reduced flying times between Europe and North America, and from the Asia Pacific region to both North America and Europe.

A second technical shift has involved the refinement of engine performance, along with management of passenger and freight loads, to create 13–15 hour point-to-point services. Extended range 747s, 777s and A340- 500s have made it possible to fly directly between places like Chicago and Hong Kong, New York and Hong Kong and Los Angeles and Singapore. Taken together these changes have helped change the pattern of passenger traffic in North America. Today, Vancouver is a major gateway city, being the fourth largest seaport in North America and more importantly for its human capital based activities it continues to develop as a major airline hub.

The ocean rim character of the region's settlement provides another reason for the growth in air travel. In effect, the region is a series of nodes around the Pacific Ocean, with strong, outward looking commercial activities, and in many cases, very limited local hinterlands. Vancouver, Los Angeles, Sydney, Singapore, share an unusual characteristic in that they have large concentrations of population, but with limited development of an inland hinterland (O'Connor and Scott 1992: 244). Thus, aircraft technology and preexisting settlement patterns form important feedback loops that enhance or diminish a city's ability to attract traffic and talent.

Different innovation systems around the world have different human capital attributes and different technological advantages and their geographic positions differ markedly, but all three characteristics matter.

Vancouver is almost unique as a local innovation system (LIS) in North America: it is not self-contained, it is dependent upon its transportation and communication links. The city and its LIS are a "pivot point" between North America and Asia, unlike many of the other high-tech cluster areas in Canada and the US. Its major continental competitor is in California, which has similar geographical attributes. There are other strong LIS systems on the Pacific rim, "city-states" such as Singapore, Hong Kong, Sydney, and some large Chinese port cities, but only a very few are gateways to larger systems of innovation.

A few of them are currently or have been manufacturing centers. Others are entrepot trade and financial centers (Hong Kong and Singapore) and two in particular, Vancouver and Sydney interestingly both at extremes of the Pacific system are based on human capital activity. The behavior of LIS on the Pacific Rim differs greatly from LIS in continental North America or Europe, or from other diverse economies such as India or inland China. Because of the distances involved, the Pacific system of innovation can be thought of being as a chain of local systems of innovation, with innovation gateways where continental lines of communication intersect the Pacific Rim.

3.3.4 Conclusion and Policy considerations

It is clear that conventional innovation policy tools, such as support for R&D, are necessary, but not sufficient. The bio-pharma cluster in Vancouver certainly started through major bio-pharma R&D investments, but that by itself is not sufficient to

explain its continued existence. Clearly conditions must also exist to attract and retain highly skilled workers (Florida's "super-creatives").

In Vancouver these conditions exist: the natural setting is spectacular, but also the various levels of government have combined to provide infrastructure and amenities that above many in North America. The Economist Intelligence Unit regularly rates Vancouver as one of the most desirable places to live in the world. The infrastructure includes significant investment in:

- mass transit
- airports
- hospitals
- schools, and universities

But government policies have also favored the development of significant cultural and recreational amenities:

- theatres
- galleries
- sports venues
- green spaces

In the Canadian system of government many of these improvements fall to the city government. Both the City of Vancouver and Metro Vancouver (the regional government) have contributed directly to the development of the Vancouver LIS. Vancouver's clusters increasing are benefiting from both the market demand and the cross-fertilization possible from the presence of Hollywood North. Further the individual cluster stories have been shown to have benefited from industry associations providing some of the needed social capital for clusters that are fragmented and dominated by small enterprises to continue to seek and develop new opportunities (Petrusevich 2005 and Reibling 2004).

But the evidence on the history of the clusters, replicating by means of entrepreneurial spin-offs from earlier firms suggests very specific policies for innovation. Experience appears to matters to a very significant degree. In such an environment that is always likely to lose larger businesses and research/manufacturing endeavors to more central places encouraging a system of mentoring and experience needs significant policy focus. While it is difficult to generalize, the specifics of the Vancouver case indicate

that clusters with low critical mass and distant from mega-regions appear to have particular dynamics. Firms seem to struggle to grow to any size and there is significant turning over of businesses and staff. Thus, the opportunities lie with speeding up the learning process for new graduates through fostering greater opportunities for experience.

4. Key factors enhancing the development of urban innovation systems

4.1 Introduction

In the previous chapter we have provided an analytic description of three case studies of urban innovation systems. Eindhoven, Shanghai and Vancouver present similarities and differences in the way they follow to achieve a high innovation performance. Certain factors appear to be, key elements leading to the success of an urban innovation system and other seem to have more local characteristics which have as a result to differentiate one urban innovation systems from another. Also each city follows its own strategy to develop its innovation systems. This means that we can't apply a particular set of policies in every city to develop an innovation system, but we must take into consideration the particular characteristics of each city separately. Each city faces particular weakness, so it should implement a strategy that fits its characteristics and is based on its comparative advantages.

In this chapter we will describe briefly the main factors and policies, which we have drawn from the case studies. We will stress the similarities and the differences between them and then we will conclude with the certain factors and functions that could play a crucial role in the development of an urban innovation system.

4.2 Key factors outlined from the Eindhoven's, Shanghai's and Vancouver's case studies.

Eindhoven is characterized by its strong specialization in high-tech systems and materials, design, life-tech and in automotive industry. The regions leader firms have particular importance in the performance of the urban innovation system and they define much of the regions physical, human and social capital. Other major sources of strength are the High-Tech Campus (Brainport), the governance network of pro-active

public and private stakeholders and the strong research infrastructure is an essential asset as o source of new talent. Also the adoption of open innovation among firms and other stakeholders and the regional branding strategy which attracts more leading firms to the region play a key role in Eindhoven's innovation system.

About Shanghai's innovation system we observe that, returned entrepreneurs play a crucial developmental role in the urban innovation system and they contribute to the enrichment of the urban knowledge base. Also the presence of the high-tech parks favors the innovation activity and attracts foreign direct investments in order to induce the creation of joint venture firms that would be the vanguard of technological development. Innovation centers and organizations for financing are included in the innovation and entrepreneurship policy in Shanghai and they contribute to the achievement of high innovation performance. Moreover another innovation and entrepreneurship policy is the formulation of incentive policies in order to encourage faculty members to commercialize their R&D achievements.

Finally the city of Vancouver is a place with a spectacular natural setting which provides infrastructures and amenities that rate the city as one of the most desirable places to live in the world. The industrial diversity makes Vancouver's production base more resilient and the accessibility infrastructures which increases the market demand are a basic factor in the performance of the urban innovation system. The cultural and recreational amenities contribute to the creativity of the city and the industry associations provide the need for social capitals which benefits the existing clusters and favor the establishment of new ones.

More detailed we have mentioned the following elements and characteristics that play a catalytic role in each one of the three urban innovation systems:

<u>Eindhoven</u>

- High-Tech Campuses
- Governance Network
- Strong Research Infrastructure
- Open Innovation
- Regional Branding Strategy

Shanghai

- High-Tech Parks
- Entrepreneurship
- Foreign Direct Investments
- Innovation Centers
- Organizations for Finance

Vancouver

- Natural setting
- Infrastructure: mass transit, airport, hospital, schools, university
- Cultural and recreational amenities: theaters, galleries, sport venues, gree spaces
- City Government
- Market demand
- Industry Associations
- Place to live

Table 1: Case studies elements of urban innovation system

	Eindhoven	Shanghai	Vancouver
High-Tech Campus	✓	✓	
Governance Network	✓	✓	✓
Research Infrastructure	✓	✓	
Branding Strategy	✓		
F.D.I		✓	
Innovation Centers	✓	✓	
Organizations for Finance		✓	
Cultural amenities			✓
Industry Associations			✓
Accessibility	✓		✓
Attractive environment	✓		✓

Source: Own process

4.3 Policies for the development of urban innovation systems

4.3.1 The meaning of innovation policy

Innovation policy is sometimes needed, but must not replace, duplicate, or crowd out what private actors can do. It shall supplement private action. Public action should contribute to solving problems that the private actors cannot handle

Innovation policy is defined as all actions by public organizations that influence innovation processes. This includes actions that unintentionally influence innovations. Innovation policy embraces all the policies that affect innovation processes, such as parts of research policy, education policy, regional policy, defense policy, and public innovation procurement. Hence, it is a question of a large number of actions carried out by, for example, many government ministries and agencies. Obviously innovation policy is defined in a very comprehensive and wide way.

Innovation policy needs to focus on creating the conditions that allow innovation to flourish, but also, and perhaps especially, on directly commissioning and procuring innovative solutions. History tells us, that these will not happen without a strong push by the local government (Mazzucato, 2011) (Edler & Georghiou, 2007).

4.3.2 Returned Entrepreneurs

As we described in the case of Shanghai's innovation systems, companies started-up from returnees are expected to make a significant contribution to the urban innovation systems. For example return migrants tend to maintain external linkages or networks, thus facilitating the flow of knowledge into the respective urban innovation system. This can help to overcome city innovation deficits and renew the production base.

Return migrants bring back the core technology or knowledge from abroad. This has as an aftermath the enrichment of the city innovation system and its differentiation. Also facilitates a continuous flow of new knowledge into the city.

For returning entrepreneurs, cooperation between them is determined by the necessity to survive in a new and unpredictable environment. In such conditions they establish networks that integrate into the urban innovation systems. Urban cooperation is also motivated by the need for resources which are mainly provided by universities and

research institutions. To conclude, returned entrepreneurs can be regarded as a factor contributing to the development of urban innovation systems.

4.3.3 Public Innovation Procurement

The connection between public procurement of goods and services and innovation is mainly based on three considerations (Edler & Georghiou, 2007) (Geroski, 1990). Firstly, procurement of innovative products and services can have a direct impact on service delivery. It can make public services more effective through improving service delivery or adding new services that add value to citizens. It can also make public services more efficient. Despite the higher search and purchasing costs associated with buying innovations, the adoption and use of an innovative product or service can lead to overall net life-cycle cost savings and thus to overall net benefit over time.

Secondly, public demand for innovation can incentivize industry to invest in innovation, with potentially substantial spillover effects. This can happen in two ways: public procurement can trigger innovations by formulating a new need, and set in motion new innovation cycles. It can also be responsive to novel products and services produced by industry, and thus send a signal to industry that the urban authorities market is a location in which innovative goods and services can be introduced and diffused. Urban demand for innovation can also give suppliers in a given city a leading edge at an urban level and potentially initiate further private demand. Furthermore, there is a particular benefit for innovative start-ups. Such firms often struggle to find the first customer to begin their 'reference list'. A city purchase helps to overcome this credibility gap and is worth far more than a grant. On the basis of largely qualitative empirical work, analysts have already characterized procurement policy for many years, as 'a far more efficient instrument to use in stimulating innovation than any of a wide range of frequently used R&D subsidies' (Geroski, 1990, p. 183).

Thirdly, public demand is seen as trigger for products and markets, the diffusion of which helps to support policy goals in other domains, such as energy, health, transport and so on. The car fleets of public organizations or the construction tenders for public buildings can set an example for the private sector, demonstrating feasibility and effectiveness, and thus lowering the entry barriers for innovations in the private sector. This then can multiply the initial public sector purchasing effect beyond its actual spending power. Hence, spillover effects must be taken into consideration when

assessing the relative benefit of a city purchase of an innovation. (Edquist & al, Public Procurement for Innovation, 2015)

4.3.4 The role of Universities in an urban innovation system

Universities have long been recognized as providers of basic scientific knowledge for industrial innovation, through their actions in research and related activities. Such benefits were understood as particularly accruing to the agricultural and manufacturing sectors (Guston 2000; Smith 1990; Hart 1988).

Universities have a "generative" and "developmental" role in local innovation systems (Cooke 2002; Niosi and Bas 2001; Lundvall and Johnson 1994). Universities and public research organizations have been given a much more prominent role in recent models of knowledge production (Charles 2006). Gunasekara (2006: 143) identifies two models of university involvement in regional development. First, the generative role serves regional needs directly, by providing boundary-spanning activities like incubators and science parks. Second, a broader developmental role is filed by adjusting research and teaching activities to regional needs.

Universities play a key role in urban innovation systems:

- They enhance the urban knowledge base through their international academic networks, serving as gateways for local businesses to reach external knowledge (Altbach 1998: 179; Fritsch and Schwirten 1998).
- They can adapt knowledge from extra-regional sources to produce new forms that are more appropriate for the urban innovation system. In doing so, they reduce entry costs for new technologies and open windows of opportunity for catch-up processes (Perez and Soete 1988: 476).
- Universities usually enjoy greater autonomy than do other actors, maintaining substantial levels of control over their financial, personnel, and academic affairs. Universities that are fully or partially incorporated tend to establish even greater levels of independence, and are capable of responding still more efficiently to city needs.

Universities are one of the main endogenous knowledge sources in many cities and thus take wider responsibility in the whole process of economic development. Local SMEs are often almost completely lacking in technological capacities, and are in need of basic technical education and services, generally without advanced research.

4.3.5 Cultivation of shared vision as a mobilizing factor

The main quality of a Vision is its mobilizing power: it should attract urban stakeholders around a common bold project, a dream, which many feel they can contribute to and benefit from. It will be easier to run this step when a city 'grand figure' (a politician, an industrialist, a leading academic, a well-known artist…) pushes the Vision forward on a large scale. Times of crisis often provide a good opportunity to generate such new Visions, starting from the well acknowledged need to escape the crisis. The main difficulty for a Vision is to be ambitious but still credible. Over-ambitious claims might undermine an urban strategy from the start, if the Vision cannot be taken seriously by city stakeholders.

The vision should be bold and wide enough to accommodate realistic priorities and specific development paths. The Vision should pinpoint possible paths for the economic renewal and transformation of the city. It may, for example, present the city as a new technology hub, based on the high density of technology-driven public and private actors. It may stress its potential as the central node in a cross-border area and emphasize its connectivity assets. It may make the link between exceptional natural assets and innovation potential. It may build on the skill sets of the population as the main driving force for future development. Moreover it may use flagship projects in cultural and creative industries to develop the innovative image of the city.

Finally, the Vision should also include justifications for its relevance in terms of meeting societal challenges, such as providing more healthy living conditions for its citizens, reducing outmigration, providing new employment opportunities for specific categories of the population, combating social divide, etc. These justifications go much beyond the alleged classical benefits of innovation for job and economic value creation.

An element closely intertwined to formulating an effective vision is communication. Good communication of the urban innovation system is essential to ensure its endorsement by all stakeholders of the city. Communication is adapting the content to the stage reached. For example, adoption of a vision, adoption of policy priorities, endorsement of an action plan, implementation of key projects. Crucial components of a communication strategy are the followings:

- *Definition of goals:* The main goal should be to place the urban innovation strategy project in a wider context such as national, to inform and create an attractive image for the identified target group of the project. But it can also pursue the goal of identifying and extending this target group by embarking stakeholders that are not yet part of the process. And it may serve the wider purpose of informing public opinion about the need to support the development of knowledge-based business in the region.
- *Identification of the stakeholder groups and their motivation*: Different target groups have different needs and should be reached with different tools. Traditional SMEs, high-tech companies, universities, transfer institutions, business intermediaries, local authorities, the media, etc. have a different understanding and expectations. The goal of the strategy should be to make sure that they all endorse and contribute to the strategy from their perspective.
- *Definition of traditional communication tools*: the tools include the use of a logo which builds and reinforces the identity of the city and puts innovation at its core. Attractive and dynamic web pages, including parts in English for wider dissemination. Newsletters and leaflets to complete the information with traditional communication tools. Specific publications on certain aspects of the urban innovation strategy (key analyses, peer review reports, etc.), conferences and seminars, including participation in international conferences, and press and TV campaigns. The content of the communication should include strategic lines and priorities but also communication and demonstration on flagship projects
- *Definition of active communication tools:* Active tools mainly include pro-active activities such as targeted visits to stakeholders or concerted workshops and seminars. Examples of active tools are: visiting the sites, marketing of the participants to the project, press conferences, round table discussions, meetings with local etc. Conferences and seminars are frequently used: launch conferences ease the awareness and stimulate the participation of the actors in the exercise. Conferences in the middle of the process stimulate the participation of the urban actors in the construction of the strategy and validation of analyses.

4.3.6 Governance of the urban innovation system

The urban innovation strategy process needs to be interactive, urban-driven and consensus-based. This is because innovation process is increasingly a collective social endeavor in which success, for cities as well as firms, depends on the inter-organizational capacity to absorb, generate and exchange knowledge in a timely and cost-effective manner. Although urban development is also a collective social endeavor in which national and supra-national levels play their part, the urban level is the most important part of the process, not least because no one has a greater commitment to or knowledge of a city than the individuals and organizations that are based there.

The governance structures and processes should not be seen as a rigid template that must be applied in all cities regardless of local circumstances. On the contrary, they are offered as general guidelines that need to be assessed and applied in particular urban contexts, each of which has its own unique combination of problems and possibilities. In other words, the urban context will help to determine the precise mix of organizations that need to be involved in the urban strategy process.

In terms of process, urban innovation strategy design involves analyses, experimentation, debates and decision making, with a wide participation of actors and experts. This needs to be communicated, understood and acknowledged, it is a time-consuming process that should be seen as an investment rather than a burden. The most important types of organization that need to be involved in the urban innovation strategy process are public authorities, universities and other knowledge-based institutions, investors and enterprises, civil society actors, and international experts who can offer benchmarking and peer review services, for example.

In the open innovation era, where innovation entail behavioral change at the individual and societal levels if the challenges of health, poverty and climate change are to be addressed, the governance system should be opened to new stakeholder groups coming from the civil society that can foster a culture of constructive challenge to urban status quo.

Getting firms, universities, development agencies and local government to accept that innovation is a collective social endeavor, where participants freely acknowledge that working in concert can deliver far more than working in isolation, is arguably the most important ingredient in the ‘recipe’ for successful urban innovation strategy.

To tap the potential of related variety, urban authorities and development agencies will need to behave less like traditional public bureaucracies and more like innovation animateurs, brokering new connections and conversations in the urban economy. The onus of responsibility for creating such iterative processes rests primarily with public sector bodies, especially universities, development agencies and local governments.

4.3.7 Access to Capital and leverage of local funds

Capital is a necessary ingredient to fuel urban growth and mobilize innovation process. Financing in many forms and from a variety of sources is needed to support basic science and applied research. The commercialization of innovation, entrepreneurial start-ups and expansion, including business incubators and accelerators, urban residential, industrial, and commercial real estate, including new collaborative spaces, place-based infrastructure e.g., energy, utilities, broadband, and transportation, education and training facilities, and intermediaries to steward the innovation ecosystem. An urban innovation strategy enhances the likelihood that different sources of capital will value the potential of this new form of development, ultimately supporting different kinds of firms, institutions, and activities.

Garnering of local capital from disparate public, private, and civic sources is an important precondition to spur urban innovation growth, particularly in the early stages. The provision of local capital, particularly at-risk capital, is a market validator and shows that local investors are willing to back the effort. To accomplish these goals, we should intently focus on redirecting local resources to new innovative purposes and smartly leveraging these resources so that they have full impact.

City government should smartly redirecting scarce public resources in ways that garner large private and civic investments. Local institutional capital can also be unlocked to spur urban regeneration.

Urban innovation systems will only reach their full potential when companies and investors outside the city either decide to locate facilities in the city or otherwise deploy capital. Urban Innovation systems, by providing both a geographic, economic, and entrepreneurial focus, can bring together, in a disciplined and market-oriented way, the disparate elements required to accelerate city regeneration and growth.

Cities must make a compelling case for investment and even create special investment vehicles tailored to disparate kinds of activities. For example cities should consider an investment strategy that presents the vision and goals of the city, shows the market momentum to date, including a profile of major investors and investments, and describes current and future market opportunities. The strategy would both make a general case for investment in the city but also target discrete classes of investors and institutions, real estate developers, equity investors, large firms, venture capital, and others.

5. Conclusions

This dissertation has explored which are the crucial factors, functions and networks in an urban framework which favor the innovation activity and contribute to the ongoing innovation process. As we have described, urban innovation systems are not a particular theory which could be applied as such, but rather a conceptual framework that its implementation must take into account the particular characteristics and weaknesses of each city. Urban innovation systems strategy isn't a policy in the logic that "one size fits all" but is a policy tool which could be the base for the design of a coherent urban innovation strategy in order to facilitate the innovation performance in a city.

In chapter 2 we mentioned the various terms and interpretation of innovation and concept of systems of innovation. Also we have described how systems of innovation theory combine with the national, sectoral, regional and urban level. Mainly we have described the concept of urban innovation systems. We have paid special attention at the actors (institutions/ organizations that play an important role in its shaping, the network they develop together to interact with each other and the environment on which the innovation activity is favored. Moreover we talk about the critical features of an urban innovation system, such as connectivity-accessibility, availability of qualified staff and quality of life. We conclude chapter 2 with the perception that innovation and innovation process are absolutely a collective activity process which require the existence of different actors and organization under an institutional infrastructure in which the networking and interrelations facilitate the innovation process.

In the next chapter we made an analytical description of three urban case studies. We have chosen Eindhoven, Shanghai and Vancouver. We mention their geographic and demographic characteristics and then we focus on their historical roots, development paths and their particular strengths and weaknesses. Also we give a short description of their future policy intervention which will follow in order to stay competitive in a globally competitive environment. We observe that the three urban innovation systems present similarities such as strong governance networks or research infrastructure and unique characteristics such as branding strategy or cultural amenities. The differences between them have as an aftermath each of the city to follow and implement a different set of policies which illustrates the way of their future urban innovation strategy.

In chapter 4 we have noticed the key factors that enhance the development of urban innovation systems. According to the literature review and to the information from the case studies we concluded that Eindhoven, Shanghai and Vancouver present similarities and differences in the way they follow to achieve a high innovation performance. Certain factors appear to be, key elements leading to the success of an urban innovation system and other seem to have more local characteristics which have as a result to differentiate one urban innovation systems from another. Also each city follows its own strategy to develop its innovation systems. This means that we can't apply a particular set of policies in every city to develop an innovation system, but we must take into consideration the particular characteristics of each city separately. Each city faces particular weakness, so it should implement a strategy that fits its characteristics and is based on its comparative advantages. Moreover we stress the importance of innovation policy as all actions by public organizations that influence innovation process. As well we provide certain policy initiatives and key elements that a city may implement to influence positive its innovation performance. These are the presence of returned entrepreneurs, public innovation procurement, the role of universities, cultivation of shared vision, governance of the urban network and the access to capital. According to the good practices which we have drawn from the case studies and from the literature review these factors could be the base for an effective urban innovation.

To conclude, the development of an urban innovation system should be an aftermath of a collective process between various stakeholders which takes into account the comparative advantages of the city and its particular weaknesses. Urban innovation system could be tool for the enhancement of innovation performance at city level. Ways of implementation and other significant factors that influence the innovation activity could be the subject for further research and study.

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Appendix

Eindhoven

Strijp-S

A concentration of knowledge-intensive activities in the Eindhoven region is Strijp-S, a former location of Philips. This 27-ha area is to become an attractive place for urban living and a hot spot for design and creative entrepreneurship. Strijp-S is a roughly triangular space, bordering the railroad on one side and a residential area and business space on the other. Up till the opening of the area in the early 2000s, the area was popularly known as the 'forbidden city' because the general public was not allowed to enter the area. It housed the famous R&D laboratory NatLab, where most of Philips's technical breakthroughs took place.

When Philips decided to downsize and focus on a small number of high-tech sectors in the 1990s, it closed most of its manufacturing on Strijp-S and concentrated all its R&D on the High-Tech Campus. So while the HTC continued to play a key role for Philips, as an open campus rather than an exclusive Philips area, Strijp-S quickly lost its relevance to the firm. Because of the proximity to the city center and the high visibility of the area, and because of its many industrial heritage sites, local stakeholders in Eindhoven realized that they needed to come up with a vision to redevelop Strijp-S. The city government of Eindhoven and the real estate company Volker Wessels together developed a vision to turn Strijp-S into a multifunctional creative district, combining urban living and working and providing an anchor for the emerging design sector. They set up a management company (Park Strijp Beheer) in 2002 to set a general framework for the redevelopment project, which the social housing corporations Trudo and Woonbedrijf went on to implement together.

Brainport Foundation

Brainport Foundation is the organization in charge of public–private development projects in the Eindhoven region, which it implements through its development company Brainport Development. Brainport Foundation and Brainport Development evolved out of the project organization of the Stimulus and Horizon projects and have

over time built up a strong reputation in the region. In 2005, an alliance of local stakeholders formulated the Brainport strategy, including plans to address what they identified as the major challenges and opportunities to the region in the near future. Because of their consensus on these issues, they formed an effective lobby at the Dutch government, resulting in the national government affirming its support for the plan. These local stakeholders include the mayor of Eindhoven, the chairman of Philips, the president of the Technical University of Eindhoven, and the chairman of the regional chamber of commerce. Brainport Development was set up to implement this strategy. It has about 50 employees, and in addition it has 28 project leaders who work part time for Brainport Development besides their function at a local firm or institution. Brainport Development has a permanent representation in Brussels to represent the region towards the European Union institutions. While its predecessors originally focused on coping with the 1990s crisis, Brainport Foundation's mission has gradually become more and more ambitious. In its 2020 strategy, it aims to further strengthen the Eindhoven region as one of the world's leading high-tech regions. To reach this goal, its project teams keep a continuing dialogue with the region's firms and research institutes to identify problems and challenges. Based on this fieldwork, it formulates a coherent strategy resulting in specific action plans to be carried out. These action plans are then presented to local stakeholders, who are asked to provide funds and personnel to carry out the tasks identified. Brainport Development has a budget to help these private actors organize these projects and takes care of all legal paperwork involved. Two concrete examples help illustrate this working style. When local firms informed Brainport Foundation of a widespread and growing lack of skilled technical staff, one of the action plans proposed was to organize activities in which primary and secondary school students are brought into contact with researchers of local high-tech firms in a fun and informal way. Many of the region's firms were then found willing to free up researchers for these activities, while Brainport Development made all arrangements with local schools.

A second example of a successful Brainport Foundation project is the 'knowledge workers plan'. When a deep recession hit the region's high-tech firms in 2008 and 2009, many firms had to lay off part of their research staff to avoid financial problems. However, they realized that as soon as the recession ended, they would face a shortage of knowledge workers again, made worse by the recent layoffs. Brainport Foundation

arranged with the national Ministry of Economic Affairs to provide funding for local research institutions to temporarily employ the research staff to be laid off at local firms, ensuring that their research projects could continue through the recession. When the recession ended, firms hired back their research staff, and as a result, precious human capital was not wasted for the region.

In the Eindhoven Region Brainport Foundation is generally regarded as a successful organizational platform that helps stakeholders in the innovation system identify and address shared challenges. Representatives of Brainport Foundation and many of the other stakeholders mention the following as its major success factors:

- It started small and began by carrying out concrete projects that achieved noticeable results within a limited time period.
- Regional stakeholders shared a sense of urgency, causing them to be willing to begin far-reaching cooperation to address shared challenges. Moreover, when the immediate crisis was over, Brainport Foundation was successful in keeping this sense of urgency alive.
- Regional development organizations like Brainport Foundation need sufficient funding to take care of project organization and to keep a permanent staff to continuously visit local firms and research institutions to ask them about problems and opportunities to be addressed in projects. But if its budget becomes too large, the organization may become too independent and complacent. Because the development company Brainport Foundation has a limited budget, it needs to mobilize private actors to carry out the projects formulated by Brainport Foundation, which requires constant dialogue and establishing strong relations. This, in turn, has shaped Brainport Development's organizational capacity. Similar projects in other regions have tended to fail simply because, an overly generous budget lead their regional development organizations and their development companies to become too independent of private stakeholders.
- Once a strong local network has been established, local actors will themselves realize when problems and opportunities exist for which Brainport Foundation can play a role. Once this point has been reached, the regional development

organization has become a key intermediary in the innovation system, but constant dialogue with private actors is needed to maintain this position.

Open innovation in Eindhoven

In his 2003 book *Open Innovation*, Henry Chesbrough argues for a new approach to innovation. In the old model of closed innovation, firms depended on their own internal R&D labs, in which researchers attempted to carry out the entire innovation process from basic research to product development in an atmosphere of secrecy. The goal was for fi rms to build up a stock of patents or trade secrets to use as competitive assets and trade barriers against new entrants who could not afford such great investments in internal R&D. Philips in its early days was a prime example of this approach to innovation and also serves to illustrate its limitations. Carrying out the entire innovation process internally can be extremely costly, especially since only some of the innovation projects undertaken can be expected to result in a marketable, innovative product. And even when internal R&D leads to the development of a breakthrough innovation, firms will only be able to recover a fraction of the revenue produced by this innovation. And finally, closed innovation is based on the assumption that outside the boundaries of the firm, there is little publicly accessible research of use to the fi rm. Shorter product cycles and the rise of the quality and availability of public basic and applied science have made the closed innovation approach obsolete.

To address these problems, firms have begun to experiment with open innovation strategies. While open innovation is not one but a range of approaches, the most basic element of open innovation is to tap existing sources of knowledge whenever possible and conduct internal R&D mainly to fill in the gaps in existing knowledge. Open innovation implies the active creation of cooperation networks and shared research institutes to pool R&D investments, especially in pre-competitive research (research in the earliest stage of the innovation process, the results of which can be used by many firms rather than being relevant for one single application). More elaborate open innovation strategies also include a role for spin-offs and venture capital. The internal R&D department of a company may produce knowledge that does not seem to have a practical use for the fi rm. One option is then for

the firm to allow (or even encourage) some of its researchers to form a spin-off firm to further develop this knowledge into a product. When it is successful, the 'parent firm' can decide to buy back its spin-off or to establish a long-term cooperation with it.

The successful application of open innovation strategies puts high requirements on a firm's innovation system. When a system allows shared research institutions and spin-offs to thrive, this opens strategic options for the application of open innovation by the firms located in it.

Eindhoven's Branding Strategy

Another key feature of Eindhoven's innovation system is its reputation and branding strategy. While Philips has been a famous firm throughout much of the 20th century, Eindhoven has been relatively unknown both in the Netherlands and abroad. It was regarded as little more than the environment in which Philips had happened to locate itself and was deemed to be of little importance to the national economy compared to the core Randstad area with its powerful cluster of financial and business services and logistics firms. As late as the 1990s, Eindhoven stakeholders had difficulty in gaining attention and being recognized as a member of the international network of highly innovative regions.

An effective branding strategy set up collectively by the region's public and private stakeholders was able to change this. Recognizing that Amsterdam (with Schiphol Airport) and Rotterdam (with the Rotterdam seaport) had gained great attention among national policymakers as the twin Mainports driving the Dutch economy, actors in Eindhoven agreed on a combined effort to add the region to this short list of key regions under the name of Brainport.

The next effort, which is still ongoing, is to raise the international awareness of the region. Again, Brainport was chosen as the brand name. Some of the ongoing efforts include lobby activities in Brussels carried out by a team of permanent representatives working for Brainport Development, the representation of Brainport at the 2012 Hannover Messe technology fair, and the organization of yearly international events like Dutch Design Week and Dutch Technology Week. By the late 2000s, the Brainport region had succeeded in gaining international recognition, and in

2011 the Intelligent Community Forum selected it as the world's most intelligent community for that year. Even though the region is quite small in size and population compared to regions such as Silicon Valley, its strong reputation gives it access to high-level collaboration partners.

Three related success factors in the Brainport branding strategy are mentioned by local stakeholders: there is regional consensus on the kind of brand the region wants to establish, it has a clear profile as the basis of its branding strategy (because the region is highly specialized in high-tech systems and design), and a number of large, innovative firms support the branding strategy. Because the region has a clear profile in technology and design, it was relatively easy to align local stakeholders behind a focused brand. Many branding strategies fail because cities or regions end up branding themselves as 'good at everything', being unwilling to make a choice and leave out those industry sectors and aspects of their development in which they do not excel. Brainport's focus on two areas (design and high-tech systems) in which it is highly competitive explains much of its success.

Finally, the fact that the region has a number of internationally renowned leader firms with a strong attachment to the region and that recognize themselves in the branding Brainport Development is working to establish helped kick-start the branding strategy.

Leader firms

The first key feature of the Eindhoven innovation system, identified by many of the interview respondents, is the presence of leader firms. The region possesses a small number of large leader firms with a strong bond with the region, including first and foremost Philips and to a lesser extent ASML, car-producer DAF, and the chemical and biotech firm DSM, located somewhat further away from Eindhoven. These firms are major innovators in their own right and also played a key role in strengthening the region's innovation system. Leaders firms not only played an important role in building a critical mass of specialized workers, tacit knowledge, and research infrastructure in the region, but they also facilitated spin-off formation to create a network of innovative intermediary suppliers, from which the next generation of leader firms could emerge.

The build-up of critical mass was most important in the early phase of the development of the innovation system. Once established, this critical mass of knowledge, workers, and infrastructure became a fertile ground for later knowledge-intensive economic activity, which continued to be valuable also when the leader firms around which the critical mass initially emerged took a more modest role in the regional economy. The build-up of critical mass is compounded by the process of spin-off formation, as spin-off firms tend to locate close to their parent firm and therefore add to the amount of economic activity in the region.

Especially in the 20th century, Philips was a prime example of an innovative firm that generated more potential projects, new product designs, and ideas than it was able or willing to exploit internally. The most viable of such projects were the seeds from which spin-off firms could grow. The company invested heavily in a wide range of R&D, ranging from advanced basic research to application oriented R&D and design, which produced a local knowledge base from which several successful spin-off firms emerged. If resulting spin-off firms were active in relevant industry sectors, Philips could act as launching customer. Besides sufficient funds, this also required the trust and patience needed to work with young firms that still need to improve their products and overcome common start-up problems.

If besides an extensive and sustained R&D effort leader firms are also supportive towards workers with entrepreneurial ideas, then the formation of a cluster of spin-off firms is expected to speed up further. While in the past Philips tended towards secrecy, it set up entrepreneurship courses for its workers to promote spin-off formation as part of its strategy of restructuring from the 1990s onward. Moreover, it became active in spin-off incubation and, among other things, opened its clean rooms at the High-Tech Campus to start-up firms.

A further and sometimes overlooked aspect of spin-off formation is that a strong urban innovation system needs independent start-up firms rather than suppliers that remain fully dependent on their parent firm. ASML is an excellent example of how a leader firm can manage this process. While being a fairly recent spin-off of Philips, ASML has already gathered an extensive network of suppliers and spin-off firms around itself, most of which are located in the Eindhoven region. To promote the sustainability and growth prospects of this firm cluster, ASML stimulates its

suppliers to find other customers besides ASML and, when needed, it helps these firms upgrade and gain access to a (international) network of customers. ASML benefits from this because firms with a diversified customer base are more reliable suppliers, less prone to bankruptcy (and supply discontinuity for ASML) during the frequent ups and downs that characterize the high-tech systems sector.

Start-up incubation at the TU/E

In 2006, the Technical University of Eindhoven (TU/E) founded its incubation center for stimulating academic spin-offs called Innovation Lab. During the first years of operation, this incubator produced a large number of small start-ups. Its strategy was to supply many small seed investments in order to give a large number of entrepreneurs a chance to introduce their product to the market. The assumption behind this strategy was that out of a large number of spin-offs, a few would grow into leader firms like Philips and ASML.

So far the incubation center has indeed helped a large number of small startups be created, but so far very few of these have grown to become viable firms. Some local stakeholders criticize this approach to incubation as ineffective. First it results in fragmenting the available funds for start-up firms into many tiny seed investments, with no solution being provided to growing start-ups that need larger follow-up investments to really breakthrough in the market. And second, this form of incubation can result in pampering young entrepreneurs with subsidies rather than forcing them to think in a more business-like way and learn to become able to independently find funding.

Over the past two years, the TU/E Incubation Lab has radically changed its strategy. Its efforts are now limited to guiding students and researchers who are interested in carrying out contract research for local firms. These young entrepreneurs receive guidance for the administrative and legal aspects of starting a firm and can apply for a seed investment. An important difference with the earlier strategy of Innovation Lab is that while it used to be flexible about the repayment of seed investments in case the start-up was unsuccessful, it now demands a repayment of at least 50 per cent if the spin-off fails to become profitable, while successful spin offs are expected to pay back twice the amount they received as seed investment. The

number of spin-offs is expected to decrease because of this change in strategy, but it is still possible for future leader firms to emerge from this incubation process.

Economic crisis and reform

In the context of the gradually emerging changes in the world economy described earlier, the oil crises in 1973 and again in 1979 put an end to the growth of both Philips and DAF. Consumption slumped in much of the Western world, and the export-oriented firms in the Eindhoven system were hit especially hard by this. But a national policy of wage reduction in the Netherlands and a resurgence of foreign consumer demand in the 1980s restored the export market of Philips and DAF, and both firms regained most of their pre-crisis production levels. During this new period of growth, industrial production capacity expanded strongly in many countries and DAF carried out an ambitious expansion into the UK market. When a new recession struck in the early 1990s, a slump in consumer demand was coupled with overproduction, and both Philips and DAF entered into a deep crisis. The response of local actors to this crisis reformed the system into its current shape. In little more than a decade, the region changed from a textbook example of a vulnerable company town to one of the world's most renowned innovation systems (for a detailed overview of this transformation process, see Van den Berg*et al.* 2008).

The first to respond to the crisis was Philips. The firm had already started to gradually trim down its extensive network of vertically integrated suppliers and no longer undertook the kind of major projects for the local community that had produced Philips libraries, Philips swimming pools, and other facilities in earlier times. In 1989, it even closed the prestigious technology museum Evoluon, which it had built for Eindhoven in the 1960s to celebrate Philips's 75-year bond with the city. In spite of these gradual reforms, Philips still faced urgent cash- flow problems when the 1990s downturn set in, and for a time bankruptcy of the firm was not impossible.

As a response, in 1990 Philips started the massive Operation Centurion, one of the largest corporate restructuring programs in the world at that time. This program included massive layoffs (about a quarter of its workers in just four years' time), the accelerated closure of its remaining activities not related to its core

business, and a rationalization of its R&D efforts. The controversial restructuring succeeded in reducing Philips's overall costs by a third in just three years' time. For the automobile producer DAF, the crisis set in much more suddenly and caught the firm in the middle of ambitious expansion plans. Banks responded very strongly to DAF's cash- flow problems and suddenly withdrew all funding from the firm, forcing it into bankruptcy in 1993. Three years later, DAF was acquired by Paccar, an American firm, and restarted its operations, but by that time massive layoffs had already occurred.

The most visible consequence of the 1990s crisis and reform of the Eindhoven innovation system was the accelerated shift from low-end manufacturing to high value-added and knowledge-intensive activities. While Philips closed down or off-shored much of the factory work in the region, it actually increased the concentration of its R&D activities in the Eindhoven region. Related to this change of focus, Philips shed all activities not directly related to its core competences, now defined as healthcare, lifestyle, and lighting. This excludes not only its low-end activities in, for example, glass and plastics production but also high-tech products like semiconductors and lithography. Rather than hastily selling off these operations, Philips supported them to become independent firms in a process of spin-off. Among spin-off firms, ASML would go on to become a worldwide, multibillion-dollar giant in lithography, and NXP became one of Europe's leading semiconductor firms.

While not all Philips spin-offs turned into viable companies, those that succeeded went on to become leader firms in the Eindhoven system. Rather than a system with one giant (Philips) and one smaller leader firm (DAF), each with a network of dependent suppliers around it, the innovation system evolved into a more interconnected network with multiple leader firms as its nodes. As suppliers were forced by the downturn to reduce their dependence on a single local customer, they chose a variety of strategies to survive and grow. For example, some DAF suppliers learned to broaden their capabilities to be able to supply Philips or one of its spin-off firms besides their core customer DAF. Another strategy used by suppliers was to work together in inter- firm alliances so together they could attain the capabilities to find new customers at a European or even global scale. The result has

been a more integrated firm cluster as part of a more dynamic and less vulnerable urban innovation system.

Besides narrowing the focus of its R&D effort, Philips also embraced a new approach to the way it carries out its research and development. Under the old model of 'closed innovation', Philips tried to develop the knowledge needed for its operations in internal R&D labs, closed off to the outside world in order to safeguard the secrecy of its knowledge base. However, as achieving technological breakthroughs tended to become increasingly expensive while at the same time shorter product cycles reduced the time available to exploit the resulting product innovations, Philips realized that it had to tap sources of knowledge beyond the boundaries of the firm. As part of Operation Centurion, the firm started to think strategically on which R&D to carry out indoors and which to buy from external sources. When one of Philips's research staff read the book *Open Innovation* by Henry Chesbrough (2003), the firm embraced open innovation as a systematic new model for its R&D strategy.

The final and most fundamental consequence of the crisis and reform has been the changing social and organizational structure of the Eindhoven system. The coinciding downturn of the region's two biggest firms made local policymakers realize that the Eindhoven economy had become too vulnerable to the ups and downs of business cycles and that the region had to develop its organizational capacity to address this structural weakness. Up to this point, local government and university leaders had been relatively passive compared to their counterparts in other regions. Philips used to directly appoint research staff at the Technical University, and local government was often bypassed when Philips contacted national level policymakers directly to address local issues normally under the authority of the city government. In a sense, local stakeholders had to learn how to take charge in the region now that Philips did not play its patriarchal role anymore.

A first move towards stronger regional-scale cooperation happened when in the 1980s, as a result of Dutch national policy a regional authority for Greater Eindhoven was set up. Shortly thereafter, national government abandoned its policy for stimulating regional governance again, but the idea of regional cooperation kept its momentum among stakeholders in the region. Two important institutions were founded in the early 1980s: an economic development office (NV REDE) and a

Brabant provincial development office (BOM). The administration of NV REDE is fully public, but it has an advisory council consisting of representatives of the local chamber of commerce, labor unions, and representatives of Philips and other major firms. Because of national regulation, NV REDE could only be set up as a voluntary cooperation organization, limiting its ability to address controversial issues at the regional scale, where conflicting interests have to be balanced. But it nevertheless proved successful in carrying out specific projects to address interests shared by regional stakeholders. At first it mostly focused on developing business parks, with the additional goals of stimulating innovation and facilitating the start-up of new firms. For example, it helped to create the Science Park Eindhoven, a selective business park admitting only innovative firms and specializing in ICT. Also, it started the development of a business park near Eindhoven Airport, with the aim to build up a cluster of export-intensive firms that would benefit from being located close to the airport. While these projects may play an important role in the innovation system by themselves, the most important role of NV REDE was to strengthen the regional organizational capacity.

The other major catalyst in regional cooperation is the SRE, a regional alliance of municipalities in the region. When in 1993 Helmond joined the cooperation organization between Eindhoven and some of its neighboring communities, the SRE was created and covered the entire Greater Eindhoven region. Like NV REDE, the SRE is a voluntary organization, and this has especially limited its ability to solve the region's traffic congestion problems, as infrastructure development remained highly controversial among local community governments.

But whenever regional actors found a shared interest, NV REDE and SRE together proved very effective vehicles for putting them into practice. An important factor in making this work was the fact that in the 1990s, a small group of people in charge of the Eindhoven community government, the chamber of commerce, and the Technical University were able to work together and shared a sense of urgency. Through NV REDE and SRE, they mobilized regional stakeholders for a response to the region's economic crisis.

When the 1990s crisis hit, NV REDE responded in two main ways. First, they arranged temporary financing for firms threatened by bankruptcy. In this way, several supply firms that might have been dragged under by the reorganization at Philips and

the bankruptcy of DAF were saved. And second, this emerging alliance of regional stakeholders also decided to apply for EU assistance. The mayor of Eindhoven took the initiative to invite representatives of the chamber of commerce, SRE, other local government representatives, local firms, and the Dutch secretary of Economic Affairs to set up a project proposal. Together they decided to start projects to strengthen the local research infrastructure, to stimulate R&D not only at big firms but also at smaller local firms and suppliers, and to stimulate spin-off formation. Another aim was to solve a growing mismatch at the labor market, with a high number of unemployed factory workers coinciding with a lack of skilled technicians. All municipal governments in the Eindhoven region were willing to contribute a fixed annual sum per inhabitant, and the Stimulus project was formulated to apply for EU regional funds. The resulting projects not only helped the region diversify and grow out of the downturn but also had a more subtle effect. Since EU funds cannot be targeted at any single firm, groups of firms had to be formed that together took part in an EU project. This stimulated the strengthening and broadening of inter- firm networks in the region.

When the Stimulus project finished, it was followed up by a new project named Horizon. The main difference was that Horizon was carried out more or less without subsidies and therefore had to be organized in a very different way. NV REDE took on a much more modest role in Horizon and let private firms and other local stakeholders take charge of its projects. This worked because firms were consulted extensively to find out what shared problems they faced and in what ways they would be willing to work together to address them. The Horizon project team of NV REDE would then help these private actors with paperwork and other practical and organizational issues. The Horizon goals (selected after consulting local stakeholders) were to address the lack of highly skilled technical workers in the region, to increase the commercial exploitation of private and university R&D, to diversify the local economy, and to strengthen the reputation or branding of the Eindhoven region in the Netherlands and abroad. After a few years, the 'Brainport' strategy replaced Horizon, keeping the same general targets and working style (Van den Berg *et al.* 2008).

In sum, in a short time, the Eindhoven region transformed itself into a more diverse region, keeping its high-tech profile but becoming less dependent on its leader firms. A strongly hierarchical network of leader firms, with their fully dependent

suppliers, changed into a more interconnected cluster of large firms, SMEs, and knowledge institutions. And finally, the region went from a relatively weak local and regional governance structure to becoming a pioneer in public– private partnership, with an organizational capability strong enough to combat economic crises.

Shanghai

New Knowledge Based Firms (NKBFs)

Knowledge-based new firms have a positive influence on the RIS in various ways (see Koschatzky 2001). First, besides established firms, NKBFs are the main actors of innovation creation within a region. As such, they contribute to the development of region-specific knowledge, which is not without significance for the RIS. Second, they enjoy stronger growth on average and have higher survival rates than other new firms and established firms. Overall, therefore, they are a stabilizing element in a RIS although this does not apply to every single start-up. Third, there is a close correlation between the learning capability of (other) regional innovation actors and the number of NKBF within an RIS. This promotes regional learning processes which are an important impulse for the emergence and liveliness of RISs, due to the cumulative character of the concept of the learning region (Florida 1995, see also Koschatzky 2001). As Lawson (1997) and Lawson/Lorenz (1999) have shown, as soon as the capabilities to learn and to forget "old" knowledge have been developed, continuous and collective learning fosters an ongoing extension of the regional knowledge stock. This process leads to new innovation-relevant questions and answers and, consequently, to a subsequent extension of the regional knowledge base. New firms are crucial for this self-perpetuating process of renewal and restructuring of the regional knowledge base. Finally, the start-ups in general and NKBFs in particular have the strongest intra-regional connections of all innovation actors. Due to their great spatial immobility, their mainly intra-regional innovation linkages and personal networks, they contribute significantly to the endogenous development potential of a region.

Knowledge flow

Howells (2002) differentiates between three ways: via patents (e.g., Jaffe 1989), via trade with knowledge-intensive products (e.g., Feldman 1999) and, perhaps most important in our context, via the mobility of highly-qualified labor/individuals.

Entrepreneurship by migrants

The terms refers to entrepreneurs who have returned to their country of origin after studying or working abroad for at least five years. Entrepreneurs may, but need not, return to their home region. It is more important that the country of origin is lagging behind the host country of the (first) migration in terms of economic and technological development. In most cases, therefore, this means migration from a developing or emerging country to an industrialized country (see Saxenian 2000, 2003). In the case of re-migration, a knowledge-intensive (high-tech) region within the target country is usually the destination.

Tax reform

Following a tax reform in 1994, Shanghai is allowed to retain approx. 30% of fiscal revenues generated in the city, and is to remit the rest to the center. In 2003, Shanghai's budget amounted to 90 billion RMB (approx. € 9 billion). Thus, although Shanghai is politically independent of the central government, financially it is less so.

Economic reforms

Economic reforms were initiated in 1978, but during the first few years, Shanghai was left out of the reform process, as the central government was reluctant to allow experimentation that might threaten its revenues. Excluding Shanghai from reforms seriously damaged its economy: In 1978, the city topped the list of all provinces and regions in contributions to national income; by 1986, Shanghai had fallen to number six, in 1990 to number 10 (Segal 2003). Shanghai's recovery was initiated by the development plan of February 1985, which arranged for the city to regain its national lead in commerce, trade, science and technology (Segal 2003). In the early 1990s, the Pudong Policy was devised to complement the original plan. The main goal of this policy was to revitalise Shanghai with the help of FDI by granting Shanghai a status similar to that of the special economic zones (Han 2000). Another important step for Shanghai's comeback was the urban 10th five-year plan (2001-05), which proposes that the future role of Shanghai should be as a high-tech hub and business centre of China. To support such a strategic transformation, the traditional six pillar industries of the 1990s (e.g. automobiles) are to be replaced by new ones, including high-tech industries (Segal 2003).

Political lock-in

Shanghai has been developing rapidly, but is still in transition from a site of heavy industry to a metropolitan region comprising a range of industries (including high-tech) and services. Therefore, it exhibits some of the weaknesses typical of old industrial regions, such as the dominance of large firms, the concentration of firms in traditional industries and a political lock-in.

Even though the government has started to officially promote entrepreneurship, SOEs and large business groups remain at the centre of attention. This is exemplified by the fact that the six largest state-owned enterprise groups generated 8% of total output value in the IT sector in 2000 (Segal 2003). The numbers in table 1 also indicate that Shanghai's high-tech industries are mostly made up of large enterprises (SOEs and multinationals), whereas Beijing's hightech output is generated by a large number of smaller enterprises. Thus, although by the mid 1990s, there were over 7,000 private companies in Shanghai, technological development in Shanghai is still not driven by what happens in these enterprises.

The reason is that in order to preserve and foster SOEs, the majority of local resources are channeled into them. Firstly, Shanghai concentrates most of its R&D budget within state-owned industries, and not within R&D institutions. Secondly, the ailing state sector is kept alive with the help of massive loans from the banking system. However, as many SOEs are loss-making, funds are used to pay employees rather than to finance R&D activities. At the same time, the preferred treatment of SOEs results in a lack of capital for private companies, constraining innovation activities in particular of private high-tech enterprises (Hong 2003).

Guanxi

"Guanxi" can be loosely translated as "connections" or "relationships". The term refers in particular to relations with the government. In China, guanxi have traditionally been the prime organizing principle of political and economic life, but have become even more important during economic transition. Although reforms were introduced 25 years ago, China is still not a market economy with stable regulatory and legal framework conditions. Instead, powerful bureaucrats control access to resources, permits and licenses. In such an environment, good relationships with government officials are necessary to operate a company successfully. Contrary to private entrepreneurs who are hardly supported, SOEs have a strong lobby in the administration and the government.

Local bureaucracies, therefore, tend to intervene on behalf of SOEs, thereby discriminating against private entrepreneurs (Segal 2003).