

Finance in Innovation

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An evolutionary economic geographic thesis on the relation between finance and innovation in the Brainport Region as a critical note on the lack of attention for the financial sector in the field of economic geography

By

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Venture Capital, and the myriad start-up firms it funds, will be an enduring part of the landscape for innovation.

- *Henry W. Chesbrough*

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You know, thanks and so.

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Preface:

Over the course of the past two decades, I've witnessed how the region in which I grew up has transformed itself. In the South Eastern part of the Netherlands, with the city of Eindhoven at its core, a socio-economical 'miracle' has taken place before my own eyes. I've witnessed how my friends who grew up in the small rural town of Boerdonk, grew up, got their education and started to work for firms in Eindhoven and came back with stories of advanced electronics, embedded software, lithography and 'something' that was happening in Eindhoven. Through them I became acquainted with names as ASML, FEI, Sioux, Prodrive; and how these firms were working on advanced technologies far beyond my understanding. Through my father, who has been a public official with a huge network throughout Brabant, stories about the extraordinary forms of cooperation around Eindhoven came to my ears. When he shared his anecdotes at the dinner table, the bleak stories about the bankruptcy of DAF, the huge layoffs at Philips and the move of the headquarters to Amsterdam in the early 1990s, gradually were replaced by stories of revival, vigour, opportunity; of cooperation, hard work and defiance in the face of economic decline. Something special was happening around Eindhoven. In 2011, on one of my regular visits to Eindhoven, a huge banner was hanging next to the train station; "Brainport Region, the Smartest Region in the World". This added a new dimension to the sense that indeed, something special was happening. Through my education as a bachelor student of history and a master student in economic geography, I have been fortunate enough to gain a profound understanding of and respect for the process of regional development which I have witnessed as a native to the region. After starting my masters in Economic Geography, in which I developed an interest in the relation between the financial world and innovation, I was given the chance to start truly understanding what this 'something special' was. My research internship and the work done to write this thesis have provided me with an dual opportunity, for which I am grateful. It allowed me to simultaneously start understanding the historical economical process which emerged before my own eyes and it provided an entry point into researching the complex world of finance which I long to understand.

Chapter One

Introduction

The Brainport region, with the city of Eindhoven at its core, generates in absolute terms the most patents in Europe and in relative terms the most patents in the world (measured per capita). Patents are an often debated, but well-respected proxy metric for knowledge generation and innovation. Knowledge generation and innovation are unequivocally linked, with knowledge being the prime input into the innovation process. The potential of the region has received international recognition over the past years, when in 2011 the world's smartest region by the Intelligent Community Forum. In the international business press the region has been prominently featured. Fortune has named the region potentially 'the next Silicon Valley' in 2012 and Forbes named the city 'the world most inventive city' in 2013 (Akhtar, 2012; Pentland, 2013). Research bureau FDI Intelligence, part of the publishers of the Financial Times, ranks Eindhoven in third place, after London and Helsinki, as best European regions to invest in (McReynolds, 2014). With a large abundance of knowledge one could expect to see substantial economic growth figures in the Brainport Region stemming from its extensive knowledge generating capacity. The region has shown stronger growth figures than other Dutch regions, however, the difference has been marginal.

The practice of starting new firms to exploit and bring knowledge generated in universities, research institutes and by entrepreneurs to the market has gained importance over the past decades in the growth, renewal and performance of regional and national economies. Start-ups and spin-outs are founded by entrepreneurs which develop new and innovative products or services based in the technologies and knowledge generated in both private and public research facilities. The successful growth of these Small Knowledge Intensive Enterprises (SKIEs) into robust small and medium sized enterprises (SMEs) providing jobs for regions has captured the attention of governments in Europe as a strategy to create economic growth. Having a thriving start-up culture has become a benchmark for being an successful innovative ecosystem, representing shift away from the more classically model of innovation in large company research laboratories.

The Brainport region appears to show a favourable environment for the founding and growth of SKIE. The region is rich in knowledge production, has strong Multi-National Corporations which cooperate closely with firms in the supply chain in the region and the region has adopted routines and practices from the Open Innovation paradigm. The Technical University Eindhoven produced the most spin-off companies of Dutch universities between 2010 and 2012 and ranks number one worldwide in industry-university collaboration (TU/e, n.d.). Eindhoven is home to the High Tech Campus (HTC) and Brainport Development runs four advanced incubator buildings for start-up companies both on the HTC the University Science Park. Both the private and the public components of the regional

innovations system shows favourable characteristics and chances for SKIE creation and survival. In practice, however, a relative low number of SKIEs survive in the Brainport Region, greatly reducing the actual renewing effect on the innovative system as a whole.

In the governance structure of the Brainport region, a growing sense that the financial infrastructure was part of the reason why SKIE survival rates are so low in the region. SKIEs require large sums of capital before they start generating profit. The ability of entrepreneurs involved in starting a SKIE to secure financial capital is critical for the survival of these firms. This was the fundamental driver of my academic interest and ensuing choice for the subject of this thesis. Since the financial crisis of 2008 I have developed an interest for the world of finance. This research internship pointed me into the direction of a specific component of the financial world, venture capital. Understanding the link between capital markets and the real economy was what moved me to start an internship with Brainport Development, where I was fortunate enough to be an intern with Carina Tielemans, head of Brainport Networking Financials.

As part of my research, I ventured into the Economic Geographical literature. There I was surprised to find that very little attention was being paid to the relation between finance and monetary capital on the one side, and innovation and regional development on the other side. Attention for the interactions between financial institutions providing capital to firms and innovative capacities of regions are fragmented at best, but these considerations are hardly an integral part of the widespread explanatory models analysing the spatial and territorial aspects of the innovation process in the field of Economic Geography. This lacuna within economic geographical theory further drove me to investigate the link between financial markets and its accompanying institutions and innovation within firms of different sizes. I found clues to these linkages work through my field work within the Brainport Region, by journeying into others fields of science concerned with economy and from the work done by financial geographers. Throughout my research I developed a sense of activism, the need to prove that without understanding the world of finance, economic geography cannot adequately explain the uneven distribution of growth of economic growth in the world.

Research objectives

The aim of this thesis is twofold. First it serves to critically address the lack of attention for finance in economic geographical models of regional development. Secondly, it is an evolutionary economic geographic study into the relation between the financial sector and the performance Small Knowledge Intensive Enterprises (SKIEs) in the Brainport Region. The industrial development paths of the region are analysed from an evolutionary perspective. This is done to understand why the region has a relatively low rate of new SKIE creation and survival, and how this relates to the regions financial infrastructure. The empirical work done was conducted both to gain deeper understanding of the complex interplays between the finance and innovation, during the emergence of the regional innovation system and in SKIEs

today, which in its turn provides arguments that finance should be at the centre of economic geographic research today.

Research objective: To gain a deep understanding of the relation between finance and innovation in the Brainport Region, specifically in regard to the performance of Small Knowledge Intensive Enterprises (SKIEs)

Sub – objectives:

- Produce a baseline study on the emergence of the Regional Innovation System in the Brainport Region from an Evolutionary Economic Geographic perspective;
- Provide recommendations for the enhancement of the Evolutionary Economic Geographic and Regional Innovations Systems literature and models;
- Provide policy recommendations to strengthen the financial infrastructure for Small Knowledge Intensive Enterprises.

Main research question:

How does the financial infrastructure in the region influence the performance of Small Knowledge Intensive Enterprises in the Brainport Region?

Societal relevance

Unemployment is a broad societal problem for the Netherlands and the European Union. Unemployment hovers around 8% for the Netherlands in the fourth quarter of 2014 and has been steadily growing for the 28 European Union member states up from 7% in 2008 to 10.8% in 2013 (CBS, 2015; Eurostat, 2015). Unemployment is high, which is not only costly to the individuals and the families directly affected, but also to the local, regional and national economies as a whole. There are both economic and social cost to which are borne by the state and society. High unemployment has an impact in government expenditure, taxation and with that the level of government borrowing and debt. That last problem is exuberated by the low levels of inflation, and even the possibility of deflation in the Eurozone ("The euro zone: The world's biggest economic problem," 2015). With high unemployment rates, more people apply for benefit payments and pay less taxes, both direct and indirect.

Data from OECD member states show that start-up firms represent the majority of new job creation (Criscuolo, Gal, & Menon, 2014; Kane, 2010). Young firms play a central role in creating jobs and enhancing growth and innovation, accounting for 17% of employment but accounting for 42% of job creation in OECD countries between 2001 and 2011 (OECD, 2014). Yet the relation between innovation and employment is complex. Innovation is associated with the destruction of unskilled jobs in the US and Europa, nevertheless, these negative effects are said to be outweighed by the increase in jobs for educated workers (Pianta, 2005). The level of education has grown in the Netherlands over all age and gender groups. The level of people who obtained an Applied Universit or University education has risen from 22% in 1996 to 31% 2011 and will continue to rise with ever increasing number of new students starting HBO's and University's in the Netherlands every year. Small Knowledge Intensive Enterprises not only create jobs, they specifically create jobs the type of jobs needed to employ the highly educated Dutch work force (Kooiker & Hoeymans, 2014).

This research contributes to the understanding on the founding and survival of Small Knowledge Intensive Enterprises. This type of firms contribute a disproportionality large share to job creation, helping to drive down levels of unemployment. By better understanding how these firms foundation and survival rates are affected by the interaction with the capital market, this research informs policy that can stimulate the survival rate of these firms, and with that, job creation.

Scientific relevance

This thesis aims to inform the debate on the merits of Evolutionary Economic Geography (EEG). The Evolutionary approach in Geography has steadily gained influence in the field of Economic Geography, successfully introducing behavioural and evolutionary concepts into the field. By deepening and broadening one of the central concepts of this approach, that of routines, this work hopes to contribute to the analytical strength of the Evolutionary Economic Geographic school of thought.

Furthermore, this work has explored the analytical complementarities between the EEG and the Regional Innovation Systems literature. Existing work on these complementarities and chances for conceptual cross pollination have already been undertaken at Lund University. This thesis has been an effort to translate the potential gain in exploratory astuteness of the Regional Innovation Systems literature in the wake of the EEG turn in economic geography by applying a combination of these two bodies of theory in a new and innovative way in empirical research.

The work done for this thesis, both in theorising and in the empirical work has been an effort to show that history indeed matters as David famously stated in 1985. This thesis hopes to show that even the static and a-historical systemic view of economic life adopted in RIS literature gains tremendously in exploratory power if researchers trace the emergence of the system, its components and its governance routines back through time.

Most importantly, this thesis aims to make a statement. Finance cannot be ignored in the field of Economic Geography. Financial capital and the agents and actors who provide it or act as mediators between those who possess financial capital and those who need it in our economy, are critical agents in shaping the geographically uneven development of economic life across the globe. By providing both an historical analysis of the importance of finance and financial routines in Philips, and with that in the industrial development of the Region, and an empirical study into the current day effects of financial routines on the development of the region, this thesis serves as an intellectual proof of concept. Finance cannot be excluded from economic geographical research informing innovation governance. By doing this, it hopes to open up new avenues of research.

Chapter Two

Theoretical Framework

After reading the intellectual tour-de-force by Peter Sunley, in which he dissects and debunks relational economic geography, I have started to gain a deeper understanding on what theory should be to an academic (Sunley, 2008). It's a tool, a lens, or maybe it's better described by calling it a magnifying glass which allows the scholar to examine that piece of reality he or she wishes to gain a deeper understanding of. But what struck me most, was the quote from Beart (2004) at the end of the paper, which functioned as a warning;

From the outset researchers are requested to commit themselves to a theoretical framework that is supposed to guide or inform the research. "Guiding" or "informing" unfortunately often implies a blinkered way of seeing things—reading the social so as to reinforce the very presuppositions that fuel the research. Researchers are encouraged to use the names of celebrated theoreticians. Whereas research in the humanities should enhance our imaginative capacities, open up new futures, this form of theory-inspired research does precisely the opposite: it closes off new experiences. However risqué or avant-garde this research would like to present itself, it is in the end intellectually deeply conservative, using the object of study not to learn something new, but to reinforce what is already presupposed.

This warning resonated with me, and together with the work by Aledré Klukhuhn has fuelled my desire to look over theoretical and academic boundaries in formulating a theoretical framework which teaches me something new about the reality I wish to understand. This has resulted in an eclectic theoretical model which takes the high theory of Evolutionary Economic Geographic as viewpoint to understand the emergence of the current economic and industrial structure of the Brainport Region. Expanding on this, the Regional Innovation Systems literature, from an evolutionary perspective, provides the conceptual linkages to understand the meso level. On the macro level the Varieties of Capitalism literature has provided insights which allowed a deeper understanding of financial routines in a changing global context. Finally and maybe most importantly, the financialisation literature has provided me with the narrative and conceptual tools to define my final object of research, financial routines. This theoretical framework, and the subsequent operationalisation of it through methodology is my activist and idealistic response to Engelsen's (2009, p.590.) call to intellectual arms;

Restricting empirics to the production and consumption of goods that, in the memorable phrase of The Economist, 'can be dropped on one's feet', risks estranging economic geographers from the real drama of our time; the intrusion of finance into all segments of economic life. And this growing relevance of studies of finance also creates opportunities for theoretical stimulation in relation to some of the fundamental interests of geographers.

Again this does not mean rejecting earlier work that does not focus on finance. Rather it means identifying and promoting the many ways that studies of finance can contribute to core geographical and social science debates of the moment.

This means that literature on the most important source of finance for SKIEs, venture capital, will be discussed at length with the objective of integrating it into the field of Economic Geography. This will be achieved through the operationalisation of the research on SKIEs in the RIS of the Brainport Region.

Evolutionary Economic Geography

Evolutionary Economic Geography (EEG) is championed by Boschma and Frenken, two Dutch Economic Geographers. Their work has influenced and shaped the debate on the merits of an Evolutionary Economic approach to Economic Geography, which Asheim 'rightfully considers a new turn' in Economic Geography (B. Asheim, Bugge, Coenen, & Herstad, 2013). Evolutionary Economic Geography can be considered a third approach in economic geography, next to Neoclassical Economic Geography and Institutional Economic Geography (R. Boschma & Frenken, 2005). A red line through EEG is the heavy focus on industry and firms, rather than the institutional arrangement as a whole, as drivers of economic development. (B. Asheim et al., 2013; R. Boschma & Frenken, 2005, 2011a; R. Boschma & Martin, 2007a; Todtling, Asheim, & Boschma, 2013a). A discussion of and comparison of these different approaches would be too ambitious to portrait in its full. In the next part the core features and assumption of EEG theory will be introduced, and where necessary, a reference is made to other strands of Economic Geography, when it serves the purpose of clarifying EEG theory through a comparison with other approaches. EEG will be discussed at length, because firstly the added value of this approach to the theoretical toolbox of Economic Geographers is unequivocal and secondly the theory explains the evolution of the Brainport Region elegantly.

Although the dialog between economists and geographers has a history of being less than fruitful, Boschma and Frenken have been successful in introducing evolutionary and behavioural economic thinking into Economic Geography (B. Asheim et al., 2013; R. Boschma & Frenken, 2005, 2011a). Both economic models argue that humans and organisations' decisions are only rational to a certain extent, a view introduced by Herbert Simon (1960). To make a truly rational decision, Simon argued, actors need to identify and access all possible alternatives and weigh the pros and cons of each of the possible outcomes to find the most cost-efficient way of reaching a goal. This process is costly in comparison to the possible yield of a choice, asserting that humans in economic life do not choose the logical or rationally derived optimal solution but choose a solution that satisfies them. Simon introduced the concept of bounded rationality which argues against the fully rational utility maximising neo-classical models. Humans and organisations operate in an environment of incomplete information, uncertainty and risk, and behavioural economics searches to explain how psychological and social processes result in economical mechanisms that can be

observed in reality. This behavioural and evolutionary view on economic life was built upon by Nelson and Winter (1982). Their work focuses on the micro level of the firms, and they argued that organisational behaviour is routinised because of the fundamental uncertainty of economic life makes behaving in a routinised way more cost efficient and satisfactory. The Evolutionary Economic Geographic approach stands in this intellectual research tradition and Boschma & Frenken have adapted the core concepts into the science of Economic Geography.

Economic geography is seen as dealing with the uneven distribution of economic activity across space. The evolutionary approach specifically focuses on the historical and evolutionary processes that produce these patterns of uneven development, by applying these core concepts and methodologies from behavioural and evolutionary economics in the context of economic geography. The concept of organisational routines has become the central unit of in Evolutionary Economic Geography. The concept of routines was introduced by Nelson and Winter, who define routines as 'organisational memory' that is tacitly embedded skills of the employees. It is the human capital of the firms, the tacit knowledge embedded into human actors, individuals, technicians, researchers and managers. Routines are understood as the cumulative organisational skills and behaviour, which cannot be reduced to the sum of individual skills and behaviour. It exists in the social space between employees, where routines are the codes, rules and scripts that shape the collective behaviour of employees both towards each other as to other stakeholders outside the firm. By choosing routines as their main object of research, a strong firm centred and behavioural view has become central in EEG. Boschma and Frenken argue that routines determine the type of activities firms undertake, the strategies they follow and the opportunities they perceive. Routines guide the exploratory activities of firms and affects their ability to react to changing technologies or market circumstances.

On a firm level, organisations are perceived to rely and build on their existing knowledge base and experience, which have been proven to be successful in the past, and have become routinised resulting in a path-dependant development of firms. Behaviour proceeds along narrowly defined trajectories that form frameworks of thought and scripts. Search for new knowledge goes along with a high degree of uncertainty: outcomes of search processes are uncertain and often unexpected. To reduce the of risk failure, searches for new knowledge are likely to be undertaken close to the existing knowledge base which has been the modus operandi in the past, and are path-dependent in the sense that they are determined by the existing technological, organisational and process knowledge embedded in the firm. In other words, organisations search for new markets and business opportunities in close proximity to their existing knowledge base, which reduce risks but also sets constraints for further improvement. It is argued that it becomes difficult to unlearn habits or routines that have been successful in the past, but which have become redundant over time. This has been described as the 'competency trap': *'becoming quite good at doing any one thing reduces the*

organisation's capacity to absorb new ideas and to do other things', and firms can become locked-in on certain pathways (Boschma, 2004. P. 1004).

Firm-specific routines are seen as underlying the firms organisational capability on basis of which it competes, and competitive advantage is gained by having fitter routines. (R. Boschma & Frenken, 2005, 2011a; R. Boschma & Martin, 2007b). Economic development, both on a regional scale as on the firm level, is seen as a process of evolution. In this evolutionary process, the selective transmission of routines among organisation entities, particularly firms, determines the development path of a firm, an agglomeration or a region. As the replication of routines among firms is imperfect, variety in routines persists over time as the routines are passed on with small modifications (R. Boschma & Frenken, 2011a). Market competition enables more efficient firms with 'fitter' routines to gain competitive advantage at the expense of less efficient firms with 'unfit' routines (Ron Boschma, 2004). This process reduces, combined with constraining institutions, the variety of routines. At the same time, radically new routines can be introduced through innovations, even if not many of them will survive the selection process (R. Boschma & Frenken, 2011a). With spinoff firms and labour mobility being its prime vehicles, routines replication is a mostly local affair.

What follows is that the spatial evolution of firm-specific routines develops along a geographically localised lineage structure, in which successful routines have a higher chance not only to survive, but also to be transferred to other local firms. Regional development in EEG is than centred around two interrelated issues, first of all the path dependant development of regional industries, and how these are locked into and locked out of these trajectories. Secondly, it focuses on the emergence of clusters as an evolutionary process of 'branching'. Firstly, EEG theory deals with path dependent development processes, which means it looks at the history and evolution of industrial development, both on the firm level as on a territorial level (R. Boschma & Frenken, 2005). The current distribution of economic activity across space is understood as being defined by random events in history; initial firms who located in an area gave rise to an economic development path. This historicising view on economic life seems a valuable addition in theorising about innovation and economic development, and the concept of path-dependence has a close relationship vis-à-vis (evolutionary) technological change, introduced by David (1985). In this model, new technological pathways are opened up as a result of "historical accidents", "chance events" or "random" actions (B. Asheim et al., 2013).

Building on Klepper's (2007) work on the US car industry using industry lifecycle, clusters are seen to emerge around initial successful parent firms who happened to have been located in a certain region. Through in a process called 'regional branching' firms produce new firms in related industries. In the context of EEG, the development paths of regional economies are researched by tracing regional entry and exit patterns of firms over time. Spin-offs inherit a large part of their capabilities from their parent firms, which explains why successful firms tend to give birth to successful spin-offs. Boschma & Frenken pose that more successful

firms produce more and more spin-offs. Since spin-offs tend to locate in the same region as the parent firm, a cluster emerges once a single firm or a few successful firms start to create many successful spin-offs, which, in turn, create successful spin-offs themselves. Labour mobility is seen in EEG as the prime process through which knowledge is transferred between existing firms on a regional scale (R. Boschma & Frenken, 2011a). These localised processes results in a regional path-dependent regional development process, in which a certain pathway is randomly selected by merits of the industrial focus of successful parent firms. What follows is that the spatial evolution of firm-specific routines develops along a geographically localised lineage structure.

The industrial and technological development paths of regions which emerged around a first generation of firms which are part of a related industry, will diversify through the spin-off process and labour mobility. Spin-off firms, and the entrepreneurs and engineers who work there, take routines from the parent firm and recombine these to create new niche markets. This means that routines are altered to fit new market needs, and that the spin-off firms do not operate in exactly the same market as the parent firms (R. Boschma & Frenken, 2011a). New industries emerge from the existing industries, which are related through shared technological routines, which are modified to create products and services which are sold in a new market. Boschma & Frenken claim that regional diversification through branching requires the presences of technologically related industries, out of which new industries will develop. This attention for the development of new industries in a region over time, called 'branching', provides a new conceptual tool in economic geography to understand the evolution of industries in regions over time.

The theoretical advances in EEG on the relationship between agglomeration economies and regional development paths goes beyond the classical notion of knowledge spill-overs as determinants of economic growth (B. Asheim et al., 2013). The presence of R&D institutions, public and private, is associated with positive external effects. The underlying idea in the private sector is that R&D activities have two different effects. One is to directly generate new innovations, the other is to provide companies with the ability to identify, evaluate, and absorb internally different forms of know-how which has been generated outside the firm. By investing in the build-up of absorptive capacity through in-house R&D, companies may therefore increase their ability to generate future innovations by remaining actively tuned on what others are doing and ready to exploit the opportunities that scientific and technological advances create (Rin & Penas, 2007). Firms being located in close proximity to public research institution are believed to benefit from knowledge spill-overs. EEG focuses less on these classical R&D indicators. Instead it focuses on how the pre-existing industrial structure determines on the one hand the composition of spill-overs with respect to knowledge and on the other the ability of the regional system to effectively transform them into growth (B. Asheim et al., 2013). Current EEG thinking focuses almost exclusively on the industrial conditions under which self-sustained localised spill-over emerge, setting it apart from Institutional Economic Geography which focuses on policy institutions and knowledge

generation outside of industry and views industry as exploiting regionally available knowledge (B. Asheim et al., 2013, p. 4.).

Systems of Innovation; the Regional Innovation System

Looking at the publications of the past decade in which the EEG framework has been developed, the attention for innovation and novelty as drivers of economic development has gradually declined in favour of a routine centred view on economic growth. This shift away from incorporating innovation in the EEG framework is recognised. However, in this thesis innovation will remain at the centre of attention. This choice is made based on the extensive attention that is being paid to innovation as driver of economic development both inside and outside of economic geography. Innovation plays such a large role in public policy, the public debate, academic research and most importantly in the strategy of many firms, large and small, that the concept is seen as rich in explanatory capacity to be stepped over. Until recently, change through Schumpeterian creative destruction was seen in EEG as one of capitalism's constants (R. Boschma & Martin, 2007a), and this constant state of flux has been famously described by Schumpeter as a process that *'incessantly revolutionises the economic structure from within, incessantly destroying the old one, incessantly creating a new one'* (Tilburg, 2009).

As Boschma and Martin argued in 2007, novelty is central to any theory of evolutionary economics (R. Boschma & Martin, 2007b). This constant process of trial-and-error, search, learning and selection results in an out-of-equilibrium process of economic development. This contrasts with neo-classical explanatory models that describe economic progress as inevitably gravitating towards a state of equilibrium. In line with this out-of-equilibrium process of economic development is the notion of innovation, which is central to evolutionary economic geography. Schumpeter's concept of innovation refers to the transformation from old to new that arises from within the socio-economic system, the enterprise driven adaptive development of new products, processes and business models. The concept of innovation and the out-of-equilibrium Schumpeterian view on economics was largely ignored by mainstream economics.

Over the past decades however, innovation has become a popular research topic both on the company level and on the regional level and the term has gained traction within mainstream economics and in policy areas. The contribution of Michal Porter has popularised the idea that regions are loci of innovation. There exists a large body of literature pointing to the advantages firms gain from locating in close proximity to each other. Concepts like industrial districts, innovative milieus, learning regions and clusters describe the crucial importance of 'face to face' interactions for shared knowledge externalities on a local level. Geographic proximity provides privileged access to diverse knowledge and networks into very different industrial and technological domains (Porter, 1998b). Besides that, it provides privileged access to the knowledge and industrial domains which constitute the core of individual firm activities. Conceptualizing localized learning as a

process of continuous search, recombination, replication and transformation occurring at the intersection between the knowledge bases of firms, research institutes and universities has been a subject of study in various strands of Economic Geography (Ron Boschma, 2005; Cooke, Uranga, & Etxebarria, 1997; Pinch, Henry, Jenkins, & Tallman, 2003; Porter, 1998a).

The territorial dynamics that are relevant to the innovation process are researched in the innovation systems literature, founded by Freeman, Lundvall & Nelson (1997/1992/1993). Cooke (1998) applied the territorial logic of innovation on regions. The regional innovation systems (RIS) has become a leading approach in explaining innovation processes and patterns shared by firms and industries at the regional level. These explanations stem from the assumption that innovation is an interactive and territorially embedded process, stimulated and influenced by many actors and information sources located both in and outside of firms. Of course, the most famous example of a regional innovation system is Silicon Valley in the USA. (B. T. Asheim, Smith, & Oughton, 2011; Cooke et al., 1997; Cooke, 2008; Doloreux, 2004; Uyarra, 2009). The RIS literature takes a broader view on innovation and economic development than the EEG approach, which focuses on the industry-based knowledge and routine generation and dissemination. Recently insights from Evolutionary Economic Geography, however, have been used to enrich the RIS literature. Asheim recently asserted that the spatial contextualisation provided by RIS approaches and the historical-cognitive contextualisation provided by EEG are complementary perspectives on regional development (B. Asheim et al., 2013).

The systemic perspective implies that regional innovation systems are conceptualised in terms of (1) system components, (2) system linkages and (3) system boundaries (B. Asheim et al., 2013). The system components refer to the private and public organisations involved in innovation processes as well as to the institutions guiding their behaviour. The system linkages refer to the relationships between the components which are part of a localised innovation network that allows for interactive learning to take place (B. Asheim et al., 2013). The boundaries of the RIS are classically drawn around a geographically demarcated region. It follows from a plethora of RIS studies that a regional systemic dynamic resulting in innovation does not occur automatically through market-based coordination but requires a variety of different governance arrangements and social capital (B. Asheim et al., 2013).

The RIS approach has traditionally distinguished between two regional subsystems, i.e. the knowledge exploration subsystem and the knowledge exploitation subsystem (B. Asheim et al., 2013). The exploration subsystem has been viewed as consisting of universities, research institutes, etc. Firms in the region which are part of similar or related industrial sectors have on the other hand been considered as representing the exploitation subsystem which feed on and transforms knowledge developed within the exploration system into economic value through the process of innovating. Partly under influence of EEG, the RIS approach has increasingly emphasised the importance of inter-industry dynamics and recognised the specialised knowledge that is developed within firms. This reduces the clear distinction

between the two subsystems and, instead, treats these as overlapping. This thesis follows Asheims' recent reconceptualisation of RIS, which suggest a combined knowledge production and diffusion infrastructure which still is divisible into an exploration and exploitation system part (B. Asheim et al., 2013). This conceptualisation puts greater emphasis on firms as the loci of innovation and may tone down the role of universities and other types of knowledge organisations in the RIS as active agents in innovation processes.

This thesis draws special attention to a particular class of firms that play a larger role in both the exploration and exploitation side of innovation in today's innovation landscapes. Small Knowledge Intensive Enterprises are firms where knowledge has more significance than other inputs such as labour and capital goods. SKIEs are firms in which well-educated and qualified employees form a major part of the work force and engage mainly in process of translating knowledge into innovative new products, services or production processes. The concept of SKIEs is closely related to the concept of Knowledge Intensive Firm and Knowledge Intensive Small and Medium Enterprises (Baptista Nunes, Annansingh, Eaglestone, & Wakefield, 2006; Starbuck, 1992). SKIEs function as a series of small laboratories that can guide the technological strategies and the market directions of large firms (Chesbrough, 2003). The denser the fabric of SKIEs in an economy the greater will be the externalities for growth and competitiveness of firms who around these hubs of SKIEs (Perez, Schenk, & Boot, 2009). In SKIEs knowledge and technological routines developed in university labs, research institutes and in corporate research labs are transformed, adapted and applied into new, innovative products and services that can be commercially exploited. In the age of open innovation SKIEs are an significant and necessary source of external knowledge in systems of innovation (Chesbrough, 2003; Perez et al., 2009).

An additional contribution to RIS conceptualisation in the wake of EEG concerns the importance and role of extra-regional linkages, which either expand as a result of established 'insiderness' in global communities – or are constrained by lock-in to specific geographical and cognitive domains (B. Asheim et al., 2013). In recent years a differentiated multi-level or multi-scalar perspective on sources of knowledge and innovation has emerged. Such a multi-scalar perspective goes beyond the 'local buzz and global pipeline' argument proposed by Bathelt et. al. (2004) that suggests that unintended and informal knowledge spill-overs are local, whereas intended and formal relations are global (Bathelt, Malmberg, & Maskell, 2004; Todtling, Asheim, & Boschma, 2013b).

The main contribution from EEG to the RIS literature is the focus on the specialised knowledge bases and organisational routines of the industrial base i.e. firms, which constitute the core of innovation systems – not university research and technology transfer schemes nor individual entrepreneurs operating in isolation (B. Asheim et al., 2013). It points back to the individual firm level, in that it allows not only independencies but also different mechanisms at work in *knowledge development* at the individual firm level and knowledge diffusion at the regional level. Todtling, Ashheim & Boschma (2013) recognise in their recent

article that the view on knowledge and knowledge bases has been too narrowly defined (Todtling et al., 2013b). Part of their argument is that there is a need for a better understanding of the types of knowledge bases involved, and the kinds of externally sourced knowledge in the regional innovation process. They recognise that the distinction between market knowledge and technological knowledge is important. However, their main suggestion is a threefold distinction between ‘analytical’, ‘synthetic’ and ‘symbolic’ types of knowledge bases, that partly transcends the dichotomy of tacit versus codified knowledge.

The conceptual importance in this distinction for this theoretical framework lies in the fact that the authors plea for a broader and more comprehensive view on innovation. Their main argument, is that research and policy should move away from the linear, high-tech and R&D oriented view, towards a differentiated knowledge base view in relation to innovation. Although this argument is made in the context of innovation systems literature which focuses on the regional – or meso – level, the logic behind this shift towards a differentiated knowledge view is similar to the logic underpinning this framework..

Innovation on the firm level

With the shift towards a more firm centred view of regional innovation systems, and suggestions that a differentiated view on knowledge bases as sources for innovation, literature from mainstream economics on firm level innovation has become more relevant for the field of Economic Geography. Even though a discussion on the different definitions of innovation falls outside the scope of this work, in light of this shift, attention is paid to innovation on the firm level. There is no shortage of work to choose from for a definition. This thesis will build upon the Oslo Manual for Innovation and work done in managerial science, who both share the firm centred approach with EEG. The Oslo Manual looks at the firm as the locus of innovation and deal with innovation on the level of the firm (Ashford, 2001; OECD, 2012). Therefore it’s a small step to take the definitions and classification of innovation and introduce them into the framework of EEG. The aim of this is to use the classifications of innovation to come to an comprehensive classification of routines, which will be constructed later on in this thesis as part of the theoretical framework.

The characterisation that is build upon in this work lies in the distinction between technological, process and organisational innovation. Ashford (2001) defines technological innovation as *“the first commercially successful application of a new technical idea, which should be distinguished from invention, which is the development of a new idea, and from diffusion, which is the subsequent widespread adaptation of an innovation beyond those who developed it”*. The Oslo manual instead of referring to technological innovation, refers to product innovation. These concepts are not the same, but both share the technological aspect of innovation. Product innovation is defined in the Oslo Manual as the introduction on the market of *“a product whose technological characteristics or intended uses differ significantly from those of previously produced products”* or *“an existing product whose performance has been significantly enhanced or upgraded”*. The common denominator in

these two supplementary definitions is that the novelty of a technological idea alone doesn't qualify it to be called an innovation. In the Schumpeterian tradition, they both see a successful market introduction as a condition for a new technological product to be called an innovation. This successful market introduction is characterised by an increase in profit, which can result from a larger market share or the higher price customers are willing to pay. Building on this, this thesis utilises the following general definition for technological innovation: *"the first new commercially successful application of a new technical idea or improvement of an existing product whose performance has been enhanced or upgrade significantly so that its increased performance or new applicability differs from previously existing products, which is recognised by the market resulting in increased profits"*

Raymond & St-Pierre (2011) refer to process innovation as *"the efforts firms undertake to improve their competitiveness by reducing production costs and increasing the flexibility of their productive apparatus"*. The Oslo Manual provides an addition this; *"A technological process innovation is the implementation/adoption of new or significantly improved production or delivery methods. It may involve changes in equipment, human resources, working methods or a combination of these."* In this thesis, human resources and working methods will not be seen as part of process innovation. These fit better under the category of organisational innovation, as used in management literature. In Ashford's definition, organisational innovation *"is used to refer to larger organisational features of the firm, beyond the organisational features of a specific product line, and is concerned with changes in and among various organisational aspects of functions of the firm such as R&D/product development, marketing, environmental and governmental affairs, industrial relations, worker health and safety, and customer and community relations."*

The distinction between process and organisational innovation then comes down to looking at novelty and improvements in production goods, the actual hardware, resources and machinery used to assemble products. Talking about organisational innovation is looking at the 'human' aspect of firms and novel and improved ways to organise the internal and external networked features of a firm. One can argue against this distinction, and this would indeed be a fruitful debate to engage with, but this falls outside the scope of this thesis. In this thesis process innovation is defined as *'the implementation/adoption of new or significantly improved production or delivery method involving improvements in equipment, resource usage and/or energy use which reduces the cost of production and/or distribution resulting in increased profitability'*.

Organisational innovation is referred to as *'improvements in the organisational features of the firm, such as changes in and among various organisational aspects of the firm such as R&D/product development, marketing, environmental and governmental affairs, industrial or business relations, worker health and safety, customer and community relations, and accounting methods resulting in better firm performance which increases profitability'*. Novelty is of less importance to this last form of innovation, or at least not novelty in the

Schumpeterian sense of the word. The novel ways of organisational behaviour do on the one hand destroy the previous form of behaviour on the firm level. However, most organisational innovations stay within the boundaries of the firm and are incremental. Ofcourse, more radical organisational innovations do emerge, for instance the shift to and from 'Big Science' as a way of organising R&D efforts emerged in the 50's and radically changed the way company laboratories managed their innovative efforts. Numerous are the different managerial methods come and go, and are endogenously to firms who adopt them, making this forms of diffusion of organisational innovations. One could argue that this means this is not a fully-fledged form of innovation, and that these organisational improvements only serve to improve the ability of firms to innovate in processes or technologically. This is a legitimate criticism, however, for the sake of conceptual clarity this distinction is maintained.

To summarise the distinction between the three above described forms of innovation is as follows. Product innovation refers to the translation of knowledge into a new or improved product, whereas process innovation refers to the translation of knowledge into improvements in the material production process and delivery methods. These improvements in the material production process are on a firm level, inside the firm, and result in lower production costs which improve the firm's ability to compete. Organisational innovation refers to the ability of firms to change its behaviour, both internally and in its networked functions with stakeholders in- and- outside of the firm, resulting in higher level of competitive advantage. These definitions are in any event related, overlap at times, and are an first effort to refine the conceptual toolkit of the economic geographer by introducing notions from another field of research.

Institutions and the Political Economy; Varieties of Capitalism

Boschma and Frenken argue that a deterministic focus on institutions, with institutions defined as a sets of rules, formal or informal, that actors generally follow, whether for normative, cognitive, or material reasons, play down the central role of creative entrepreneurs and global firms as drivers of economic change(R. Boschma & Frenken, 2011b; Hall & Soskice, 2001). This does not mean they discard the concept of institutions as having any influence over firm's behaviour, however, institutions condition rather than determine firm behaviour and regional development (R. Boschma & Frenken, 2011a). As a reason for this downplayed role of institutions they refer to the fact that firms and actors in the same region act or perform in the same way, whilst still being subject to the same institutions. However, they don't address the similarities that do exist in routine behaviour in reaction to institutions in regions. Hall & Soskice (2001) provide a more comprehensive view on the relation between firms and territorial specific institutions in their work Varieties of Capitalism. These institutions offer firms a particular set of opportunities; and companies can be expected to gravitate towards strategies that take advantage of these opportunities. Based on the difference in strategies of firms observed across countries in similar industries, Hall & Soskice argue that institutions have a more pervasive influence on company's

behaviour. For them, the market is seen as a space governed by both market and non-market institutions and thus, since firms aim to take advantage of the opportunities provided by institutions, strategy follows structure. This broad view on market and non-market institutions is complementary to the EEG view. Since routines are selected on the bases of fitness, routines that exploit the particular opportunities provided by an institutional arrangement on any given territorial (or cultural) scale, be it municipal, regional, national, or worldwide will survive the evolutionary process. These two views don't exclude each other, rather they provide complementary conceptual explanatory value to each other. The treatment of institutions as co-evolving with markets, technologies or socio-cultural changes as proposed by Boschma and Frenken is a novel contribution to institutional theory. The process of institutional evolution is a dynamic process, that mutually influences firms, society and governance structure. Interesting is the work done on how new industries create opportunities seized by regional governance actors to adopt their institutions to fit these dynamics, or to enable the revival of mature industries.

VoC, like many networked views on economic life, emphasise the relational aspect of the economy. H & S view the firm as relational, seeing the firm as actors seeking to develop and exploit *core-competencies* or *dynamic capabilities* understood as capacities for developing, producing and distributing goods and services profitably. *"Because a firm's capabilities are ultimately relational, a firm's success depends substantially on its ability to coordinate effectively with a wide range of actors."* This relational, networked view of economic development fits with relational turn in Economic Geography. The quality of the relationships the firm is able to establish, both internally, with its own employees, and externally, with a range of other actors that include suppliers, clients, collaborators, stakeholders, trade unions, business associations and governments is seen as important. Core competencies and dynamic capabilities refer to firm's behaviour, and these concepts resemble the concept of routines. Routines that enable firms to interact with other actors in the economy are seen as critical in their view. Following the VoC approach, because firms capabilities are ultimately relational, a firm's success depends substantially on routines which allow them to coordinate effectively with a wide range of actors. Incorporating the relational capabilities of firms into an EEG approach opens up avenues for identifying and categorising routines that specifically deal with this aspect of firm's behaviour.

The work of Hall & Soskice uses a narrative that is inspired by and grounded in game theory, and utilises a neoclassical model that predicts that markets naturally gravitate towards an equilibrium, fundamentally different from the behavioural economic foundation used by EEG. However, there is an entry point in their analysis for history and culture, which bridges this divide. Hall & Soskice argue that a shared history breeds a common culture between actors. Culture is for them a *"set of shared understandings or available 'strategies for action'"*, mirroring the language of routines as utilised in Evolutionary Economic Geography. History influence institutions in two distinct ways. Firstly, institutions are created by actions that establish formal institutions and their operating procedures, and those action are

necessary in the past. Secondly, repeated historical experiences build a set of common expectations that allows the actors to coordinate effectively with each other. The latter conceptualisation of a common experience reducing transaction costs, calls to mind the concept of 'social capital'.

The terms on which finance is provided to firms will depend on the monitoring capacities present in the political economy. Hall & Soskice point out that the presence of institutions providing network reputational monitoring can have substantial effects on the terms on which firms can secure finance. Where potential investors have little access to inside information about the progress of the firms they fund, access to capital is likely to depend on highly public, generalised criteria about the assets of a firm of the sort commonly found on balance sheets. This monitoring problem is generally resolved through the presence of dense networks linking the managers and technical personnel inside a company to their counterparts in other firms on the terms that provide for the sharing of reliable information. Reputation is a key factor. Where investors are linked to the firms they fund through these networks that allow for the development of reputations and access to information about the internal operations of the firm, investors will be more willing to supply capital to firms on the terms that do not depend entirely on their balance sheets. The financial system or market for corporate governance typically provided companies with access to finance that is not entirely dependent on publicly available financial data or current returns. Access to this kind of "patient" capital makes it possible for firms to retain a skilled workforce through economic downturns and to invest in projects generating returns on the long run.

Finance

Until quite recently the world of finance did not attract much attention from academic economists and policy makers dealing with innovation, let alone economic geographers (E. Engelen & Faulconbridge, 2009; Lee, Clark, Pollard, & Leyshon, 2009; Muellerleile, 2009; Tilburg, 2009). It is a curious tendency within Economic Geography that it has an explicit lack of attention to flows of money and finance (Lee et al., 2009). Economic geography has had a strong focus the "real" economy, with empirics and theories looking at the production and consumption of goods that, in the memorable phrase of *The Economist*, 'can be dropped on one's feet' (E. Engelen & Faulconbridge, 2009). This neglect for value or capital networks is associated with the traditions of Economic Geography interest in the material and knowledge landscapes of economy (E. Engelen & Faulconbridge, 2009; Lee et al., 2009). The circulation of money and finance were regarded as self-evident, and in a Schumpeterian tradition seen as merely facilitating entrepreneurs. In mainstream, neoclassical economy as well, the study of finance was seen as irrelevant. The neoclassical assumption was that the financial markets functioned perfectly, since information was transmitted efficiently through the pricing mechanism, and capital would be readily available for profitable investment opportunities. A seamless fit between the needs of the real economy and the supply of capital and financial instruments by the financial sector was assumed (E. Engelen & Faulconbridge, 2009; Lee et al., 2009; Tilburg, 2009). New insights into the relationship

between the financial world and the real economy are dawning. Already before the financial crisis of 2008 a growing body of empirical research questioned the neoclassical and neo Schumpeterian assumptions that finance 'will follow' market needs (Ron Boschma, 2004; Ewald Engelen, 2008; Perez et al., 2009; Perez, 2004; Tilburg, 2009).

This rapidly growing body of work shows that financial development is not only the result of the developing real economy, but is actively shaping economic development. Empirical studies conducted outside of the field of economic geography found that specific characteristics of national financial sectors are an important determinant of the speed and direction of innovation and growth in the economy. Van Tilburg (2009) cites numerous empirical studies that suggests there is a strong relationship between financial institutions and the performance of firms and innovations systems. This relation between financial institutions and innovation systems has not been recognised in either Evolutionary Economic Geography or in Innovations Systems literature with its innate focus on the real economy. Outside of Economic Geography, the financial landscape is increasingly identified as one of the most important elements of the innovation system in which firms operate. Financial institutions are, just as any other industry, geographically unevenly distributed. Mirroring the way other institutions, knowledge sources and industry bases, financial institutions are to be assessed as part of systems of innovation. Financial institutions are part of this thesis and for that matter should be, like Engelen said, "*at the centre of economic geographical research*" (E. Engelen & Faulconbridge, 2009; E. Engelen, Konings, & Fernandez, 2008; Ewald Engelen, 2008; Ewald Engelen et al., 2012). Capital is not allocated in a perfect way, but through geographically unevenly distributed financial institutions which interact in varying ways with different industries and firms. This unevenly distributed flow of capital is part of the explanation for the uneven distribution of economic growth and innovation. The availability of capital and the ease with which the capital can be accessed by firms matters a great deal for firm performance and regional development. This strikes to the core of the field of economic geography (Tilburg, 2009).

The rise of finance from the mid-1990s onward has drawn attention from some economic geographers, Financial Geographers, with explanatory models being constructed around the concept of financialisation (E. Engelen & Faulconbridge, 2009). No clear demarcated definition of financialisation yet exists. However, Dickens provides a comprehensive explanation of the concept. He refers to financialisation as an all-pervasive system of values based on the overriding prioritisation of an equity culture, in which 'shareholder value' and profitability have become central to *all* aspects of economic activity to the virtual exclusion of all other interests (Dicken, 2011). Central to this new logic is the shift in organisational routines as performance indicators in firms away from product and labor markets based indicators and towards finance and capital markets based indicators. Performance is expressed in terms of added monetary value, in an effort to be able to communicate with financiers, requiring firms to adopt financialised routines (Muellerleile, 2009). The blind spot for the role of financial institutions has created an implicit distinction between the "real"

economy and the financial world. Engelen and other financial geographers argue that maintaining this distinction in economic geography is untenable (Pollard, 2007). This is based on the observations that any manufacturing economy is intimately related to the financial economy, both because of the need for credit but also because of the influence of stock markets and shareholder value logics on management strategy (E. Engelen & Faulconbridge, 2009; Muellerleile, 2009).

Pike & Pollard (2009) provide an summary of research into the spread of financial routines. Various indicators of the growing prevalence of financial calculation include pressures to manage corporations to deliver “shareholder value” in the form of dividend streams and asset appreciation that privilege financial ownership over other agents (Folkman, Froud, Sukhdev, and Williams 2006; Williams 2000); marked growth in the long-term market capitalisation of firms (Gibbon and Ponte 2005); increased turnover in short-term share ownership; the proliferation of fee-earning intermediaries (e.g., hedge funds, private equity fund partners, corporate lawyers, and fund managers; see Froud and Williams 2007); the trend for non-financial corporations to buy up assets and financial subsidiaries (Blackburn 2002; Martin 2002); and the deeper and wider enrolment of individuals in the realm of financialised capitalism—by 2000, for example, some 40 percent of U.S. and U.K. households had some of their savings invested in stock markets (Williams 2000). Their own research into the beverage industry showed how institutional investors became more powerful in beverage producing firms (Pike & Pollard, 2009). Through the primacy of the capital markets as part of financialisation, narratives demanding enhanced shareholder value have forced brewing companies away from capital-hungry production and packaging toward the sales and marketing of brands (Lee et al., 2009).

In evolutionary models of entrepreneurship outside of EEG, entrepreneurs are said to generate variation by founding new firms, pursuing different strategies, and attempting to combine different bundles of assets to do so. Selection is then generated by the decisions of external resource holders to allocate their resources among these firms (Baum & Silverman, 2004). This mechanism of resource allocation as selection mechanism is implicitly part of the EEG model. EEG asserts that firms compete in the market, on the basis of routines. This market competition can be seen as a battle over customer’s resources, both business or consumer. However, the allocation of capital resources among firms through financial markets is not part of EEG.

Financialised routines are becoming more important to the competitive advantage of firms in the capitalist system. The growing influence and power of financial markets places new demands on firms, forcing them to develop routines to cope with this new reality. Seeing as Economic Geographic research has paid virtually no attention to finance when looking at economic development, this means it is lagging behind in its knowledge, data, and understanding of these financialised routines. Understanding where those routines come

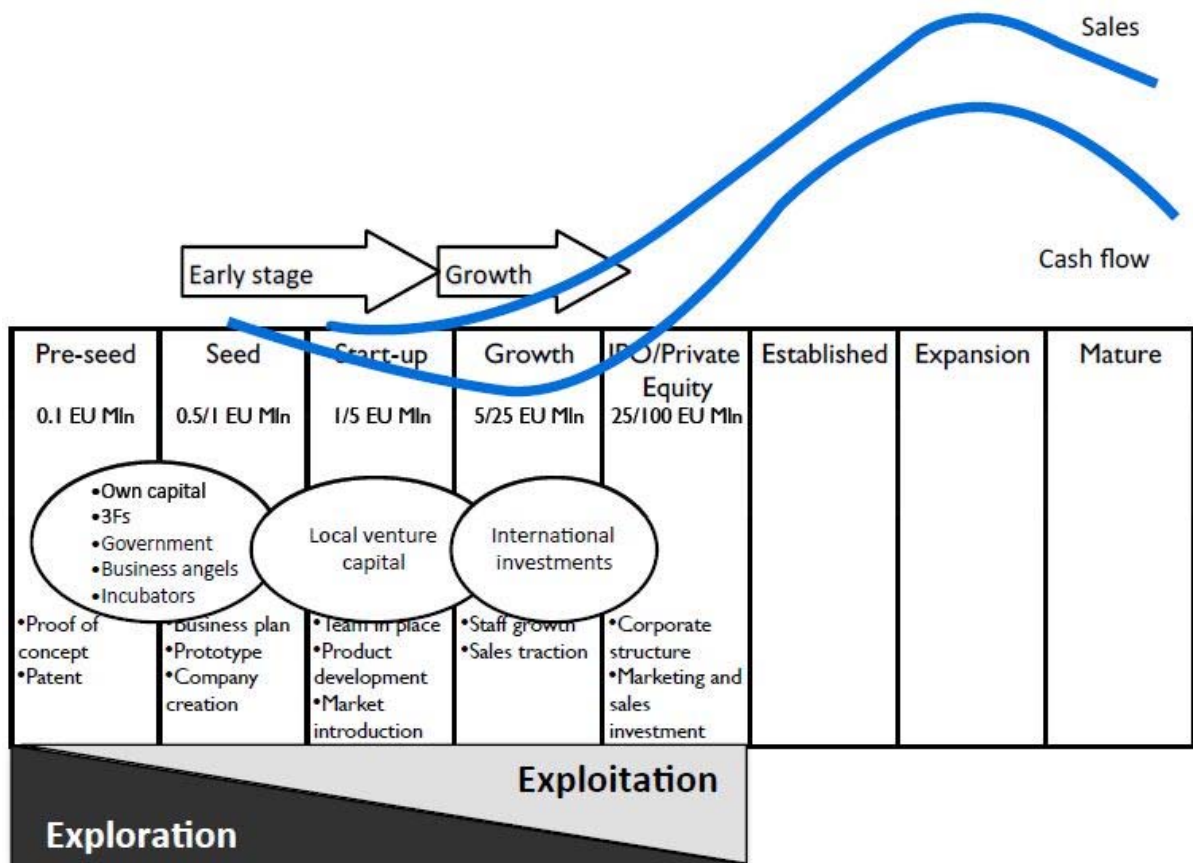
from, how they disseminate and how they influence firms ability to compete, greatly increases the explanatory value of any Evolutionary Economic Geographical study.

Venture Capital: Finance for Small Knowledge Intensive Enterprises

This research project focuses the specific class of firms known as SKIEs. There is a specific set of financial institutions with accompanying financial routines which supply the capital needed to start and grow SKIE's; Venture Capital. Venture capital is considered to be the most appropriate form of financing for innovative entrepreneurial firms in high-tech sectors (Bottazzi & Rin, 2002; Chesbrough, 2003; Grilli & Murtinu, 2014). Venture Capital (VC) refers to investments provided to early-stage, innovative, and high-growth start-up companies in return for an equity stake with the aim of making an eventual capital gain by selling the equity stake (Chesbrough, 2003; Cumming, 2012; C. M. Mason & Harrison, 1995). Some general insights gained in researching SKIE financing will be shared, to guide the reader into understanding the specifics of SKIE financing. Firstly, knowledge intensive start-ups do not generate profits and do not have a positive cash flow. They depend on external sources of financing for their survival. Secondly, the high risk profile of SKIE's is one of the defining features of these types of firms. Risk taking is an integral part of entrepreneurship, which leads to possibility of high returns, but the other side is that many firms fail. Figures differ per region, country and region but a 'general rule of thumb' often repeated was that out of ten firms, roughly seven fail, two become 'walking dead' – firms that survive but never generate any return on investment – and one survives, grows and generates profit (Baum & Silverman, 2004; Rhodes-kropf & Nanda, 2012; Tilburg, 2009). The cultural perceptions around bankruptcy differ. The CEO of the MIT Entrepreneurship Centre remarked that *"In Silicon Valley, honest bankruptcy is like a duelling scar earned in a Prussian officers' mess. People who don't fail from time-to-time are not pushing the envelope"* (Keeping, 2006). Thirdly, the R&D activities of SKIE's don't create collateralisable assets to use in order to secure more traditional forms of debt structured capital. Investments in SKIE's are made based on the promise of future revenues. This precludes them to use many financial investment products and accompanying financial routines offered by banks (Collewaert, Manigart, & Aernoudt, 2010; Insider, 2013; Tilburg, 2009). Lastly, the amount of capital needed and the time needed for SKIE's to develop their technological routines into marketable products differs greatly per sector.

The corporate lifecycle of SKIE

Start-ups rely on an integrated chain of financial tools during their corporate lifecycle, most of which are forms of venture capital. With the different phases in the corporate lifecycle of a SKIE as guideline, the financial institutions related to these phases will be discussed in the context of the Brainport region.



Government Seed investments

Governments worldwide are very active in early investments and are the most important supplier of investments the earliest stage in the corporate lifecycle of firms in Europe (Vermeulen, 2014). The risk involved in investing in SKIE's in the pre-seed and seed phase are substantial and form obstacles for private venture capital investors to invest in this phase. In the early phase different sources of government funding are combined into a financial routine referred to as 'bootstrapping'. This refers to the stacking of different sources of government funding. SKIE's apply for various research and valorisation grants and debt-based financing, which is covered through tax support regulations called the 'Tante Agaat' regulations. Sources for grants are the European Union, the Dutch NWO, which distributes grants directly for exploratory research, and through STW for applied research in the exploitation phase. The amount of these grants varies between 25.000 and 200.000 euros, often to be released in tranches after certain targets have been met. These grants and debt based financial instruments however require a lot of paper work to be filled in, diverting time and organisational capacity away from R&D and entrepreneurial tasks.

The financial routines utilised by governments to increase the supply of early stage capital have evolved over time (Murray, 2007). Besides grants and debt based financial routines, governments now typically adopt an equity based approach, similar to venture capital (C. Mason, 2009). These often take the form of incubator funds or 'seedfunds' that invest in return for an equity stake, with the goal to sell this equity stake to private investors once the

firms have matured. These funds operate on a regional scale, with backing of national funds. On a national scale, AgentschapNL, the branch of the Dutch Ministry of Economic Affairs provides loans up to 4 million euros to set up public/private investment funds through the Innovationfund MKB+, and 41 of these applications have been honoured since the founding of this Seed Capital Arrangement in 2005 (Insider, 2013).

Business Angel Investment

Informal venture capital is provided by business angels (BA), which are private individuals who provide risk or venture capital to new and growing businesses in which they have no family connection (Aernoudt, 2005; Collewaert et al., 2010; European Union, 2002, 2012; C. M. Mason & Harrison, 2001; Maxwell, Jeffrey, & Lévesque, 2011; Sorheim & Landstrom, 2001). The amount individual BA's invest varies from country to country, and especially with the recent emergence of super-angels, the maximum amount is rising, however for the EU research indicates an investment range of 25.000 to 250.000 euros per angel, per investment round (*EBAN Tool Kit*, 2009; European Union, 2002, 2012). The term business angel historically refers to private investors of the Broadway theatre, who by investing at the end of the 18th century saved the theatre from bankruptcy (Gullander & Napier, 2003). The business angel market is a relatively invisible part of the total venture capital market, but it is the oldest kind of venture capital. It is made up of individuals, mostly males aged 35-69, who are self-made, financially strong, often millionaires and regularly successful serial entrepreneurs themselves. In the corporate life cycle of SKIE's, BA financing is the 'next step', to grow as a firm; it is used to scale R&D efforts, set up production facilities, expand into new markets and strengthen organisational capacity by attracting specialised human capital. Once an investment has been made into a firm informal investors often provide follow up investments, released in tranches when beforehand agreed on performance indicators, referred to as milestones, have been met. BA investments have a stark geographical dimension and invest in firms in close proximity to their home. European surveys show that 95% of investments made by angels are in firms located no more than half a day's travel from home (*EBAN Tool Kit*, 2009; C. M. Mason & Harrison, 2002).

In the informal venture capital market the supply of capital is offered though a high degree of anonymity. SKIEs encounter difficulties in accessing this form of financing, which boils down to the fact that BA's often do not want to be found, do not want to be visible. From a theoretical point of view, this is a persistent market failure. Information about where to find informal venture capital flows inefficiently. This creates a funding gap, which is greatest for new and inexperienced entrepreneurs who are seeking external financing for the first time and who are not familiar with the possibility of BA investment and lack a network in the financial world in the region (Gullander & Napier, 2003; Insider, 2013; Maxwell et al., 2011).

To counter this market inefficiency, BA's have been organised into Business Angel Networks (BAN's), a tradition strongly integrated into the innovation system of the USA. This practice spread to the UK in the beginning of the 1990s, and has spread throughout continental

Europe where policy makers have embraced this financial routine to stimulate the informal venture capital market and thereby economic growth. The rationale for supporting the informal venture capital market emerged following publications of early empirical studies on the BA market in the EU, which supported earlier studies on the size and success of the BA market in the USA (C. Mason, 2009).

There are roughly 200 BAN's active throughout the European Union, each of which has been set up with government funding and in 2009 68% still received public funding to remain operational. When this research project started, there were 12 BAN's active throughout the Netherlands. Estimates suggest that between 14% and 50% of all individuals who can be classified as a BA are connected to a BAN in the Netherlands, with the number of registered BAN members ranging around 2400. The broad figures of these estimates are a testimony to the effort it takes in tracking down BA's. High-tech regions comparable to the Brainport Region, such as Lombardia, Oxfordshire, Stuttgart and Cambridge, all have mature BAN's, many of which are closely affiliated with universities (*EBAN Tool Kit*, 2009; European Union, 2002, 2012; Raspe, Weterings, Thissen, & Langeweg, 2012; Vermeulen, 2014).

The arguments for public support of the informal venture capital market by setting up BAN's such as Made in Brabant found in literature are fivefold. Firstly, BA's are a vital part of the financing chain related to the corporate life cycle of SKIE's, making small investment in seed and start-up businesses, making these investments based on non-financial motives as well. Research worldwide show the possibility of return on investment is listed as the number one motivation to invest, however, this is consistently followed by reasons such as 'liking the challenge', 'for fun', 'wanting to give back to society' and 'staying informed' which are not financially motivated. (Gullander & Napier, 2003; C. M. Mason & Harrison, 1995; Maxwell et al., 2011; *Nulmeting informal investment*, 2011). Secondly, because business angels are widely distributed and make the majority of their investments 'locally' they are able to address regional gaps in the availability of finance (Collewaert et al., 2010; *EBAN Tool Kit*, 2009, *Nulmeting informal investment*, 2011). Thirdly, investing in BAN's is deemed one of the most efficient ways of spending tax money to boost the economy. Research into the success of government reported for French, UK, Canadian, Spanish and most notably the Flemish BAN's has shown how successful government support for BAN's is in stimulating investments in firms, increasing the supply of informal investment capital. The research in the Flemish market was based on a sample representing 36 of 55 BAN-backed companies, the 34 BA's who invested in these firms acknowledged that they most likely would not have made investment in these firms. It was calculated that each government euro invested in the BAN elicited 20.83 euro's in BA investment, and it was shown that these BA backed firms significantly outperformed non-BA backed firms, both in value creation as in job creation. Calculated on the taxes paid by the BA backed firms over five years, it was estimated that each government euro spent on the BAN generated a direct return of 1.03 in taxes levied through corporation tax paid by these firms alone (Collewaert et al., 2010). Finally, informal venture capital is considered 'smart money', as the large majority of the investments are

accompanied by many kinds of non-financial support. Business angels are typically 'hands-on' investors who seek to contribute their experience, knowledge and contacts to the benefit of the businesses they invest in. Business angels provide assistance in areas such as forming the business strategy, searching for additional funding, recruiting key staff, designing business plans and models and introducing the entrepreneur to professional networks of national and international origin. Since most business angels have an entrepreneurial background and often invest in sectors where they have had experience this involvement can also be expected to benefit the businesses in which angels invest.

The difficulties that entrepreneurs have in finding BA's was listed in the top three of barriers for BA's to make investments in a recent survey of the Dutch BA market (*Nulmeting informal investment*, 2011). The top two reasons in coming to a match, however, were related to first of all the lack of quality of the entrepreneur and secondly the lack of quality of the business plans written by entrepreneurs. The concept of financialisation provides the language to analyse this phenomenon which plagues many of the starting SKIE's in the region and is related to the aforementioned lack in organisational and financial routines. BAN's themselves often provide assistance to entrepreneurs with ideas for starting up new business. This routine of scouting, assessing and helping entrepreneurs by finding them and providing them with assistance in developing their business propositions, called the matchmaking process, is aimed firstly at finding entrepreneurs in need of investment and secondly at increasing the investor readiness of the firms.

Independent Venture Capital, Corporate Venture Capital & Governmental Venture Capital

The next phase for SKIE financing emanates from Venture Capital Funds, who invest in sums of between 2 and 300 million euro's in firms. There are three different categories of VC funds. The oldest category is that of Independent Venture capital funds (IVC). IVC's are a form of financial intermediaries, who attract capital from institutional investors, such as pension funds, mutual funds, insurance companies, hedge funds or banks to set up investment funds with the purpose to take equity interests in firms which they 'exit' after a 3 to 10 year period, by either an Initial Public Offering (IPO) or through an acquisition. IVC investments range from 2 to 300 million euro's and though many IVCs operate locally, an equally large share operates either on a Pan-American, Pan-European or global scale (Baum & Silverman, 2004; Chahine, Filatotchev, & Wright, 2007; Rin & Penas, 2007; Vermeulen, 2014). This form of venture capital was born in 1946 when Harvard professor Georges Doriot created American Research and Development (ARD) together with Karl Compton, president of the Massachusetts Institute of Technology, Merrill Griswold, chairman of Massachusetts Investors Trusts, and Ralph Flanders, president of the Federal Reserve Bank of Boston. ARD raised funds from wealthy individuals and college endowments and invested them in entrepreneurial start-ups in technology-based manufacturing (Bottazzi & Rin, 2002). Venture capital expanded enormously during the 1980s as a result of changes in tax and securities legislation and has been a central source of finance for commercialising radical innovations

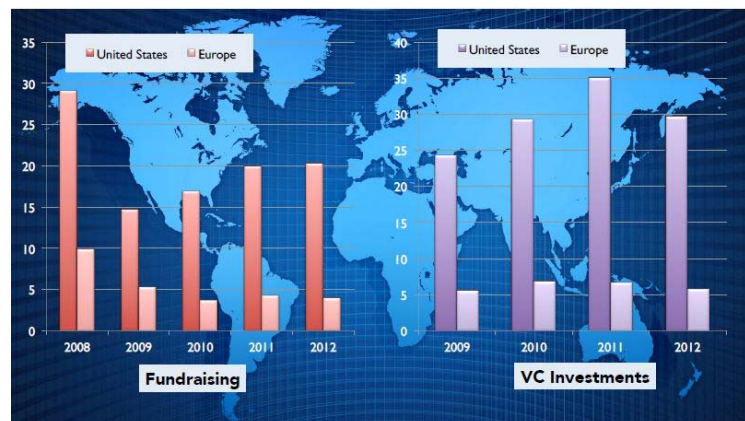
in the US economy over the past several decades (C. M. Mason & Harrison, 1995). The emergence of new industries such as semi-conductors, biotechnology and the internet, as well as the introduction of several innovations across a spectrum of sectors in healthcare, IT and new materials have been driven in large part by the availability of venture capital for new start-ups in the USA in close proximity to Silicon Valley, concentrated on Sand Hill Road (Grilli & Murtinu, 2014; Rhodes-kropf & Nanda, 2012). Many of today's most dynamic and successful corporations received venture capital at the initial stages of their lives emanating from Sand Hill Based VC funds: Amazon, Apple, Cisco, e-Bay, Genentech, Tesla, Intel, Microsoft, Space-X and Facebook. Independent Venture Capital, and the myriad of start-up firms it funds, is seen as an enduring part of the landscape of innovation today (Chesbrough, 2003).

The success in the Independent Venture Capital industry encouraged MNC's to start their own Corporate Venture Capital divisions in the mid-1960s. Corporate Venture Capital (CVC) are funds which are legally separated from the parent firm, and invest for a minority equity stake into SKIE's and are the second form of VC funds. This form of Venture Capital plays an important part for MNC's in utilising SKIE's as sources of outside knowledge. Intel is a pioneer in this area, by investing in hundreds of firms in the 1990s to strategically expand its Pentium business. This practice has evolved, with Intel's corporate VC program allowing Intel to explore new business area's and technologies by observing the experiments in these start-ups and even linking them to their own exploratory research program (Chesbrough, 2003). Many of the VC backed firms in the Silicon Valley RIS, firms like IBM, Facebook, Apple and Google, have set up CVC's which adopted variations of this financial routine. These funds are major players in the Silicon Valley RIS. Top ivy-league universities in the USA have cooperations with VC funds to provide capital to university spin-offs, with Stanford, Harvard and UC Berkeley being first, second and third in investments received (Vermeulen, 2014). There now exists a wide consensus among economists, business leaders and policy-makers that a vibrant venture capital industry is a cornerstone of America's leadership in the commercialisation of technological innovation (Bottazzi & Rin, 2002).

The positive effect of VC investments on the performance of SKIE's has been widely documented in empirical research (Bottazzi & Rin, 2002; Chahine et al., 2007; Tilburg, 2009). VC backed firms are shown to perform better in measures of R&D efficiency, number of patent applications, patent citations, significant reductions in the time needed to bring a product to the market and ability to produce disruptive innovative new products of services (Baum & Silverman, 2004; Rhodes-kropf & Nanda, 2012; Rin & Penas, 2007; Tilburg, 2009). There are five main reasons advocated in the literature for the positive impact VC investments have on firms. Firstly, VC investors (VCs) are better at screening entrepreneurial firms that have high potential than other capital providers, and lift the financial constraints resulting in better firm performance. Secondly, VCs add value to portfolio companies through the provision of both managerial skills and competencies. The active role of venture capitalists in portfolio companies has been documented by several studies. Venture capital

speeds up product commercialisation and the adoption of human resource policies and that it strengthens companies' commercialisation strategies (Rin & Penas, 2007). Thirdly, VC investments represent a signal of the quality of the portfolio firm to other stakeholders in the political economy. Fourthly, VC-backed firms benefit from the network of business contacts (e.g. suppliers, customers, institutional investors) of their VC's. Finally, research into the Dutch VC market shows how VC investments increase the absorptive capacity, defined as the capacity to assimilate and exploit new knowledge', increasing the firm's ability to generate future innovations (Rin & Penas, 2007). Using a broad set of organisational routines which vary from fund to fund, VC's have been proven to increase the performance of SKIE's.

Venture Capital financing as a financial routine spread to Europe during the 1980s and 1990s but the development of the VC market has been dramatically different from that in the US. Whilst the VC market in Europe the amount of funds raised increased by a factor of 12 and funds invested by a factor of 6, these figures are dwarfed by



Source: Dow Jones VentureSource (Funds Raised & Amounts Invested in US\$B)

the growth in the VC market in the US, where the amount of funds raised increased 80 fold and the amount invested 24 fold (Bottazzi & Rin, 2002). The difference in VC capital invested in the US market versus the European market has gained the attention of the European Union as early as 1998, which led to the founding of Government Venture Capital funds (GVC). These funds are criticised because the investment decisions were potentially subject to political influence and government bureaucrats lack investment, monitoring and commercial skills. The subsequent underperformance of portfolio firms led to market distortion because of lower return expectations. Also, the large dependence on government funds to raise the capital required to found IVC funds, which rose from 9.9% in 2007 to 39.1% in 2011, has been seen as a problem in the European VC market (Grilli & Murtinu, 2014; Vermeulen, 2014). Additional problems exist in the European VC market, where a persistent funding gap exists in the late seed to early growth phase, called 'the Valley of Death'. Firms experience great difficulty in acquiring funds after the BA investment phase. It has been recognised that it is difficult for firms to acquire funds in the 2.5 – 10 million euro's range, follow up investments required to scale operations, build factories, hire more personnel and to expand in to different geographical markets. VCs over the last decade in the EU have invested in later stage SKIE's to reduce their risks of failure, a development exacerbated by the financial crisis of 2008 (Insider, 2013; Vermeulen, 2014).

Chapter Three

Methodological framework

Research strategy

Three lines of qualitative data collection have been followed during this exploratory study, resulting in three sets of data which were analysed for the writing of this thesis. All three lines have been pursued simultaneously and in relation to each other, cumulating in a spiralling research approach. Firstly and foremost a hermeneutical process of literature research has been followed, continually finding new secondary, tertiary and academic quantitative and qualitative sources inspiring progress through new insights. Secondly, during the research internship a form of Participatory Action Research yielded ever new data gathered through ethnographical methodology. And thirdly, following a line of dramaturgical interviewing, using unstandardised interview methods to allow for creative interviewing, a group of expert respondents was selected using purpose sampling. These multiple lines of action have been followed to allow for triangulation. The aim of this was to try and refine, broaden and strengthen conceptual linkages. As mentioned before, the conceptual model builds upon multiple theories and during the research period multiple methods of data collection were used because each method is believed to reveal a different aspect of empirical reality. By doing so, different lines of sight on the research object have been introduced to increase the epistemological clarity. Each of the three methods of data collection will be elaborated upon in this section.

Hermeneutical literature and data research

Being educated as an historian, a hermeneutical method of literature and data research has been a major avenue of research. The literature research was conducted with the strong belief that scientific debates from other fields are of great value. Starting out with searching primarily for secondary sources and academic handbooks on financing, innovation and economic geography, search terms were formulated to guide and limit the search (Booth, Colomb, & Williams, 2008). Additional uses was made of tertiary sources, especially for the more recent developments around spin-off creation in the Dutch high-tech sectors. Tracing often cited authors, relevant articles were located in the fields of Economic Geography, Financial Geography, Business Finance and Management Sciences amongst other. Primary sources that would have been valuable for this thesis, quantitative sources on firm entry and exits, and investments made in the Brainport Region, were not available. Through tertiary sources and through secondary sources with relevant quantitative data, this lack of high-grade quantitative data has been sufficiently covered.

Participatory Action Research

From June 10th 2013 until November 1st I conducted a research internship at Brainport Development, after which I was offered a contract and continued working at the Brainport

Networking Financials Project until March 31st 2014. The research internship at Brainport Development a form of Participatory Action Research (PAR), a more engaged form of participant observation. It is a highly collaborative, reflective, experiential, and participatory mode of research in which all individual involved in the study, researchers and subject alike, are deliberate and contributing actors in the research enterprise (Berg, 2009). Participant observation, having its roots in social anthropology and in symbolic interactionism, attempts to learn the symbolic world in the research setting, to discover the delicate nuances of meaning (Lewis, Thornhill, & Saunders, 2007). PAR builds on this, but has more applied activist dimension to it. For the period of ten months I was part of the staff which operated and ran Brainport Networking Financials. This allowed me to interact with entrepreneurs, business developers, governance actors, financial professionals and financial service providers which were part of the Regional Innovation System and its financial infrastructure. As a research intern I was able to actively contribute though my literature research, interviews and networking activities to the formation of a Business Angel Network in North-Brabant and the maintenance, bolstering and expansion of Brainport Networking Financials. Participatory Action Research is a method of research in which the researchers becomes part of a team, organisation, community or network, who are collectively seeking to improve the organisation or situation of its participants or target audience. In this type of field research, ethnography techniques of data collection are suitable. Descriptive observations or narrative accounts have been collected to create a thick description of the routines traced through the hermeneutical literature research and interviews. Data collection and data analysis become part of the same process, happening simultaneously though analytic induction.

Interviews

A number of experts was selected to be interviewed, which through their experiences represent a body of tacit knowledge on the subject of SKIE financing. A dramaturgical approach to interviewing was adapted, since it is intended for very fluid and flexible formats for conducting interviews. Following Berg et. al. 's interpretation of David (1985), a form of creative interviewing was conducted. Creative interviewing involves using a set of social performances to move past the mere words and sentences exchanged during the interview process. It includes creating an appropriate climate for information exchanges and mutual disclosures. This means that the interviewer will display his or her own feelings during the interview as well as elicit those of the subject. This approach has been chosen it fits my personality closely, making this interview technique easier to master (Booth et al., 2008). To create the space in which this bond between interviewer and interview subject can fully develop, an unstandardised interview format was chosen. During an unstandardised interview, the interviewer sets out with the assumption that they do not know in advance what all the necessary questions are. Consequently, a fully predetermine a list of questions cannot be written. In an unstandardised interview, the interviewer must develop, adapt, and generate questions and follow-up probes appropriate to each given situation and central to the purpose of the research project, and are often used in field research projects. A dramaturgical approach to interviewing, using unstandardised interview structure to

conduct a creative interview requires that the interviewer is versed in the language used by the subjects as to set rapport and to establish some sense of common ground. Mastering the language used in the entrepreneurial world and the world of finance was a prerequisite to be able to utilise the dramaturgical approach to interviewing, which can be described as ‘a conversation between two people on one person’s perceptions on the events in life, but is not a conversation between two equals’. In the most cases, the interviews were recorded and transcribed. In other, field notes were taken to secure the data. Interviewing these subjects, the answers to the questions asked and their stories present a way to circumnavigate the bounded rationality of the researcher.

Respondent number	Type of respondent	Function of respondent
1	SKIE, University Spin-off	Director – Owner – Commercial
2	SKIE, University Spin-off	Director – Owner – Technological
3	SKIE, Private Spin-out	Director – Owner – Technological
4	SKIE, University Spin-off	Director – Owner – Financial
5	Service provider, University	Business Developer
6	Governance, SKIE service provider	Project Manager – Financial – Commercial
7	Service provider	Project Manager – Financial – Commercial
8	Service provider	Business Developer – Manager - Director
9	Business Angel	BAN Director
10	Business Angel	BAN Director
11	Business Angel	Business Angel
12	Independent Venture Capital	Investor Manager at Independent Venture Capital Fund

Operationalisation

The empirical research is subdivided into three parts. Chapter 5 & 6 trace the emergence of the Regional Innovation System to the founding of Philips and detail how the region’s economic structure is shaped by the behaviour of Philips. The empirical research investigates the historical processes underlying the current economic development in the Brainport Region from an evolutionary economy geographical perspective. It will unearth the path dependant evolution of the region, the regional branching process and subsequent diffusion and recombination of routines in the process of spin-off founding and how financial routines have helped shape those development paths, resulting in the evolution of the Philips dominated economy into the RIS revolving around multiple leader firms. Chapter 7 is an empirical investigation into the relation between the financial infrastructure in the Regional Innovation System in the Brainport Region and the performance of Small Knowledge

Intensive Enterprises, based on the fieldwork and interviews conducted. It serves as a proof of concept that the relation between finance and the performance of SKIE's is salient and evident and should be part of any economic geographic analysis of the uneven economic distribution of growth.

The behavioural view on economic life central to evolutionary economic geography, and the subsequent attention for routines is incorporated into the research. This results in defining routines as the subject of analysis. One central aspect of this operationalization is that a categorisation of routines is constructed, as a first attempt to differentiate between different types of routine behaviour firms exhibit. In line with the argument for differentiated knowledge bases put forward by Todtling, Asheim & Boschma, a differentiated view on routines is put forward (Todtling et al., 2013b). It is assumed that by categorising between different kinds of routines variances in the mechanisms through which these routines emerge, diffuse and enable firms to compete can be unearthed. This opens up the possibility of integrating finance into Evolutionary Economic Geographical work, as will be explained below.

Based on a synthesis of the EEG approach, RIS literature, research into knowledge bases, management literature, innovation research and financialisation research a distinction will be made between (1) technological routines, (2) organisational routines and (3) financial routines. Each of these three definitions of routines are complementary to each other, and elaborate upon Nelson and Winters work as utilised in the Evolutionary Economic Geographic work.

Technological routines refer to the firm's capacity to utilise or combine existing or new knowledge, gained by learning by doing, research & development or from outside sources, to develop a new technical idea into a new technology, production method or product, or to apply it to improve an existing technology, production method or product whose performance has been enhanced or upgraded significantly so that it results in increased performance or new applicability which differs greatly from previously existing technology's, production methods or products. Product innovation, process innovation and exploratory, fundamental long term research are merged in this definition. Research & Development routines therefore fall inside the definition of technological routines. An innovation system is believed to have an exploratory side and an exploitation side, with the implicit distinction being made between advanced technological routines developed on the exploration side and technological routines on the exploitation side, closer to market introduction. The choice is made to exclude successful market introduction of new products or technologies from this definition. Plenty of firms have proven themselves more than capable of developing novel technologies, products and services which did not sell and through the lens of this framework do not qualify as innovations. From a pure technological point of view, products which aren't a commercial success can still be seen as an technological success for a firm. For example, Philips' introduction of the Video Long Play (VLP), a record on which

video information was stored, is considered an obvious commercial failure. However, taken into account that the Compact Disc (CD) is a direct follow up of the VLP, the technological routines which were gained in the VLP project were instrumental to the successful introduction of the CD innovation (Vries, 1999). The technological routines supporting the VLP resulted in competitive advantage through the introduction of the CD. Another argument to leave the successful market introduction out of this definition is that technologies, products or services, once developed, don't sell themselves. To introduce a product into the market, a firm needs at least rudimentary commercial or organisational routines. History provides ample examples of technologically superior products that have failed, like the Phillips Digital Compact Cassette, which was in sound quality and durability and had a storage capacity vastly superior to the CD (Vries, 1999). It failed not because the technological routines. It failed because the organisational and commercial routines were inadequate.

Organisational routines refers to firm behaviour related to organisational features of firms such as, marketing, sales, environmental and government affairs, industrial or business relations, internal business structure, strategic management, human resources, worker health and safety, customer and community relations and other forms of stakeholder management. Organisational routines encompass the internal and external relational and commercial features of a firm, inspired by the relational view in firms capabilities as put forward in the VoC literature and management literature. The introduction to the market of products falls within the definition of organisational routines. One important note has to be made in relation to Research and Development. The way R&D departments are managed, structured and incorporated in the business model of the firm is considered to be part of the organisational routines of a firm as these issues exist with the relational realm of a company's behaviour.

Financial routines are defined as firm behaviour related to attracting and allocating financial capital, both from outside sources, i.e. financial institutions, and inside sources, i.e. retained earnings, in the form of accounting methods, and other forms of financial management, that deal with the assessment of prices, risk and (future) streams of income, that express information in a quantitative idiom of monetary value. Financial routines that deal with attracting or allocating capital for investment purposes, such as R&D expenditure and other innovation related activities, such as acquiring new knowledge, technologies, opening or upgrading production facilities, are of special interest to this thesis. As argued in the theoretical discussion, financial capital and interaction with financial institutions matter a great deal to the ability of firms, and regions for that matter, to compete. A new phase in capitalism, financialised capitalism, appears to have given rise to a new metric that should matter to each geographer interested in the uneven distribution of economic development over space, namely the ability of firms to interact with capital markets through financial institutions and intermediaries.

Chapter four: Emergence of Philips Town Eindhoven

To understand the current industrial economic structure and knowledge intensive nature of the RIS in the Brainport region, the history and evolution of the region will be traced back over a hundred years, to when the Philips company was founded in 1891. The genesis of many of the technological and industrial development paths, the knowledge intensive profile of the region in combination with high-value added manufacturing, can be traced to this period. Out of this follows that the focus is on the evolution of the private component of the RIS. The emergence and adaptation of technological, organisational and financial routines by Philips in the period between its foundation in 1891 and the 1970s will be researched to analyse who these routines shaped the region's development path. Talking about Eindhoven and the Brainport region means talking about Philips, and talking about the innovative performance today means talking about the Philips Natuurkundig Laboratorium (NatLab). Special attention will be paid to the way financial routines shaped Philips' research efforts throughout this period.

Chapter five: Transformation into the Regional Innovation System Brainport Development

Next the period of restructuring of Philips and NatLab, culminating in the operation Centurion, and the rise of the Regional Innovation System (RIS) that emerged from a process of regional branching will be analysed. It will be analysed how global pressures put pressure on the existing financial and organisational routines, which locked Philips into a pathway which almost led to bankruptcy, and how these routines were transformed or replaced. In this part the emergence and evolution of the current Regional Innovation System (RIS) of the Brainport Region will be linked to the restructuring of Philips in reaction to the changing configuration of the world economy. Philips was locked in to unsustainable development pathways, which it tried to alter through two parallel and entwined processes. Firstly the rationalisation and opening up of Philips' research capabilities and secondly the slimming down and dissolving of Philips vertically integrated value chains. In this phase the regional branching process emerged. Philips started spinning out parts of the value chain into new and independent firms. Next to that, Philips opened up its internalised innovative system. The region changed from its Philips dominated vertically integrated industrial architecture to RIS with a horizontally networked high value adding and knowledge intensive economic structure organised around multiple leaders firms, many of which are Philips spin-offs, at its core.

Chapter six: Finance for Small Knowledge Intensive Enterprises in the Brainport RIS

The fieldwork and interviews were conducted to understand the perceptions of stakeholders towards the effect different sources of SKIE financing in the region. The results of this serve as a proof of concept to show that economic geographic research cannot adequately claim to understand the geographically uneven development of economic growth without incorporating the world of finance into their research, since finance has such a potent and salient role in shaping the 'real' economy. The fieldwork and interviews were informed by

and combined with secondary data gathered through hermeneutical literature and data research. There are limitations to the secondary data collected for this part of the thesis, however. Firstly, there is little to no data publicly available on investments made in SKIE's, due to the private nature of these investments. There are some databases, such as Startupgenome, Prequin, Dow Jones VentureSource, Venture Deal Analyst Crunchbase and Seed-db, which are costly to access, focus mostly on the American market and use secondary data sources to create their own data sets. Secondly, for the Brainport Region, there is no comprehensive data set on an aggregate level available for start-up, spin-off and spin-out creation and survival, a lacuna for policy formulation but also for this research project. I choose to interview experts working in different parts of the regional innovation system. Experts working in the public knowledge generation subsystem, in the regional development agencies, in the knowledge exploitation subsystem, financiers and entrepreneurs of University spin-offs and private spin-offs were interviewed. Based on the data collected in these interviews and through the knowledge gained through my participatory action research I ventured to better understand how access to and interaction with the different sources of venture capital influences the performance of SKIEs in the RIS in the region. The interviews only represent a part of the data gathered, in the 10 months as research intern and later project assistant, I observed and interacted with a broad range of different actors inside and outside the Brainport RIS. These observations and interactions were vital to develop the conceptual and practical understanding needed to understand the complex world of financing SKIEs.

The data gathered has been analysed from an evolutionary economic perspective to find out how the provision of capital and the interaction with the different capital sources have influenced the SKIEs routines. Following the same sequential logic laid down in the discussions of the theories, the results will be discussed based on the corporate lifecycle of SKIEs. There is a high level of overlap of the different sources of financing throughout the life phases of firms and the boundaries of the different phases should not be seen as absolutes. The lifecycle model is a potent way of structuring the fluid reality of individual firm evolution on a higher generic and abstract level. Besides the analytical advantages to this model, it is utilised by the actors in the world of venture capital and SKIEs. It is a discursive model which shapes their worldview using this model is a way of getting into their world. First the pre-seed and seed phase will be discussed. In this phase SKIEs receive outside capital from governments, from business angels and the SKIEs are aided by incubators and the effect of the access to and interactions of these sources in the Brainport Region will be analysed. Next, the start-up and growth phases will be discussed. This means that different venture capital funds; independent, government and corporate, will be discussed.

Chapter Four

Emergence of Philips Town Eindhoven

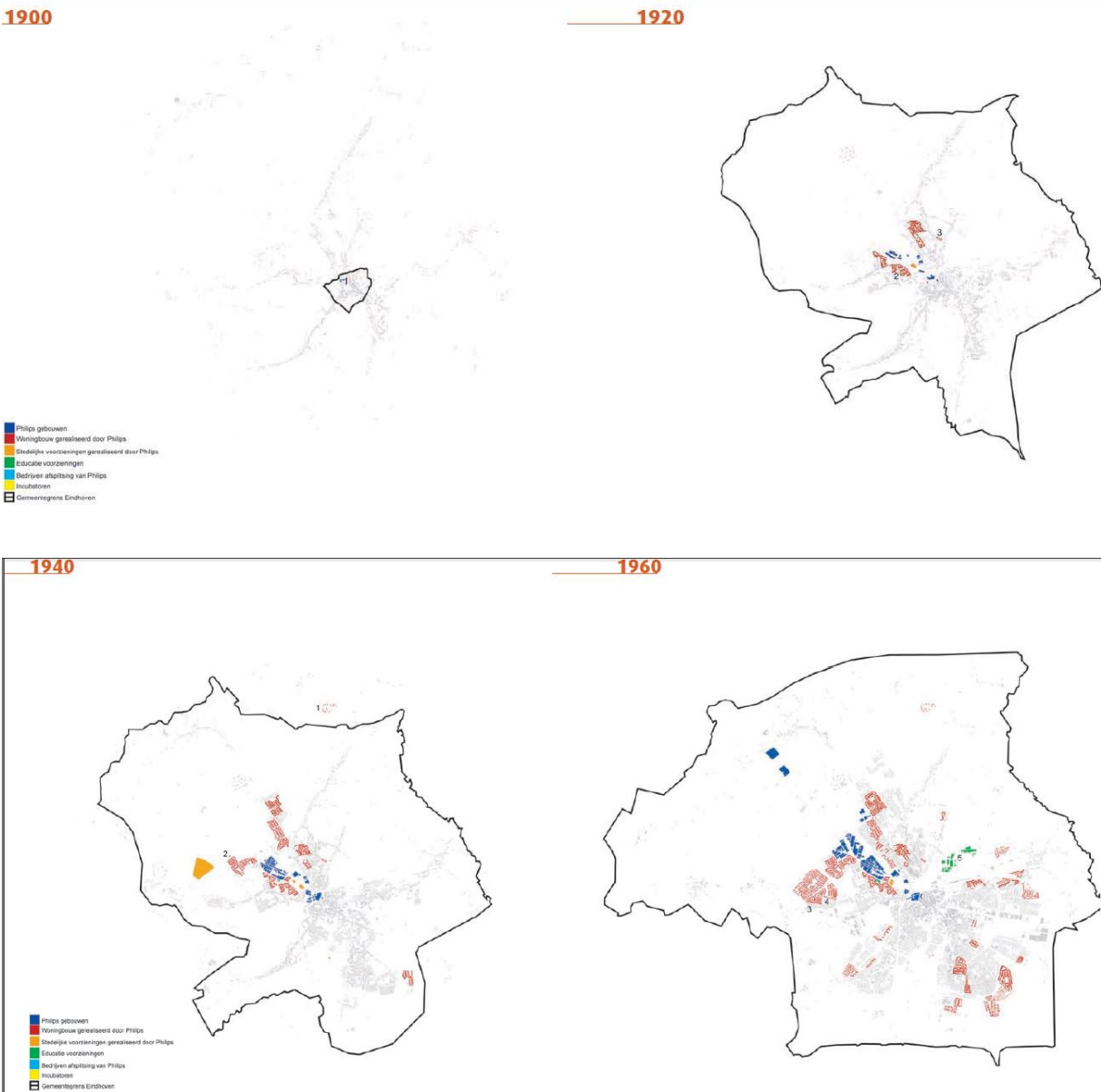
During this chapter the emergence of the knowledge rich profile of the Eindhoven region will be traced back to the founding of Philips. Eindhoven is part of a particular class of cities which depend greatly on a single firm for their emergence, growth and further development (Braun, Otgaar, Winden, & Witte, 2012). When Philips was founded in 1891 by the brothers Anton and Gerard Philips, Eindhoven only used to be a small countryside town with a largely agricultural based economy. The company's founding heralded a period of rapid growth, providing jobs, housing development, recreational facilities –most notably the Dutch Premiere league club Philips Sport Vereniging (PSV)- and part of its healthcare and education system. Philips grew rapidly through a combination of an international orientation and world-class research capabilities (Braun et al., 2012). The spatial layout of the city has been defined by the Philips driven growth of the core village of Eindhoven, which absorbed the surrounding villages of Tongelre, Stratum, Woensel and Gestel. As can be seen on the map on the next page, Philips factories, housing projects and facilities were found all over the town and dominated the urban spatial growth of the city.

The wider region

While Philips was the sole large employer in the Eindhoven Region before the Second World War, the automobile producer DAF gradually emerged as a secondary leader firm in the city. Starting from the 1930s it produced trucks and trailers, and after the Second World War the company accelerated its growth after receiving large orders for truck from the Dutch army, and it became a major producer of passenger cars. DAF did not adopt a vertically integrated strategy as Philips did, it developed an extensive network of supply firms, first near Eindhoven and expanding into Limburg and Belgium. In terms of R&D investment DAF had very little impact on the regional economy. More importantly, whilst in the same region, the supply, R&D networks and development industrial development paths of DAF and Philips remained separate from each other and had very little functional overlap.

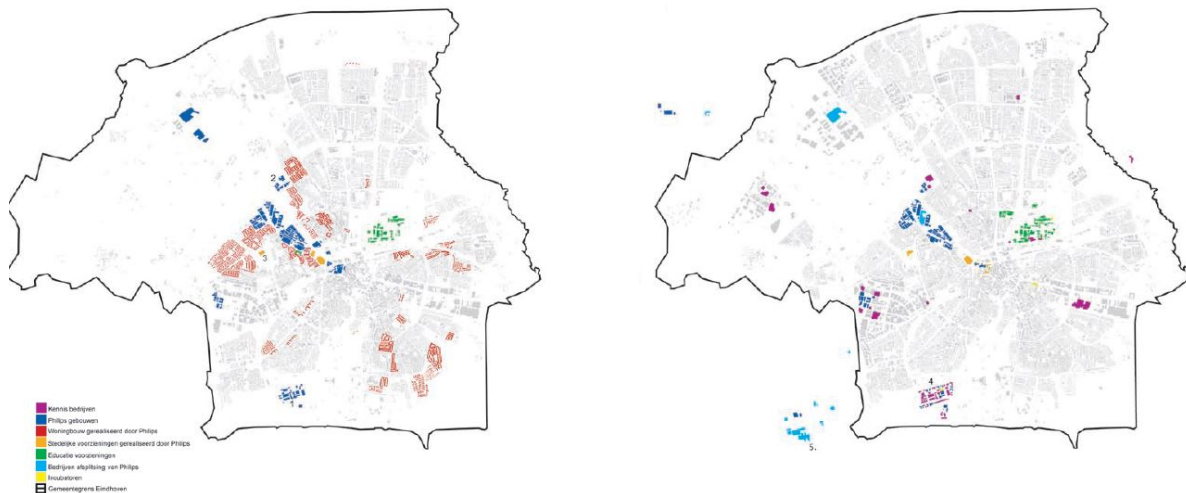
Several cities near Eindhoven saw single leader firms dominating the social and economic development of the cities, albeit in smaller scale. Océ emerged as a major producer of copy machines and other office equipment in nearby Venlo, and in Southern Limburg DSM, originally a state-owned mining company, developed itself as a high-tech firm when it diversified into the chemical industry from the 1960's onwards. As the supply networks of these firms gradually expanded in size and geographically extent these firms are starting to play a role in the Eindhoven day. In the governance structure these firms and supply networks have already been integrated into the narrative on the Brainport Region.

Today Eindhoven is the fifth largest city of the Netherlands, located no more than 120 km away from the other four major urban centres which lie in the Randstad region, the economic core of the country, in the West of the Netherlands. The city is located only 15 km north of the Belgian border and 50 km from the German border. On a European scale, Eindhoven is located right in the economic core area of Europe, between the ports of Antwerp and Rotterdam and the Ruhr area in Germany, and close to the European capital Brussels. The region as a whole has good international accessibility with the port of Rotterdam and the international airport of Schiphol within 1.5 hours driving range. Moreover the region is serviced by the rapidly growing Eindhoven airport, with regular services to over 70 European capital and regional airports.



1980

2006



The development of Eindhoven 'Philips Town'

The industrial development path of Eindhoven has been dominated and shaped by the rapid growth of Philips during the 20th century. The company was founded by Gerard Philips, a trained engineer, who was joined by his merchant brother Anton (Braun et al., 2012). One of the respondents shared the anecdote that Gerard meant to start Philips in nearby Helmond, but that the town's vicar wouldn't allow it, forcing him to move to Eindhoven instead. This historical accident, if it is true, opened a variety of new technological and industrial pathways shaped the path dependent development of the region. The brothers implemented routines, which emanated from their personal attributes, that characterized Philips way of doing business and with that shaped the industrial development path of the Eindhoven region. The first characteristic organisational routine of Philips was of seeking business opportunities in foreign market and is attributed to the commercial and mercantile instincts Anton Philips. He recognised market opportunities in foreign markets and went on to secure export markets for Philips. Perceiving the Dutch domestic market as being too small for a light bulb producing firm, he turned Philips into a Multi-National Corporation (MNC) with a strong international sales network. In the years 1880 – 1920 other Dutch multinational companies (MNC's), such as Akzo, DSM and Shell (than "Koninklijke Petroleum") were founded and expanded their operations globally in the early years of the twentieth century. This fits into the Dutch trade tradition, which throughout its history has relied on international trade as an economic pillar. Manufactures, part of the RIS in the Brainport Region today, are still heavily export oriented.

The financial routine to invest a relatively large fraction of the firm's retained earnings into advanced Research & Development capabilities (R&D) defined the path of the company and the region until this day. Philips sought to discover new breakthroughs; develop them into products; build the products in its factories; and distribute, finance, and service those products—all within the four walls of the company. From early on, Philips had internalised the complete innovation process, from exploration to exploitation, adopting the closed

innovation model widespread throughout most part of the 20th century (Chesbrough, 2003). The financial routine of investing in advanced R&D emerged in the USA and spread globally in the period of 1905 – 1930, when a ‘scientification’ of technology took place, especially in the fields of chemical and electrical engineering.. In the USA several of the larger industrial companies had started up their research laboratories at the beginning of the twentieth century. The General Electric’s lab was set up in 1900, the chemical company De Pont in 1902, AT&T between 1910 and 1912, Eastman Kodak in 1910, and Westinghouse in 1916. In Germany, Siemens had set up its Physikalisch-Chemisches Laboratorium in 1905; Telefunken started its lab in 1914 who all adopted the routine of closed innovation. In England, the Marconi Research Centre was founded in 1912 and the General Electric Company’s lab in 1919 (Vries, 1999). During this period the organisational routine of starting in-house research facilities spread to the Netherlands, resulting in a marked increase in the number of scientific laboratories in companies besides Philips as well (Vries, 1999). The adaptation of this routine by Philips was fuelled by Gerard’s early leadership in this matter. The company housed its first modern internal R&D laboratories early in the 20th century. It added the now famous NatLab to its research facilities in 1914. Located in the Strijp district, in the centre of Eindhoven, this was the world’s largest R&D laboratory at that time (Braun et al., 2012).

Furthermore, Phillips vigorously adopted a strategy of vertical integration. This organisational routine was adopted when the First World War disturbed Philips supply lines for raw materials and intermediary goods, and shaped the industrial development path of the region until the early 1990s. From the 1910s, Phillips absorbed its entire supply chains within the boundaries of the company, and this started when Philips opened its own factories for glass and gas production in 1915. Since it used paper and cardboard for packaging finished products, Philips built its own paper and cardboard factories in Eindhoven. The vertically integrated modus of production has characterised Phillips’ corporate structure and organisational routinised way of operating for the larger part of the twentieth century. Philips routinised behaviour of vertically integrating its supply chain defined the industrial development path of the Eindhoven region, resulting in a regional branching process which was internalised in Philips’ corporate structure. The routine of vertically integrated a large supply chain within the boundary of the firm, virtually internalising the whole process of regional branching within its company

One could regard the knowledge landscape in the early twentieth century as a series of fortified castles located in an otherwise impoverished landscape. Within the castle walls of each company’s central R&D organisation were deep repositories of understanding based on thorough, detailed investigations of a wide range of phenomena. Each castle was relatively self-sufficient, receiving occasional visits from outsiders, and its inhabitants ventured out occasionally into the surrounding landscape to visit universities or scientific expositions. But most of the action occurred within the castle walls, and those outside the castle could only marvel at the wonders produced from within.
Henry Chesbrough (2003)

boundaries, remained a typical feature of the regional economy until the 1990s (Braun et al., 2012). Philips grew fast, in 1935 already it had grown to include 46 factories and 69 sales departments. In 1948 the company's structure was formalised with the formation of a number of Product Divisions (PDs), under which complete vertically integrated value chains of factories and their sales departments were subsumed (Vries, 1999).

Philips Natuurkundig Laboratorium

The existence and evolution of the current regional innovation system in the region is unequivocally the result of the founding of Philips in-house advanced research and development facilities, the Philips Natuurkundig Laboratorium (NatLab). The foundation of the NatLab in 1914 was a direct reaction to the competitive pressure from the General Electric light bulb. Philips faced increasing competition in the light bulb market when GE leased out its patents on light bulb production technology to three major light-bulb producing companies in Germany, a conglomerate of companies known as the '*Patentgemeinschaft*'. This saturated the European market, and Philips was forced to search for opportunities in the USA. In negotiations with GE, Philips agreed not to expand into USA market in exchange for a license that allowed Philips to make use of GE's light bulb technology. In return for this, Philips was offered a license contract to use GE's than most advanced light bulb technology. The brothers Philips realised that being dependent on other companies' knowledge bases and patents was a long term threat. This, combined with the changing institutional arrangement in the Netherlands with an changing institutional arrangement with the introduction of the Rijksoctrooiwet 1910, were the catalysts and the Brothers Philips decide to establish their own physics laboratory (Vries, 1999).

From the onset, the research conducted in the NatLab was heavily focused on doing exploratory, fundamental research, routinising a tradition of advanced, scientific frontier oriented, capital intensive and long term oriented research. The first director of the NatLab Gilles Holst was given the task to conduct fundamental research into understanding the physical phenomenon behind the workings of light bulbs. Gerard Philips expected that this type of research would yield new insights that would enable the company to become less dependent on external knowledge and patents owned by other companies (Vries, 1999). Like other corporate R&D labs around the world at that time, this was a fundamentally inwardly focused effort. Applied scientific knowledge was scarce at the end of the 19th and beginning of the 20th century and many highly respected leaders in science were only interested in 'pure' science (Chesbrough, 2003). So if Philips wanted to incrementally innovate and improve their products as a means to secure its competitive advantage on the long term, it would have to develop the fundamental scientific knowledge and technological routines itself.

The financial consequences of the ambition to always develop the knowledge necessary to innovate into new product areas, or improve existing products within the boundaries of the firm were substantial; advanced research was and is a capital intensive process. To fund

these research efforts, the financial routine of total and direct research funding was introduced from the beginning of the 20th century. This capital allocation process was institutionalised in the corporate structure by allocating a substantial part of the retained earnings of the whole firm through the board of directors directly to research in Philips (Vries, 1999). These financial routines were the industry standard worldwide for firms which had centrally organised research and development departments. For firms like GE, Siemens and Bell advanced R&D labs were central to those companies' strategies, regarding them as critical business investments (Chesbrough, 2003). Philips adopted and adapted the financial routines which had emerged in these firms to fit their own company. Researchers were given the financial means to equip laboratories, hire personnel, acquire patents if necessary, receive additional training, buy materials and systems without having to account for the costs in relation to future projected market opportunities. The researchers in the NatLab were expected to determine the technological pathways in which the company should advance and expand in order to extend its product range, and were provided with the financial capabilities to do so.

Growing Business

In the first part of the twentieth century, Philips found a market for nearly all the new products, and the market was able to absorb these innovations (Braun et al., 2012; Vries, 1999). Philips exploited almost every market opportunity it could cater, having the capabilities with its network of supplier factories and firms to broaden its product portfolio and routinely ventured into low and medium added value product markets all over the world. Philips sold everything, from high-tech radar parts to garbage bins, and the market was able to absorb these products. Philips was hugely profitable because of this.

The fact that Philips was not part of a mother company gave the company board the freedom to develop new financial routines to allocate funds to start new businesses and move beyond exploiting obvious market opportunity. Philips routinely invested in disruptive innovations by actively creating new product markets, based on technologies developed in the NatLab. For example it realised that its radio business would only grow if sufficiently attractive radio broadcasting would be available for radio listening. Philips subsequently invested heavily in providing free radio transmission equipment to radio enthusiasts in the Hilversum area. Similarly, after sensing an opportunity after the development of X-ray equipment, Philips continued to divert large capital flows internally in its medical products even though it remained unprofitable for an extended period (Braun et al., 2012).

During the first decades of the 20th century, with Holst as its director, the NatLab established its name as a high quality advanced research lab which provided ample job opportunities for scientists, researchers and supporting engineers. Holst wanted to have a research laboratory that was filled with researchers with excellent scientific reputations (Vries, 1999). He took various steps to create an academic reputation and an attractive scientific research culture within the NatLab. He routinised efforts to maintain strong ties with the scientific frontier in

the national and international world of academia. Colloquia were organised in which the world's most famous physicists were invited to come to Eindhoven, to share their views with NatLab scientist. Amongst those who visited the NatLab were the likes of Albert Einstein, Niels Bohr, Hans Geiger and many others. Philips scientists and researchers were encouraged to publish in scientific journals, preferably leading ones, to establish the name of the NatLab in the global scientific community and to create incentives for new scientists to consider working at the NatLab. Consecutive directors of NatLab build on these routines and maintained this academic culture in the industrial research laboratory.

There are different organisational routines required for an academic research orientation, than are required for industrial research. In the NatLab discussions about the tension between academic, long term oriented research and industrial, applied research revolved around the term 'fundamental' research. Fundamental, long term, exploration oriented research required high-levels of freedom in the choice of research topics, which had to be funded from an un-earmarked budget for the scientists. Looking for new directions of scientific developments required a type of researcher who was able to exploit that high-degree of freedom. On the other hand, looking into the direction of the companies industrial interest, to possible applications for future innovations, required a different skill set. Philips routinely teamed up multiple researchers with different orientations to tackle this problem. (Vries, 1999). In the perspective of NatLab's management, NatLab as a professional organisation only needed to provide its scientists with the proper financial and organisational framework for their research work. Within that framework researchers were expected to pursue the creation of knowledge and technological routines with a high degree of freedom and personal responsibility.

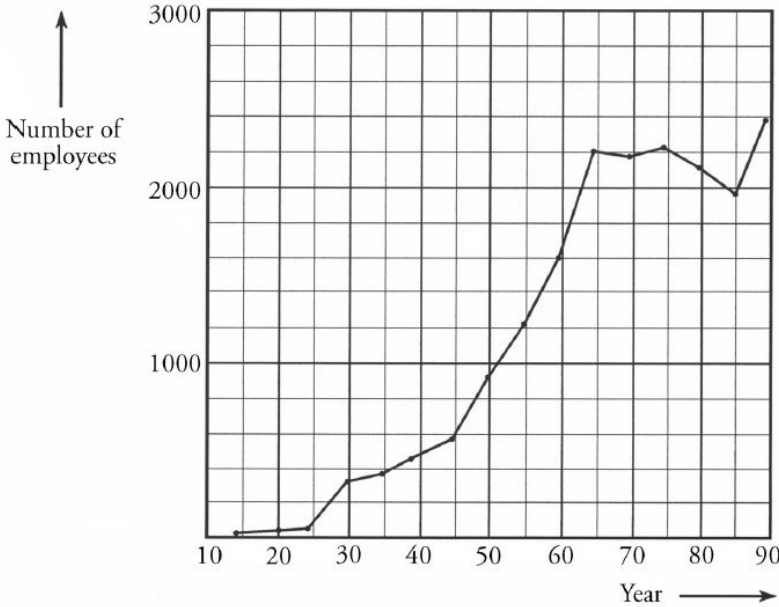
Philips started founding dedicated factory laboratories in the 1920, where solutions to production issues were researched. Within the corporate structure of Philips the factory labs were linked to NatLab, with the aim to coordinate a smooth transfer of technologies developed on the exploratory side in the NatLab, to the factories on the exploitation side of Philips internalised innovation system. On a regular basis NatLab scientists were transferred to the factory labs, and with that the routines and knowledge which were tacitly embodied in those scientist. The more production oriented incremental, applied research and development projects were step by step removed from the NatLab, and transferred to the factory laboratories, closer to the exploitation side. This development allowed the scientists in the NatLab to focus on even more on exploratory, fundamental long term research, with its core task to provide the technological foundations for future innovations.

After the second world war the position of NatLab within Philips corporate governance structure as an independent research facility was further solidified and institutionalised. The financial routine to directly invest a large share of the retained earnings into the advanced research and development capabilities was expanded. In 1948 Philips committed itself to invest one percent of the firm's revenue in the fundamental research in NatLab and smaller

research labs Philips ran in other countries. This funding was not tied to any sales, production or performance criteria and during this period, there was no project-wise budgeting. The result was that the amount reserved for the NatLab and the foreign labs (including the costs for obtaining patents and licenses) grew from NLG 5 million in 1947 to NLG 130 million in 1965, and the labs scientific personal in the NatLab more than tripled in this period. The research costs for the NatLab alone amounted to about 40% of the entire research budget of Philips worldwide (including the research in the factory laboratories). This financial routines to impose no financial constraints on the researchers was implemented to provide them with the freedom to focus on the type of exploratory, fundamental long term research expected from them. It provided the financial independence and security without having to worry about market applicability of the research. This financial institution within Phillips’ corporate structure locked Philips, and with that the region, into a development path of internalised innovation process, a path which mimics the developments of other corporate R&D labs in the world.

NatLab’s independent position was further strengthened when the factory labs were taken out of the NatLab’s research portfolio and became part of the Product Divisions (PDs) after the second world war. With these two shifts in the corporate structure, the PDs lost their formal influence over the research conducted in the NatLab and the distance between the exploratory and exploitation side of Philips internalised innovation system was widened. This institutionalised a fissure in the Philips’ research capabilities, and two innovation strategies emerged alongside and in

virtual isolation from each other within the company. The development labs focused on incremental innovation, by solving product and production related issues. The NatLab focused on radical innovation, with doing fundamental research into the science underlying materials, processes and techniques used by the company and the accompanying technologically advanced routines.



The company’s phenomenal growth continued in the economic prosperous years after the second world war, in which the world’s manufacturers output quadrupled (Vries, 1999). The product diversification resulted in turn into an every extending range of research topics for

the NatLab. Philips aimed to understand the physics behind the materials and technologies used in all of their products and product ranges. Top scientific personnel from all over the world was hired to come and work in the NatLab located in the heart of Philips “Secret City” in the town center of Eindhoven. The size of the pool of researchers and supporting personnel grew from a staff of under 400 in 1930, to a staff of over 2200 in 1965. Philips invested to keep the spatial layout and size of the facilities in coherence with the growth in number of scientists in this period. In 1944 the total floor area of the NatLab in Strijp was 20,000 m². By 1952 it had increased to 25,620 m², and in 1955 a new wing came into use, which further increased the work floor area to 27,920 m² (Vries, 1999). In 1963 the official move to new facilities situated in the village of Waalre near the southern border of Eindhoven started, to the location of what today is the High Tech Campus. A large world renowned knowledge base, both tacit and codified, in diverse fields of science emerged within Philips, and geographically centred in the South-East part of Brabant. With the founding of the NatLab, an economic development path was opened for an industry which relied on a community of researchers which produced advanced exploratory knowledge and technological routines.

Structural Weakness in Philips Innovative Performance

Philips enjoyed major successes with innovative products throughout its existence. It achieved several successes in bringing radical innovations to the market with the introduction of the compact cassette, the compact disk (CD) and DVD as the most recent examples. However, throughout the company’s history, Philips in general has had serious trouble in commercialising the knowledge and technological routines created through its advanced R&D capabilities. The company’s history is dotted with extremely capital intensive research projects not yielding any usable technologies, resulting in losses being made due to the write down of those technologies and of money invested in the R&D efforts. Example of this are research into the Stirling engine, the Video Long Play system and the Mega-project. The successes that did occur in technology transfers and subsequent product development to the PD’s did counterbalance the costs of the unsuccessful research and research transfer activities up until the 1960s. This veiled the underlying problem that the flow of knowledge from the exploratory side of the firm to the exploitation side of the firm. This problem persisted throughout most of the 20th century, which inhibited Philips’ capacity to innovate and capitalise fully from its knowledge potential. (Braun et al., 2012; Vries, 1999) The costs of research which was not brought to the market as innovations weighed heavy on Philips budget and represented a large base of unused knowledge potential. Not all of the research efforts were lost however, knowledge and technological routines generated in the VLP and Mega research were adapted and applied for uses in other research efforts which did yield commercial success.

Three main reasons for this weakness in the internalised innovative system can be identified, which are inherently intertwined with each other and amplified each other. Firstly the financial routine of total and direct research funding through the board of directors

equivalent to one percent of the annual turnover had a marked effect on the way the technologies researched and developed in the NatLab disseminated through-out Philips. The financial infrastructure within Philips resulted in no direct financial interdependence between the PDs which represent the exploitation side of the internalised innovation chain, and the NatLab representing the exploration. It resulted in the PD's behaving selectively with respect to the product ideas that the NatLab offered them for their product portfolios. They did not see it as a loss with regard to their own resources when they refused to transfer certain research outputs, since the research was not funded out of the PDs operational budget. Even though the internal governance structure of Philips was built around transferring knowledge and technologies from NatLab to the PD's, the financial structure created a risk averse incentive for the PD's which routinely prevented knowledge and technologies to be developed into actual products. The relationship between the NatLab and the PD's can be characterised as lacking mutual commitment (Braun et al., 2012; Vries, 1999). This impeded the smooth dissemination of knowledge and technologies researched in the NatLab throughout the company and with that the commercialisation of the knowledge researched on the exploration side.

Secondly, the financial routine of investing in a broad scope the projects in the NatLab resulted in a wide variety of knowledge and technologies being developed. This routine had emerged out of the broad product portfolio. The figure below shows the number of research fields and within that the number

of research topics. Philips research laboratories abroad were engaged in different research topics, raising the number of research topics in which Philips

	1946	1954	1968	1972
Research Fields	9	7	7	
Research Topics	23	37	27	30

as a whole was engaged even higher. The research fields included fields such as Atomic Physics and Nuclear Power, Materials, Chemistry, Mechanics, Medical and Biological work, Systems and Devices (Vries, 1999). The broad multidisciplinary nature of the research being done meant that Philips was only able to bring a part of it effectively to the market as successful innovations. A lot of technological routines and knowledge was never commercialised, representing large capital investments which did not generate return on investment (Braun et al., 2012; Metze, 1997; Vries, 1999).

Thirdly, and closely related to the last point, the organizational routine of giving a high degree of freedom to the researchers on multiple occasions lead researchers to pursue research projects which have been described as 'hobby projects', with little practical relevance to the firm (Braun et al., 2012). The high degree of independence that scientists were expected to have allowed them to follow their own research interests, and some researchers abused this freedom to start research topics which added no value to Philips' long term interests. NatLab's culture of independence served in theory the long term commercial goals of the company. However, the great distance between the market and the exploration side, combined with the stable financial basis being provided to the NatLab, created adverse incentives to the researchers, of whom some appeared to feel little

responsibility towards the company (Vries, 1999). Due to the costly nature of fundamental research, these hobby projects cost the firm dearly in terms of capital lost.

Besides the costly nature of the failures in commercializing knowledge and technological routines developed in the NatLab, the technology push method of innovation had a negative effect on the products that did reach the market. During my field work, many references were made to the lack of sense for market needs as being having negative effects on Philips' commercial success from the 1970s onwards. The routinised behaviour of Philips as a firm to push advanced technologies onto the market resulted in a long list of costly failures, which to this day appear to be part of the collective memory in the region. The specific culture of innovation within Philips' shaped a large community of scientists, researchers and engineers who behaved in a characteristic way. In the conversations held during my research period at Brainport Development the impact of the routinised research paradigm was cited as a major reason for the stagnation of Philips. Actors in different layers of the local governance structure, as well as entrepreneurs, referred to the detached nature of the product introductions by Philips, detached from the needs of the market, and pushed on the market by a firm convinced that technological superiority alone was enough to sell products.

Signs of change in the World Economy

Philips reached its peak in employment in the Netherlands in 1970 with 98.000 employees, and worldwide in 1974 with 412.000 employees. By the end of the 1960s the macro economic climate was beginning to deteriorate, seriously affecting Philips' sales. In 1965 the first indications of financial problems for Philips as a whole were noticed. In 1968 inflation started to increase. In 1971 the international monetary system came under pressure when the Bretton Woods system collapsed, which had provided a stable monetary basis since 1945. The overarching institutional structure in the Dutch political economy created a monetary position which set the Netherlands apart from the rest of Europe (Hall & Soskice, 2001). In the 1960s a situation of over-investment in the Netherlands was created when industries were continuing to invest, even though the overall profitability had decreased. Wages increased, and increased further when the Dutch government tunnelled the profits of the recently found gas deposits directly into the Dutch economy. Labelled as the "Dutch disease" by *The Economist* in 1974, the practice of the Dutch government to use the profits from the recently found gas deposits for social spending caused the Dutch currency to increase in value, to a point where Dutch manufacturers couldn't compete internationally. When the 1973 oil crisis hit, the Dutch economy, and with that Philips, was especially vulnerable. Profit margins fell because of the higher labour costs and expensive Dutch currency, right at the time when Philips felt the increasing competition from technological firms in emerging markets. The consecutive energy crises of 1973 and 1979 immersed the internationally oriented economy of the Netherlands in recession which was hardest felt in 1981 and 1982. Both globally and in the Dutch market Philips felt the effects of the crisis when consumer and business spending dropped (Braun et al., 2012).

Within this macro-economic setting, two major changes occurred in the high tech sectors in which Philips operated occurring in the 1960s and 1970s, which exposed the weaknesses in

Philips' way of doing business and which exposed the shortcomings of and vulnerabilities in Philips internalised, closed innovative system. Firstly competition in the high-tech sectors became much more fierce, with the entrance of mainly Japanese competitors. Product life cycles shortened, and with that the time available to recover the expenses for bring the new products to the market. Advanced research –both academic and private- became much more widely distributed worldwide. When Japanese industrial policy changed in the 1970s, large state funded research projects further strengthened the position of Philips competitors like Hitachi, Mitsubishi, Nippon Electrics and Toshiba. This combined with continuous high levels of R&D expenditure in the USA created a knowledge rich world in which the costs of R&D needed to make a breakthrough with product innovation increased (Braun et al., 2012; Chesbrough, 2003). Secondly, increased competition in the lower value added product segments put pressure on Philips' vertically integrated supply chain. Many of the factories in the Eindhoven region produced products in the low cost segment, providing a significant amount of jobs to the region. During the 1970s and 1980s it became clear that Philips had to close these factories, because the products were simply not competitive and not relevant to Philips' core business.

Conclusion

With the founding of the NatLab and Philips' financial dedication in funding advanced, long-term exploratory research, the economic evolution of the region gave rise to an industry rich in technologically advanced routines. The leadership of Gerard Philips was seminal in adopting both the financial and organizational routines related with advanced R&D capabilities, which emerged in Germany and the US. Philips as parent firm governed the dissemination of the advanced technological routines through the individual value chains, enriching the evolutionary fitness of the technological routines in each of these development paths. NatLab and the community of researchers working there can be considered and an techno-industrial development path in its own right, an overarching umbrella, feeding into the different value chains. Embedded in these researchers was a huge reservoir of advanced technological routines, which were supposed to shape the future of Philips through the possible innovations they represented. This was made possible by the financial routine of complete and direct research funding, siphoning capital from the individual value chains and allocating these retained earnings to the centralised research hub, NatLab.

The internal supply chain of Philips produced low, medium and high value added products in a broad range of sectors, and Philips developed capabilities in all these sectors. During the first part of the 20th century, several development paths were opened up simultaneously as a result of the organisational routine of vertical integration. It can be argued that each of these value chains represents an unique and distinguishable industrial development path, since each PD developed its own technological and organizational routines to bring products onto the market in different sectors.

Chapter Five

Transformation into the Regional Innovation System Brainport Development

Rationalising Philips Research

As seen in the last chapter, the development of the region was dominated by the emergence and growth of Philips. The organisational, financial and technological routines developed internally in Philips shaped the development path of the region. In this chapter the recombination of these routines in light of global shift which affected Philips' business will be explored in relation to the effect these shifts had on the regional development path. Set in motion by the financial setbacks in the 1960s, Philips started to reevaluate its organisational and financial routines. A stronger relation between NatLab and the PDs was sought in an effort to increase the commercial successes resulting from the R&D investments. The number of big hits in research was too small to counterbalance the for all the unsuccessful research efforts (Vries, 1999). It was a slow process of rewriting existing organisational and financial routines, in an effort to rationalise Philips' internalised innovative system. Starting in the 1970s, Philips and NatLab started to gradually adjust, transform and modify its organisational routines.

Several of the existing organisational routines within the research organisation were changed. A small shift in the research paradigm was beginning to show when Pannenberg took over from Casimir as the new director of the NatLab in 1974. He defended the independent position of the research organisation, but he insisted on decreasing the attention being given to 'technology push' and he insisted that more attention should be paid to 'market pull'. This represents a shift in the thinking about where the impetus for new innovations should emanate from. Pannenberg expressed that changing the routines would take time, but by opening up this discussion, he wanted to take the first steps to allow social and market needs (and with that commercial chances) to trickle upstream in the innovation system within Philips (Vries, 1999). Starting in 1978, the agenda setting for the companies research programs was entirely structured according to the company's existing PDs. During the 1980s the PDs' needs became more important a criterion for starting or finishing research topics. Research lines were abandoned if no PD was found to have interest in them, reflecting the more selective attitude towards research topics for which there was no direct PD relationship or interest. The restructuring the organizational routines of the NatLab and research within Philips during the 1970s and 1980s served as a prelude to the radical changes implemented during the 1990s and early 2000s.

Rewriting the financial routines of research funding

The costs of maintaining a world-class advanced research and development lab rose in the new knowledge rich world that started to emerge since the 1960s. During the first half of the

20th century, costs per researcher remained stable. However, after the second world war the annual costs per scientists had risen tenfold in the 1945-1972 period (from 5.000 to 50.000 NLG) reflecting the changing global R&D environment (Vries, 1999). In order to curb the surging research costs, a zero growth policy was implemented early in the 1970s which meant the number of scientists, researchers and engineers was to remain stable, which was the first time Philips modified a financial routine as to limit the amount of funding flowing into fundamental research.

It took until the end of the 1980s before Philips made radical modifications in its financial routines regarding research funding. In 1989 the financial routine of total and direct research funding by providing corporate funding equivalent to one percent of the annual turnover was abandoned. The formal ruling was that 0.3% of the company's turnover, a 67% decrease, would be allocated to the research budget directly, and the remainder had to come from contracts with the PDs (Vries, 1999). By introducing this new financial routine, the Board of Directors wanted to force the researchers to think more commercially in Philips' interests (Metze, 1997). At the time of the introduction of the contract research was seen as a defeat for the research organisation which had always fiercely defended its financial independence. The practice of contract research, however, was already known to have been introduced in several other large companies, so Philips had to respond to the changes in competitors routines. Most vocally within NatLab, but also from the side of some of the PD managers, the concern was voiced that the amount of short-term research based on contracts with the PDs would increase at the cost of long-term research (Metze, 1997; Vries, 1999). The rupture like change in the financial routines profoundly impacted the NatLab's community of researchers in the short term. The introduction of contract research was evaluated by F. Carrubba in 1992. He moved from Hewlett-Packard to Philips in 1991 to assume the role of holder of the research portfolio on the Philips Board of Management during operation Centurion. His research concluded that the introduction of the new financial routine of contract research resulted in the PDs using the researchers as product developers, rather than for fundamental, exploratory long term research. He reported to the company board of directors that the change in focus drove away many of the researchers, and those who were left behind were afraid of losing their job, which was 'killing' for the research organisation (Metze, 1997). An unforeseen consequence was that the overall research budget dropped markedly more than intended. The PDs, by then subjected to the budget cuts part of operation Centurion, were very cost-conscious during the negotiations over the contracts for research. This led to a larger drop in research spending than decided upon by the board of directors. The NatLab ended up having to shoulder 30% of the costs cut over three years, with the foreign research labs having to bear the other 70% of the cost reductions.

Next to the centrally distributed budget and the contract budget, a new financial routine was introduced with the Self-Financing Activities (SFAs). This form of research financing was focused on maturing strategic key technologies and capabilities, for which no contract with the PDs could be drawn up, until they could be spun out and generate revenues though the

sale of equity interest, or until they could be transferred to one of the PDs (Vries, 1999). These SFA functioned as firms within the parent firm. In 1991 around 200 people were involved in SFAs, which after some years proved profitable. In 1998, the Dutch Newspaper *NRC Handelsblad* even reported on the successes of Self Financing Activities in generating business for Philips (“Geslaagd,” 1998).

Adaptation

After the turbulent period of adopting new financial and organisational routines, and the subsequent drop in Philips’ overall R&D expenditure, the R&D expenditure started to rise again midway through the 1990s. Besides the rising levels of capital available for R&D, the community of Philips researchers started to adapt to the new financial institutions shaping the research environment within Philips. The contract research caused researchers to take the problems of the product departments more seriously on the one hand, because this was a new source of research funds. It also forced the Product Departments not to treat research as a ‘free good’ on the other hand, and to work with the NatLab from the inception of the project, since they were paying for it. After a small dip, the number of publications produced by NatLab started to pick up again in the early 2000s, signalling a return to a environment in the lab where there was still room for exploratory research. The amount of patents applications per researcher has dramatically increased, a clue that researchers pay more attention to the possibilities for commercial exploitation of knowledge. Philips Research is ranked third in Europe for total patent applications in 2012, handing in 1839 patents, a 39% increase in comparison to the year before.

Moreover, as part of the rationalisation process, Philips made Eindhoven and the NatLab its focal point of its research and development efforts. In return for the move of the headquarters of Philips to Amsterdam, CEO Cor Boonstra increased the concentration and extent of its R&D activities in the Eindhoven region (Gerwen, 2012). The R&D activities were scattered over Eindhoven and

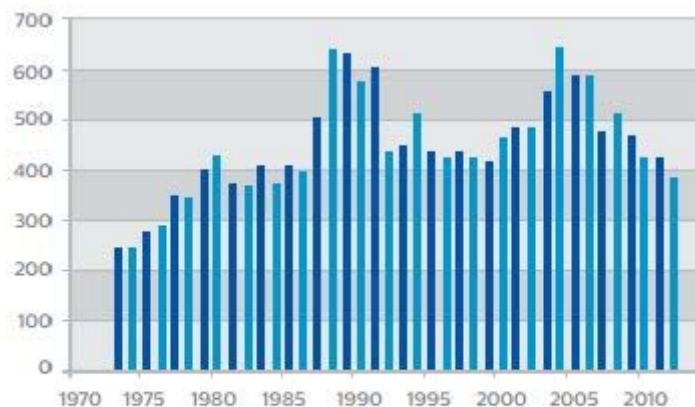


Figure 1 Publication totals from Philips Research⁹, data from Web of Science

researchers were working in out-dated facilities due to the budget cuts in the years before. With the *war on talent* raging, the derelict state of the facilities posed a problem when trying to hire top researchers. Philips moved all its research facilities to the NatLab campus and invested heavily in upgrading these facilities to create an ‘open’ atmosphere, renaming the facilities the Philips Technology Campus in late 1990s. The Philips campus was opened to other firms and research institutions in 2003.

Open innovation

After reading the work of Henry Chesbrough (2003) the project team charged with restructuring Philips Research felt their efforts legitimised and further aligned them with the idea of open innovation (Gerwen, 2012). Open innovation as a new paradigm emerged in American corporate R&D labs in reaction to the changing knowledge landscape described earlier. Open innovation means that valuable ideas can come from outside as well as inside the company and can go to the market inside or outside the company as well (Chesbrough, 2003). Chesbrough's work showed how long and painful the process of transforming from an closed to an open innovation model can be, but with great potential for large companies to continue to profit from their innovative investments by modifying their organisational and financial routines.

Open innovation is not one coherent strategy. Rather it refers to a broad range of different organisational and financial routines aimed at entrepreneurial ways of commercialising technological routines developed in our outside companies R&D laboratories. Philips and the other leader firms in the region have adopted various ones of these routines and adapted them to fit the context of the Brainport Region. Firstly, the active creation of cooperation networks and shared research institutes to pool R&D investments, especially on exploratory 'pre-competitive' research has been adopted. The transformation of the former NatLab-cleanroom facilities on the Holst centre for pre-competitive, a collaboration between Imec, TNO and Philips has been a catalyst within Philips in this sense (Gerwen, 2012). Contracts play a much smaller role in collaborative R&D in the Brainport Region than in other regions which have adopted an open innovation paradigm. It is common practice in the Holst centre and throughout the region to work without binding research contracts for the first years. There is a sense amongst the private stakeholders in the region that researchers from different firms can only work together if they trust each other. Routinely, contracts are only drafted after concrete results start to emerge, to set rules on the IP rights and returns of the project. When asked about the origins of this 'software' of trust and willingness to cooperate, stakeholders in the Eindhoven region point to the strong, historically rooted sense of local community, a sense of pride for the region and the fact that many of those involved are former Philips employees forming a community with shared values that facilitate cooperation (Braun et al., 2012).

Philips gave open innovation a specific meaning by removing all Philips signs from the area and renaming the area the High Tech Campus (HTC). The phase of redevelopment was completed in 2012, and the HTC was sold to a consortium of Dutch investors that year. The HTC plays a pivotal role in the RIS, and is a breeding pool for innovation shared by more than 8000 R&D engineers from over ninety companies. All the major private players in the RIS have their production and R&D facilities located on the premises. Next to the R&D and manufacturing oriented firms, service providing firms such as consultancy firms and law firms are located on the campus. The campus has been redesigned, from a paragon of closed

innovation in its NatLab time, to a space tailor-made to be the geographical manifestation of open innovation (Braun et al., 2012). The campus management has implemented specific organizational routines to safeguard and strengthen this environment. It actively screens firms on the principles of related variety, fostering various forms of proximity and distance at once, and having a different but related knowledge base is required. As part of a pro-active acquisition strategy, global industry leaders have been offered a proposition for locating on the HTC. Intel, IBM and Texas Instruments are notable examples of firms which opened offices and started small scale R&D activities as a result of this strategy (Braun et al., 2012). The most basic element, however, of open innovation is to tap in existing sources of knowledge whenever possible and conduct internal R&D mainly to fill the gaps in existing knowledge. Rather than funding a large number of internal R&D projects from a broad range of scientific disciplines as was Philips strategy during the 20th century, the firm decided to concentrate on a few core disciplines and uses external sources of knowledge whenever possible. Besides the obvious sources, such as universities, research institutions and buying intellectual property rights, SKIEs are vital sources of external knowledge. In the USA, where the open innovation paradigm emerged, large incumbent innovative firms such as Intel, IBM, Facebook and Google rely for a large portion of their knowledge on their investments in SKIEs. Many of these SKIEs are spin-offs of other firms, or start-ups created by entrepreneurs who are former employees of high-tech firms.

A central element of the open innovation paradigm is the creation of SKIE start-ups and spin-offs in close cooperation with venture capital. Though the spin-off process, knowledge and technological routines, which do not fit strategically with the current business, are put out to the external market by setting up new businesses (Chesbrough, 2003). Research institutions and universities use a similar model in bringing parts of its internally developed knowledge to the market. First, this requires a delicate balance to be struck in exploratory research efforts being focused on areas strategically important to the firm and the creation of a more entrepreneurial environment that nurtures and rewards speed, teamwork, and prudent risk-taking. Secondly, this requires capital to be invested in different funding rounds to commercialise the knowledge and technological routines. In the open innovation paradigm adopted by firms in the Brainport Region, the venture capital community, and the start-up community are regarded as mutualistic participants in a complex ecosystem of firms that create, recombine, imitate, and interact with each other (Chesbrough, 2003).

Crisis & Regional Branching

In reaction to the economic woes starting in the 1960, Philips gradually started trimming down its extensive vertically integrated supply chain network. By letting go of the organizational routine of vertical integration, it followed the global trend of outsourcing production and service activities to supplier firms which started during the 1970s, kick-starting the process of regional branching in the region. Through outsourcing, firms restructure to concentrate their capability and resources in their respective core businesses,

giving up those activities where firms do not have any competitive advantage (Chesbrough, 2003; Perez et al., 2009). The guiding idea is that the core competences are what gives the strength and the competitive edge as well as the long-term value to the company, while the other activities can in principle be outsourced without jeopardising the future. The organisational routine of outsourcing is not about separating innovating activities from non-innovating ones. On the contrary, it is about deciding who will innovate in which area. When outsourcing the assumption is that by giving the job to specialists, you expect them to concentrate on innovating in that area with much greater expertise and success than an internal department could have done (Perez et al., 2009). This practice of global corporations has very important consequences for the fabric of the economy. It induced the proliferation, through the spin-off process, of small knowledge intensive enterprises (SKIEs) which are active innovators at the same time as they serve as a sort of technical infrastructure for attracting further user investment. Philips started spinning out all activities not directly related to its core competences, which set in motion the process of regional branching in the Eindhoven's regional economy (Meer, Winden, Berg, & Beckers, 2010).

When the global economy once again stagnated in the early 1990s, Philips faced with urgent cash-flow problems and for a while balanced on the edge of bankruptcy after which it drastically increased the rate of its corporate restructuring process. As a response and after almost a year of consultations within the different layers of Philips corporate management structure, Philips' launched operation Centurion on September 30th 1990. The program included massive layoffs (about a quarter of its workers worldwide in 4 years), and accelerated the closure and sale of its remaining activities not related to its core business. Philips low-value added factories in the region were closed, and during the 1990s many of its high-tech, high value added divisions were spun-out. The operation, the largest corporate restructuring program of its kind in the world at that time, succeeded in saving the company by cutting costs by over a third in three years' time. The automobile producer DAF was in the middle of a capital intensive process of expanding into the UK market. When the crisis set in, DAF too faced cash-flow problems to which banks reacted strongly by withdrawing all funding from the firm, forcing bankruptcy in 1993. The firm was acquired by Paccar, an American firm, and restarted operations, but by that time massive lay-offs had already occurred.

When Philips dismantled its vertically integrated supply chain, departments producing high-tech products like fibre-optics, semiconductors and lithography, were labelled as not strategically relevant to its core business. Some divisions were sold to MNCs, whilst others were spun-out to become independent firms. Three of the spin-out firms grew into MNCs who are major world players in their respective fields. These Philips spin-outs are leader firms in the RIS in the Brainport Region today, besides many other Philips spin-outs who grew into stable SMEs part of the RIS. The first and most successful Philips spin-out in this respect is the lithography producer ASML. ASML started in 1984 as a 50/50 joint venture with Philips and ASMI, but ASMI sold its remaining 50% share to Philips in 1988, the same

year that ASML entered the Asian market with the help of Philips. ASML has grown steadily over the years and is now world leader in the field of lithography. Philips earned several hundred million Euros through divesting its stake in ASML down to an ownership percentage of 6.7 % in 2000 (ASML, n.d.). In December 2005 it was announced that Philips intended to spin out Philips' semiconductors division, with locations in Eindhoven, Nijmegen and in Silicon valley. This process was completed in 2006 when Philips sold 80.1% of its shares in its semiconductor division to a consortium of Venture Capital Funds, and NXP Semiconductors was born (Dierick, 2013). The third major high-tech player, FEI Company, already existed as a relatively small university start-up from Oregon, USA. FEI Company was invited to take over Philips Electron Optics, and after first merging in 1997, FEI company acquired Philips Electron Optics in 1999 ("History of FEI Company," n.d.). The CFO responsible for this process on the side of FEI, Eugene Kaerts, was my colleague at BNF during my research internships, and is one of the experts spoken to for this thesis. He is now responsible for the NextOEM accelerator program. FEI Company sells top-end electron microscopes and has become one of the global leaders in this sector. Other firms that spun-out of Philips or were founded with help of Philips by former Philips personnel in the Eindhoven region were Capax and ODME, both of which did not survive, ItoM, Gemco, Neways Electronic, Simac and many others are still a vibrant part of the RIS. The success of these firms changed the regional economy, which evolved into a more interconnected network with multiple leader firms. The bond between Philips and Eindhoven grew thinner during the 1990s, dramatically symbolised by the move of Philips' headquarters to Amsterdam in 1997. Eindhoven emancipated from Philips, and was no longer Philips town but was on track to becoming Brainport (Meer et al., 2010). The process has reached its pinnacle with the massive restructuring announced in 2014, when in June it was announced that its LED division was spun-out, followed in September by the historical announcement that Philips will split into two separate firms (Edelman, 2014b). Mid-2015 the Lightning division will be put into a new legal entity, opening the door for equity investors, and the remaining divisions of Healthcare and Consumer products will merge into Healthtech (Gerwen, 2014). Both firms will continue to operate under the Philips brand. As a result of this process, the regional industrial structure branched out into a variety of related industries which spread technical and organisational routines of the parent firm Philips throughout the region.

The response of local actors to the crisis of the 1990s helped shape the regional economy into the RIS it is today. This process had a huge impact on the region and the reaction of the local stakeholders towards this turbulent period shaped the development path of the region. The consequence of the 1990s crisis and reform of the Eindhoven region was the accelerated shift from the Philips dominated low-end manufacturing industrial structure, to a high-added value and knowledge intensive networked Regional Innovation System around multiple leader firms. There are three ways in which the crisis has changed the evolutionary path of the region to become one of the most visible innovative hotspots in the world today. Firstly, crisis and reform has been the emergence of an social and organisational governance

structure which intertwines and binds together different stakeholders in the region. Secondly, rather than an regional economy dependent on one leader firm with a network of dependant suppliers around it, the regional economy has evolved into a interconnected network with multiple leader firms as its nodes. Thirdly, it accelerated the process in which Philips abandoned the closed innovation paradigm in favour of an open, collaborative and entrepreneurial mode of innovation.

Local Governance response

The economic difficulties of the 1990s constituted a trigger for local firms and governmental actors to organise themselves, and approach national and EU-level authorities with a coherent vision. The social capital that was built during the crisis and which was institutionalised into a governance network which has proven to be highly effective for the management of the highly regional innovative system of the 2000s and beyond. One of the strengths of the RIS is the constructive cooperation within these regional public and private governance networks, which developed organisational and financial routines which exist on the level of this governance structure.

Two pre-existing economic development intuitions, NV REDE and the Brabantse Ontwikkelingsmaatschappij (BOM) played a large role during the early 1990s. NV REDE was fully public and helped to create different business parks in Eindhoven aimed at high-tech sectors, but its most important contribution to the regional economy was to strengthen the region's organisational capacity. On the governmental side the Samenwerkingsverband Regio Eindhoven (SRE), an alliance of municipalities around Eindhoven, has been a major catalyst in the regional organisational capacity. A small group of the people in charge of the Eindhoven community government, the chamber of commerce, and the Technical University were able to develop and disseminate routines through NV REDE and SRE which mobilised regional stakeholders to respond effectively to the region's economic crisis. A financial routine was adopted by the municipalities in the region, which were willing to contribute a fixed annual sum per inhabitant. The regional actors codified their plans in the "Stimulus" project plan, which served as a strategy to apply for EU regional funds. The project sought to strengthen the local research infrastructure by stimulating the R&D at smaller firms, the University and other research facilities and to generate spin-offs with these efforts. Another aim was to solve the growing mismatch at the labour market, with a high number of unemployed factory workers coinciding with a lack of skilled technical personal. The region pioneered financial routines in the Netherlands, aimed at attracting EU funds from the European Structural Funds and European Regional Development Funds (Meer et al., 2010). The EU funded the project with 181 million euro in three trances through the financial routine of co-funding, funding up to 50% of each approved project plan. SRE calculated that through co-funding between the core period of 1994-1999 a sum of 1.4 billion guilders was invested under the umbrella of the Stimulus program(Meer et al., 2010). Stimulus ended in 2005 and was followed up by the Horizon project. The organisational routines were modified, and private firms and stakeholders took a much larger role in the coordination and

implementation of the Horizon program. The NV REDE project teams would help the local actors, by sharing their financial routines and helping with the paperwork necessary in securing EU or other grants. The Horizon goals were to increase the exploitation of private and university R&D, to address the lack of highly skilled technical workers in the region and to strengthen the reputation or brand of the Eindhoven region in the Netherlands and abroad. The depth of the RIS increased in the 1990s when several public and private research institutes came to Eindhoven through acquisition activities of NV REDE. TNO Industry (1996), EURANDOM, The Dutch Polymer institute (1997) and the European Embedded Systems Institute all moved to Eindhoven in this period.

Based on the existing routines and network, a specialised public-private organisation was able to grow out of the temporary crisis-fighting projects. Brainport Foundation with its subsidiary Brainport Development was founded and absorbed NV REDE. Brainport Development was charged with implementing the Brainport2020 strategy, which succeeded the Horizon program. This strategy emerged out of the pre-existing organisational routine of public-private cooperation and was formulated under guidance of key players of the local government, research and corporate stakeholders, such as the CEO of Philips, the mayor of Eindhoven and the president of the TU/e. Brainport Development's mission has become gradually more ambitious, with the aim of becoming one of the leading high-tech regions in the world. The pre-existing organisational routines have been modified and have become increasingly sophisticated. Project teams of Brainport Development keep a continuing dialogue with its regions firms and research institutions, and is able to react flexibly to changing circumstances, though the formulation of action plans. These action plans are then presented to local stakeholders who are asked to provide funds and personnel for the projects. There is a long list of successful projects which have been carried out, aimed at a variety of different aspects related to the RIS categorised as people, technology, business and basics. Brainport Development shares its offices, called the Brainport House, with many of the other actors in the local governance structure. The monthly meetings of the Brainport Foundation enable the leaders from research, private and governmental institutions to discuss programs and progress at the highest level of the local governance network.

Brainport Development has proven very adept at lobbying in Brussels and The Hague. Outside of The Hague and Brussels, Brainport Development's lobby played a major role in being named the world's most intelligent community in 2011, being named Europe's most entrepreneurial region in 2013 and recently in being recognised as having the third best investment climate in Europe, after London and Helsinki. With BPD and the social capital created by its continued project based public-private collaborations the region has a flexible governance infrastructure equipped with a repertoire of organisational and financial routines adept at addressing long-term constraints and opportunities for the development of the RIS.

Regional Branching; cooperation in the supply chain

One of the strengths of the region, which has often been mentioned by those spoken to during the fieldwork, has started only recently started to emerge. There is a successful

cooperation between the leader firms and supply chains in the region. Philips, and to a lesser extent ASML, DAF, FEI and DSM, who is located further away in Limburg, govern and foster innovation in their supply chains. The related variety in the region is proving to be a breeding ground for innovation. SKIEs that have spun-out of these firms have integrated into the RIS of the region, with the large leader firms acting as their launching costumers. The SKIEs in the supply chain have organised themselves in Brainport Industries, which started as a project of Brainport Development. Brainport Industries has spun out of Brainport Development, but the ties remain close. During my research internship I cooperated closely with Brainport Industries, which still hold offices in the Brainport House. ASML is being seen in the region as a in pioneer supply chain governance by the introduction of two new routines. Firstly, ASML has directed its supplier firms to diversify its customer base and to find other clients besides ASML. By doing so, the sustainability and growth prospects of these firms are being are increased. Many of the new costumers are found in the region itself, strengthening the fabric of the RIS. When need, ASML invests in these firms and helps them gain access to an international network of customers. The practice of investing in supplier firms has been adopted by ASML through its contacts with Intel, which pioneered this routine (Chesbrough, 2003). In 2012 Intel invested approximately \$4.1 billion in ASML, partly through acquiring an equity stake and a \$829 million direct investment into ASML's R&D budget was part of this transaction, too strengthen ASML as a supplier. Secondly, it requires its suppliers to deliver plug-and-play modules, which are finished and tested before being delivered to ASML. The supplier firms are provided with incentives to incrementally innovate and improve these modules, allowing ASML to focus its R&D efforts on more exploratory research in the field of lithography whilst the more applied research is partly carried out by its suppliers.

Conclusion

Philips, and DAF for that matter, almost went bankrupt through the competitive pressures on their organizational and financial routines. The adoption and adaptation of new financial routines by Philips in the way it funded its research had strong short-term ramifications on the performance of its research organisation. After a transition period, however, the new framework created by these financial routines helped the research organisation to survive and after more than two decades it is still the largest private research organisation in the region. As part of this adaptation to the changing global economy, low value-added industrial development paths were closed off by Philips, changing the nature of the regional economy dramatically.

Public and private actors responded to this crisis, by pioneering routines on public- private cooperation, to counter these difficulties. These same routines proved very successful and effective for coordinating an RIS, and a close networked economy with warm ties between firms fosters innovation. Whilst some industrial development paths were closed, new ones were opened though the process of regional branching. Philips spin-outs gave rise to related industries, adapting technological and organizational routines in various new markets niches,

who are nodes in this closely bound RIS. Philips recognized that the organizational and financial routines regarding its advanced R&D, after costing Philips large sums of money, had to be adapted to fit the changing global knowledge landscape. New financial and organizational routines, emerged in the USA and broadly fitting the open innovation paradigm, were absorbed and adapted to fit the context of the Brainport Region.

Chapter Six

Finance for Small Knowledge Intensive Enterprises in the Brainport RIS

The emergence of the current Regional Innovation System has been shown to be a direct result of the rewriting of organisational and financial routines within Philips and the reaction of regional stakeholders to economic crisis resulting from these changes within Philips. Out of Philips NatLab a blooming space of innovation has emerged and technological, financial and organisational routines developed within Philips have spread over the region through the spinout process and the regional branching process. Following the same sequential logic laid down in the discussions of the theories, the results of the research on the relation between different sources of finance and the performance of small knowledge intensive enterprises (SKIEs) in the Brainport regional innovation system will be discussed. For reference, the corporate lifecycle model can be found on page 21.

Pre-seed phase; government investments

Governments worldwide are very active in early investments and are the most important financier in the earliest stage in the corporate lifecycle of firms in Europe (Vermeulen, 2014). In the earliest stage, research grants and valorization grants together with debt based forms of tax incentives are provided by regional, national or European governmental institutions. Respondent 1 and 2 had both received financing in the form of grants through the Dutch NWO, of which they were grateful but critical in regard to the amount of time, that went into the paper work. The grants allowed their firms to improve the technical routines and knowledge through further research. Respondent 1 explained how the grants and debt based financial instruments required a lot of paper work to be filled in, diverting time and organisational capacity away from his entrepreneurial tasks. During the period in which respondent 1 was stacking different forms government grants and debt based sources of financing, he reported to be hampered in his ability to build a repertoire of organisational routines needed to bring his innovative product to the market. The technological routines were already developed in the laboratory of the university before respondent 1's SKIE was founded. To develop the organisational routines to scale and the application of those technological routines, was difficult with grants and debt based finance. Respondent 2 and respondent 4, entrepreneurs from a SKIE which evolved out of the merger of two university spin-offs, one based in Zurich and one based in Eindhoven, were less critical of grants since they fitted their SKIE context better. The technological routines they were developing for the medical sector take much longer to develop, resulting from the requirements of clinical trials. Grants provided them with the funding for research and development needed to develop the technological routines. Respondent 5 and 8, who both came into contact with a large and diverse population of SKIEs, emanating from different sources, voiced similar observations on the effect of grants on SKIEs. Grants enable the development of technological routines but provide a barrier to the development of organisational routines. Respondent 1 and 8 explained how the ability to write grant applications is a skill in itself,

which arguably allows that skill to be seen as a financial routine in itself. For respondent 1 founding a firm based on this financial routine was his back-up plan, if his SKIE might fail. The repertoire of financial routines in the application process and the organisational routines needed to handle the paperwork are a service which can be sold to entrepreneurs who want to found SKIEs. Early stage government grants are adept at helping SKIEs to develop repertoires of technological routines, but provide barriers for the SKIEs in developing organizational routines. The application and managing of grants can be seen as a financial routine in its own right.

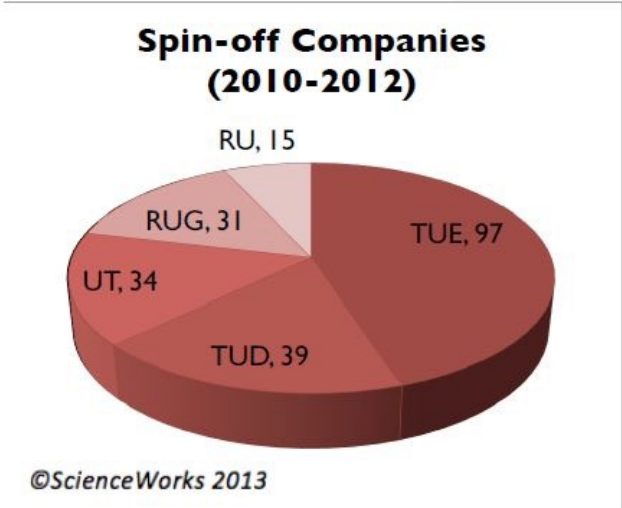
Government interventions to increase the supply of early stage venture capital have evolved over time (Murray, 2007). Besides grants and debt based financial routines, governments now typically adopt a capital participation approach (C. Mason, 2009). There are two government seed funds active in the region, which utilise these practices. The first is the Technostars fund, which covers North-Brabant and Zeeland and has invested all its funds in a total of 26 firms. The second fund is the Brightmove fund, exclusively targeting the Brainport Region. Besides providing capital, these seed funds help the entrepreneurs in SKIEs with developing the financial and organisational routines necessary to apply for an investment by the seed fund. Furthermore, once the SKIE's received their investments, these funds offer commercial knowledge, network and extensive help with securing follow up investments. The cooperation between BPD, the HTC, TU/e and these two funds is close. Many of the firms that received investments from these funds are housed in one of four dedicated incubator buildings on the HTC and TU/e campus which are run under management of Brainport Development. Respondent 5 used to work for Brainport Development as a close colleague of respondent 8 and these close ties benefited the SKIEs significantly. Labour mobility between the different government institutions and firms in the region spreads routines and creates strong network ties between the different governance actors.

At least two SKIEs which were housed in the incubator buildings run by Brainport Development were able to secure a much needed seed investment from the seed funds during my research intership, because respondent 8 used his close network ties to the fund managers to help the SKIEs in securing an investment from one of either funds. Respondent 8 claimed that without these quickly arranged investments, these SKIEs would have failed. Respondent 2 and 4 had received investments from one of the two funds when I interviewed them. Respondent 1 received an investment after I spoke to him. Especially respondent 4 was very positive about the effect the investment had on the SKIE's performance, referring mostly to the support the fund managers and the related stakeholders gave his firm to expand his operations and network in the region. Besides the relief of capital constraints, it allowed them to build up organisational routines and network ties which helped the firm be embedded in the region and to grow.

These funds are major players in the early phase of the financial ecosystem in the region and have received a lot of attention in the local political area. As discussed before, investing in

SKIEs brings with it high risks since many firms fail. There was broad political backing when these funds were founded, but this backing evaporated quickly when the first firms started to fail. Those involved in setting up and running the funds warned the political actors when the funds were founded that firms failing would inevitably happen since it is inherent to investing in this phase. Respondents 5, 8 and 12 voiced their apathy towards the political sphere as a result of these developments. The financial capital provided by the funds, however, plays a major role in providing funds in the pre-seed and seed phase for firms spinning off from the TU/e, Fontys Hogescholen and the research institutions. Incidentally the funds have invested in spin-out firms, such as Océ spin-off Mutraccx. The positive effect of receiving an equity investment from these funds on SKIEs is broadly recognised by entrepreneurs and service providers alike in the region. Receiving an equity based government investment requires less organisational capacity to be diverted into managing the paperwork compared to grant based government financing. The capital received can be freely allocated into R&D efforts, attracting additional human capital and scaling up production capacity, allowing for the build-up of organisational and technological routines as seen fit by the SKIE management. Besides the build-up of a repertoire of organisational and technological routines, the efforts by the fund managers in helping the SKIEs to secure follow up investments transfers financial routines to the SKIEs. The fund managers and the other governance stakeholders who aided the firms are experienced in the world of finance and their knowledge and routines are made available to the SKIEs, resulting into partial adaptation of these financial routines by the SKIEs. However, finding these follow up investments in the seed phase is one of the problems in the region.

The TU/e Innovations Lab is responsible for the exploitation of university knowledge, by providing assistance in maturing SKIEs and in cooperating with these firms in the long term. Most TU/e start-ups receive a pre-seed investment from the Brightmove fund, in which the TU/e has a 30% stake. However, the Innovation lab has no investments tools available after the pre-seed phase and the SKIEs have to find follow up investments in the financial market. The Innovation lab



supports the spin-offs with human resources, network in sales and suppliers, finding additional venture capital by helping the entrepreneurs and allowing them to build up organisational and financial routines. Respondent 5 mentioned how Innovation lab adopted routines developed in America with regards to University spin-outs, and adapted these routines for use in the Brainport Region. TU/e retains ownership of the patents and with that the technological knowledge, which it licences exclusively to the spin-off firm and free of royalties in return for an equity stake. With follow-up investments, this percentage of shares

dilutes, decreasing their relative equity stake in the firm, with the intention of eventually selling their equity stake. Ideally the exit is made as early as the seed-phase. In practice this rarely happens because the capital attracted in this phase by the firms is allocated to firm development and not to buy-out equity partners. TU/e has standardised financial routines regarding equity, making a distinction between finder and founder shares. Finder shares are a reward for the technological discovery made. A third of the shares goes to the scientist who made the technological discovery regardless of if he or she is part of the spin-out firm, another third goes to the central TU/e funds and the final third goes to the faculty where the discovery has been made. Founder shares are divided amongst entrepreneurs who are actually involved in founding the spin-out, and additional shares can be earned by personnel who join the spin-out by means of a financial incentive.

Whilst it is easy to attract funding up to 50.000 euro's in the region from government backed sources, finding investments after this phase is hard in the region. The well-functioning supply of pre-seed capital in the earliest phase of the SKIE lifecycle partly explains the high number of SKIEs spinning-off from the TU/e. The difficult nature of attracting follow up investments in the seed phase, needed to survive and grow, has been named by respondents 1, 5, 6, 7, 8 and 12 as one of the main factors in the high rate of SKIE failure in the region.

Pre-seed and seed stage; Business Angel Investment

A lot of my time and efforts during my research internship were directed at the informal venture capital market, more commonly known as Business Angel (BA) financing. The initial research design was aimed at understanding this part of the financing chain and how BA financing in the Brainport Region should or could be stimulated. Early on it became apparent that even though BA financing plays an important part it was only one of the sources of finance for SKIEs and the scope of the research broadened. In the corporate life cycle of SKIEs, BA financing is the 'next step' after government funding. It is needed to grow as a firm; it is used to scale R&D efforts, set up production facilities, expand into new markets and strengthen organisational capacity by attracting specialised human capital. Attracting BA financing is problematic, and was an often named deficiency in the financial infrastructure of the RIS in the Brainport Region by actors in the governance and business infrastructure in the region.

Research into the business angel market in Europe and America shows that the informal nature of the business angel market poses difficulties for entrepreneurs to track down business angels. Respondent 1, who had just received a BA investment from two groups of informal investors described how the long search for BAs almost resulted in his firm going bankrupt. Tracking down private individuals through informal, trust based networks takes time. Respondents 1, 5, 6, 8 and 12 all made similar remarks about the hidden nature of individuals who have the financial means and willingness to invest. As respondent 12 remarked, these individuals do not advertise the fact that they are wealthy, for the fear of

attracting to much unwanted attention from all sorts of different parties who are then after their money. Respondents 5, 6, 8 and 12 all personally knew business angels with track records of investing in SKIEs or other type of firms. All these respondents explained that they were very stringent in allowing SKIEs to access these BAs, only firms that they themselves already viewed as viable were given access to the angels. They acted as gatekeepers to their informal networks of business angels, making sure not to risk these bonds by allowing too many SKIEs access to the BAs.

Respondents 1, 5, 6, 7, 8, 10, 11 and 12 all expressed that they knew or believed there to be a much larger number of BAs to be active in the region than currently known by the governance structure in the region. Respondent 6 was a member of an informal network of financial professionals in the region and remarked that within that network, individuals regularly met on an informal basis to discuss investing in SKIEs. Respondent 12, part of the same informal network, claimed that he knew over 100 million worth of informal investors within in a one kilometer radius around his office, located in the city centre. Respondent 11 explained how he used his informal network on numerous occasions to mobilise fellow BAs in the region to co-invest in firms, and visa-versa, how he was asked through to co-invest himself. It can be said that private individuals with enough capital to invest and the willingness to invest are located in the region, but very hard to find for entrepreneurs. The wealthy individuals providing informal venture capital are a hidden network in the region, informally organised in small groups who know of each-others existence but hard to track down for outsiders. As stated in the literature, the information flows imperfectly through the market, since the BAs often do not market themselves, making it hard for SKIEs to find the BAs for follow up investments.

At the start of my research internship in 2013 the Brainport Region did not have a Business Angel Network (BAN). As discussed in the theoretical part of the thesis, BANs are often government founded initiatives to unlock the business angel market. The fact that the region did not have a Business Angel Network which could unlock the informal investment capital market was mentioned as a serious problem for SKIEs trying to attract capital in the Brainport Region by respondents 1, 2, 5, 6, 7, 8, 9, 10 and 12. Respondent 5 went as far as calling it a disgrace that the region did not have a BAN, at the time he was interviewed. The 12 BANs active in the Netherlands are focussed on the western part of the country, with the exception of 'Meester van de Toekomst', which operates through the regional development agency NV Oost, which services the provinces of Gelderland and Overijssel. The benefits of having a dedicated BAN and the important role that BANs play in other regions suggest that the absence of this financial institution has damaged the ability of the region to support SKIE development.

During the period of my fieldwork, BPD was involved in establishing a BAN together with other stakeholders in North-Brabant. The idea, initially called 'Brabants Vermogen', had already been on the table for two years, inspired by the success of BANs in other European

regions. Much of my initial research served as input for negotiations and deliberations to set up the BAN, which started early in 2014 after a lengthy and difficult period of preparations. The first attempt to get EU backed funding for the project was rejected in early 2013, due to the low quality of the project proposal. At the end of 2013 funding was received, albeit for a much smaller amount as originally budgeted for in the initial project plan, which resulted in frictions between the participating stakeholders and a process of redevelopment in which my research contributed. I helped in establishing contacts between the BAN in Flanders and Brabants Vermogen, resulting in the transfer of organisational and financial routines from the Flanders BAN to the Brabants Vermogen project team. Methods used in Flanders have been adapted to fit the needs of the regional context in North-Brabant. Made in Brabant now has two BAN managers operating out of the BOM offices in Tilburg. Due to the financial constraints in the Made in Brabant project financing, the ability to provide assistance to the entrepreneurs is limited. Instead, firms are being referred to one of the partners involved for business advice to help the entrepreneurs to increase their investor readiness, effectively outsourcing this part of the matchmaking process to the business development staff of Brainport Development for the Brainport Region.

Respondents 5, 7, 8, 11 and 12 mentioned that in many cases when entrepreneurs of SKIEs were able to come into contact with potential informal investors, the low quality of the business case presented by the entrepreneurs caused the informal investors to back out. The concept of financialisation provides the language to analyse this phenomenon which plagues many of the starting SKIEs in the region and is related to a lack in organisational and financial routines. Entrepreneurs starting SKIEs in the Brainport Region have little to no commercial experience and are unable to convince BAs of the commercial potential of their technologies. Entrepreneurs write unrealistic and unconvincing business plans, which are either presented on paper or in 'pitches'. A pitch is a face-to-face presentation of the business plans, often in front of an audience of multiple investors. The pitches of SKIE entrepreneurs are often complex technological presentations which BAs do not understand. They are very able to explain the superiority of the technological routines and predict 'world domination' for their products, as one of the actors involved in supporting entrepreneurs jokingly called this. However, BAs use financialised assessment criteria, based on financial metrics such as expected market size, market share, possible return on investment and predicted future earnings. That language and those criteria are alien to many entrepreneurs in SKIEs which do not possess these financialised routines. The entrepreneurs then fail to convince the potential investors due to this mismatch, which was in the opinion of the respondents just as big a factor in SKIE failure as the difficulties in BAs and entrepreneurs finding each other.

Besides the difficulties in attracting follow-up investment, an often named factor in the high failure rate of SKIEs in the region has been the lack of organisational and financial routines present in SKIEs in the Brainport Region. Respondent 3, 5, 8, 11 and 12 referred to the lack of organisational and financial routines amongst entrepreneurs in SKIEs, and an overtly strong focus on technological routines. Entrepreneurs in university spin-offs have a

background in research, obtained PhD's and have been conditioned in exploratory research rather than exploitation and applied research. A telling remark, repeated by respondents 3, 8, 11 and 12 was in regard to entrepreneur's attitude in university and research spin-offs. The entrepreneurs were said to want to refine technological routines to achieve 98% efficiency, fulfilling the entrepreneurs academic and scientific interests, rather than a market need. If the technological routine would have been commercialised at 70% efficiency it would also have been a great innovation. Obtaining those extra 28% is what makes university and research institute SKIEs often fail. Firstly, because the R&D efforts consume large amounts of capital draining the firm's budget. Secondly, because the time it took to put the product on the market increased, allowing competitors to fill the niche market making the innovation obsolete before it even reached the market. Thirdly, if this metaphorically 98% efficiency is reached and the product is put onto the market, leading to some financial returns, the academic entrepreneurs tend to be satisfied. The entrepreneurs either return to scientific research or are content with a small profitable firm with a limited life span and little growth. This strong focus on technological routines was explicitly linked to the industrial historical evolution of the region by respondent 3, 6, 8 and 12.

Besides the restraints observed in the region resulting from the underdeveloped BA market and the only recently founded BAN, the positive effects of receiving investments made by business angels in the literature can be seen in the Brainport Region as well. Respondent 1, who's firm just received this type of investment, described how the equity based investment revitalised his firm, allowing the entrepreneurs to work on acquisition of customers, expansion of production and fine tuning of their business case. The respondent juxtaposed this to the earlier described constraints of grants and debt based financing backed by the government. The positive effects, which the equity based informal investment has, since it lifts capital constraints, were named by respondents 5, 7, 8 and 12 as reasons why BA financing is so vital. The entrepreneurs are provided with a sum of capital which is free to be allocated for the growth of the SKIE, allowing for the development of technological and organisational routines.

Besides lifting the capital restraints in a debt free way, respondents 5, 7, 8, 11 and 12 all mentioned the positive effect the personal involvement of the business angel had on the performance of SKIEs. As is mentioned in the literature outside of the field of economic geography, informal venture capital is considered smart money. Business angels were said, varying per individual case, to provide the entrepreneurs with knowledge, contacts, business strategy advice, help with recruiting human capital, advice and experience. The private individuals who made the investment spend time and energy in the firm, helping the SKIEs in building a repertoire of mostly organisational routines. Respondent 12 actively sought to include proactive business angels in the investments his venture capital firm made in SKIEs because of the organisational routines an experienced business angel injects into a firm. Respondents 5 and 8 compared the effect of the advice and guidance business angels provide with the effect of hiring consultancy firms have in developing business. Respondents

1, 11 and 12 nuanced this, by stating that the positive effect was related to the sectorial background of the business angel. The improvement in organisational routines of SKIEs was in their view only of great impact if the business angels had entrepreneurial experience in the same sector in which the SKIE operates. Both respondents 9 and 10 shared similar observations, that the positive effect of the personal involvement of business angels was the most relevant when the business angel had knowledge of or experience in the sectors in which the SKIE operates. During my research internship, I was engaged in talks with the Dutch Polymer Institute (DPI), who were in the process of setting up a sectorial dedicated BAN. Based on the argument that the chemical sectors in which SKIEs spinning out from the DPI required such specific knowledge, only wealthy individuals with a background in these sectors were allowed to join this business angel network. Respondent 1 mentioned that none of the business angels which invested in his firm had any knowledge of the sector in which he operated, nor had they the knowledge to understand the technological routines developed by his firm, which he viewed as a miss.

Business angels help SKIEs with finding additional sources of finance according to respondents 1, 5, 6, 9, 10 and 11. Once one business angel is convinced of the investment potential of a SKIE, he or she actively starts to scout for more business angels when follow up investments are needed. As mentioned earlier, business angels appear to be better able to find other, since they are part of the same informal networks. Informal investors move in the same circles and are able to mobilise groups of informal investors to co-invest in the same firm, called syndication. This importance of finding multiple business angels which can invest in a SKIE has grown over the last years due to development in the venture capital fund market. Venture capital funds have been investing later in the lifecycle of SKIEs, a development which is seen throughout the Netherlands and Europe, leaving a funding gap in the 1 million to 5 million range (Grilli & Murtinu, 2014; Insider, 2013; Vermeulen, 2014). This gap has been named 'the valley of death' in policy circles and this term has been adopted by the governance structure in the Brainport Region. Addressing this gap has been identified as one of the goals of the Brainport Networking Financials project. (European Union, 2012; Insider, 2013; *Nulmeting informal investment*, 2011; Vermeulen, 2014). Respondents 5 and 8 voiced their concerns about the ability of the BA market in the region to provide these sums of capital.

Start-up and growth phase: Venture Capital Funds

The venture capital fund market in the Brainport Region is seriously underdeveloped. This has been widely acknowledged both inside as well as outside the region (Braun et al., 2012; Cumming, 2012; Luminova, 2012; Vermeulen, 2014). A recent research report commissioned by Brainport Development on the finance market for start-up firms in shows that 19 firms have received an either an IVC or Corporate Venture Capital investment between 2005 and 2013. The vast majority of Dutch IVG are located in the Amsterdam metropolitan area, the heart of the Dutch financial centre. The VC and the BA markets in the Western part of the Netherlands, the 'Randstad' dwarf the Eindhoven market in number of

investments made and amounts invested (PriceWaterhouseCoopers, 2014). Only two Independent Venture Capital (IVC) funds have their headquarters located in the region. Eindhoven Corporate Finance Group (ECFG), the oldest of the two, has emerged out of the Stimulus, Horizon plans run by NV REDE. It has been operating as an IVC fund for the last few

Venture Capital market in the Brainport Region

Pre-seed € 0.1 - 0.5 Mln	Seed € 0.5 - 1 Mln	Start-up € 1 - 5 Mln	Growth € 5 - 25 Mln	Size (Mln)	Run by:
Innovation Fund				125	BOM
Energy Fund				60	BOM
Biobased Fund				13	BOM
Cleantech Fund				12	BOM
Eindhoven Venture Capital Fund				unknown	ECFG
Made in Brabant				-	BOM
Spin-off Fund Brabant				15	BOM
Piont-One Innovation Fund				8	Independent
Agro & CO Kapitaalfonds				6.2	BOM
Brabant Life Science Seed Fund				8	Independent
Technostars I, II & III				16.5	Independent
Stimulus Venture Capital Fund				unknown	ECFG
MKB Innovatiefonds Brabant				25	BOM
RedMedTech Ventures				7	Health Valley
Brightmove				8.5	Independent

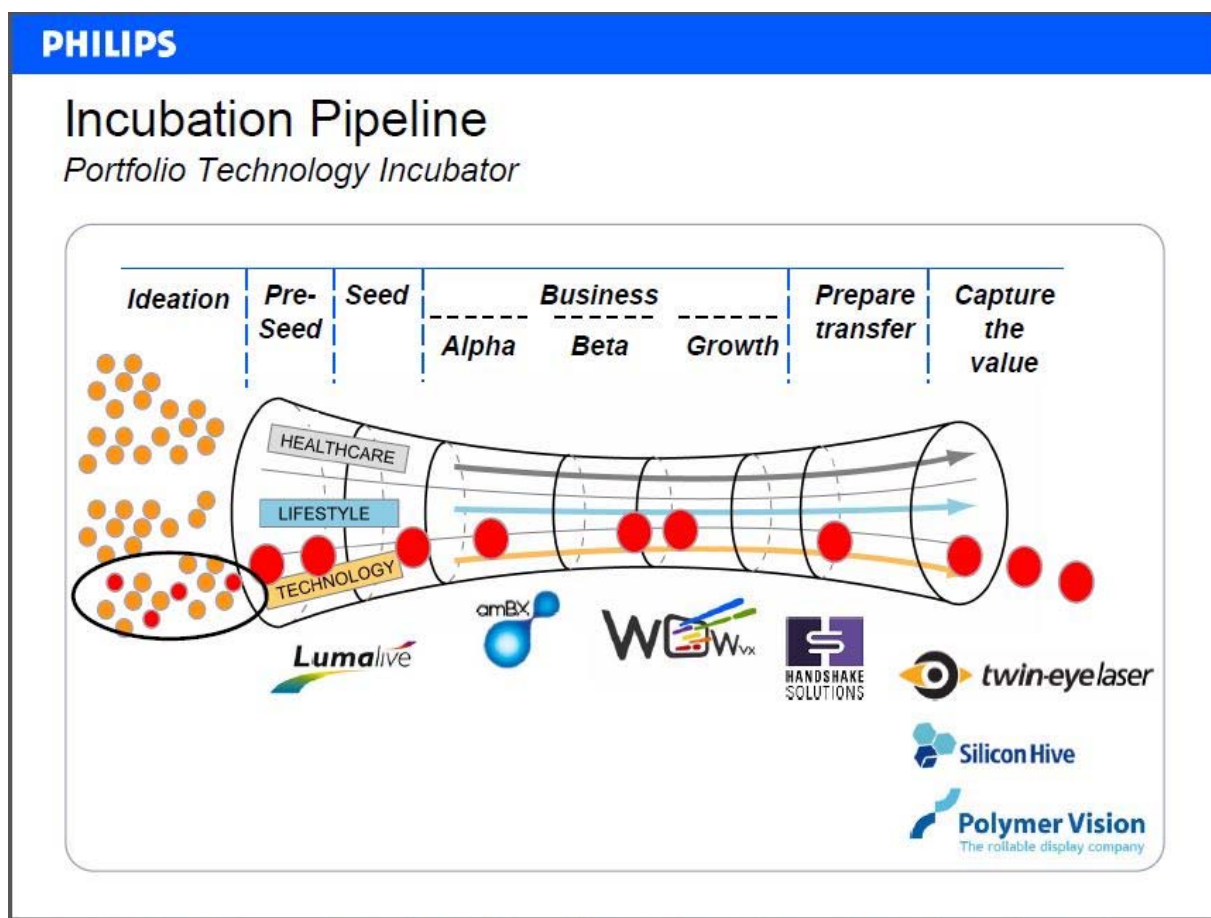
= Full
 = Still active
 = Private

years. ECFG has three funds under management, of which two are already full. The ties between ECFG and the governance network are strong, with respondent 5 having worked at ECFG and respondents 5, 8 and 12 have all worked together as colleagues at NV REDE. The second IVC fund, Dutch Expansion Capital (DEC), has been operational for no more than three years. During the start-up phase of DEC, there have been far going negotiations between Brainport Development and DEC on intensive forms of cooperation or co-investment, which did not succeed in establishing a formalised partnership. Currently DEC has made no investments in firms in the region. Prime Ventures, an Amsterdam based IVC holds offices on the HTC and has been the most active IVG in the region. The cooperation between the governance network and the IVC is strong, and all three IVC have contributed in the founding of Brainport Networking Financials.

The venture capital market in the Brainport Region is dominated by Government Venture Capital (GVC) funds. The BOM now runs four GVC with a combined worth of 210 million euros, which invest in the whole province of North-Brabant. Research into the performance of GVCs throughout Europe shows these types of government backed and managed venture capital funds to structurally underperform in comparison to IVCs (Grilli & Murtinu, 2014; Vermeulen, 2014). This also appears to be the case in the Brainport Region. The GVCs in the region are mostly run by the BOM, which has multiple funds with a combined value of well over 200 million euros. There is widely heard criticism on the way the BOM cooperates with stakeholders, how they choose their investments, how well they manage the investments. The relation between BOM and Brainport Development is strained to say the least. Respondents 3, 5, 6 8, 11 and 12, were cynical of BOM's investment strategy and capabilities. Respondent 11, a very wealthy private investors in the region was unwilling to cooperate with them, because of the underperformance of funds managed by the BOM.

Over the course of 2013 and 2014, many of the institutions in the RIS and the financial ecosystem were consulted by the BOM on how to allocate 125 million euro of investment capital. This sum of capital had become available through the sale of Essent. The Province of North-Brabant was stakeholder of Essent, which was sold to RWE in 2009 for 9.3 billion euros. BOM was advised by a broad coalition of stakeholders to invest the 125 million into an IVC, including respondents 8 and 12. The BOM was advised against setting up a fund which they managed themselves. When the BOM eventually decided against this, and founded a 125 million GVC, this decision was met with general disapproval in the region. The presence of the GVCs run by the BOM provides SKIEs in the region access to capital. However, investments by these GVC funds do not provide the well documented added benefits that accompany IVC investments. It can be argued that the overabundance of the GVC capital in the region distorts the market, preventing SKIEs in the region to look over regional boundaries for IVC investments. This prevents the SKIEs from potentially benefiting from the transfer of organisational, technological and financial routines that accompany an IVC investment.

Corporate venture capital in SKIEs play a minor role in the region outside of Philips. At the end of the 1990s, Philips started to experiment with venture capitalist models to commercialize knowledge and technological routines developed internally, in line with the shift to an open innovation paradigm (Braun et al., 2012; Chesbrough, 2003; Ford, Garnsey, & Probert, 2009; Vermeulen, 2014). A review of existing financial and organisational routines in the market outside Philips has resulted in the adaptation of the Bell–Mason stage-gate process. This model developed previously for venture capitalists in the US market, has been adopted and modified, resulting in Philips starting an internal incubator program (Ford et al., 2009). The first incubator, the Philips Technology incubator, has been launched in 2002 and



has been successful in introducing financial and organisational routines mimicking a market environment inside the boundaries of the firm. Subsequently, two new incubators have been founded inside Philips. At its launch, the incubator was provided with €5 million funds from each of Philips Research and Philips Applied Technologies to support the ventures inside Philips. As the number of ventures housed in the incubator increased over the past years, so has the funding provided to the incubator, with this rising to €20 million in 2004. Philips adopts three financial routines aimed at the ventures in the incubator. Firstly, those technological routines that remain strategically aligned with the firm are absorbed back into the company through a routine called spinning-in. Secondly, when outside SKIE's outside of Philips are identified as possessing knowledge, that strategically strengthens Philips long

term ability to innovate, Philips Venture Capital invests in these SKIE's. Philips collaborates with existing Venture Capital Funds in order to participate in dedicated Venture Funds for this purpose. Amongst others, Philips has invested 100 million in the Healthcare III fund run by Gilde VC (Joon Knapen, 2010). In some cases, SKIEs which have R&D capabilities, knowledge and technological routines, that are considered vital, are absorbed into Philips and placed into the Incubator. An example of this routine in practice is the recent take-over of the Danish firm Unisensor, a SKIE that has been absorbed by Philips, for its exploratory R&D capacities (Edelman, 2014a). By acquiring this SKIE, Philips is benefiting from the organisational experiments in this firm to commercialise their R&D capacities in the field of medical sensors.

Thirdly, technological routines that provide business opportunities, but are not relevant to the core business of Philips are spun-out. For this it cooperates with the venturing firm, New Venture Partners (NVP). NVP itself is a spin-out of the Bell Labs/Lucent Technologies Venture Group, the Venture Capital Group, an organisational innovation of the Bell Laboratories. The NVG was created to commercialize Bell Laboratories technologies that did not fit with any of Lucent's established businesses (Chesbrough, 2003). Through this collaboration, Philips benefits from the financial routines developed for spinning out SKIE's in the Bell Labs. Recently, Philips also started to cooperate with Amsterdam based IVC Prime Ventures, where the former CEO of Philips Incubator is now a managing partner, to try and secure venture capital for firms in the Philips Incubator.

Not all Philips spin-outs are able to secure funding in the Brainport Region, as the example of Shapeways shows. After spinning out of Philips in 2008, the 3-D print SKIE was unable to attract capital in the Brainport Region (Raaijmakers, 2008). After receiving an investment of \$5 million, the company moved its headquarters from Eindhoven to New York (Edelman, 2010). This received a lot of media attention both in Eindhoven as in New York, where Shapeways was hailed by the New York Times as Manhattans 'Amazon.com'(Vance, 2010). The move of Shapeways away from Eindhoven grieved and shocked actors in the governance structure, sentiments that were still felt and voiced when my research internship started. Shapeways tried to raise the investment capital in Eindhoven, but after having failed to attract BA or VC investments in Eindhoven, it sought investments elsewhere. The New York investors were able to convince the entrepreneurs of Shapeways to move to New York. The Shapeways episode was a catalyst in the governance structure in formulating joint action in starting efforts to strengthen the capital infrastructure in the region, resulting in the founding of Brainport Networking Financials.

Conclusion

How does the financial infrastructure in the region influence the performance of Small Knowledge Intensive Enterprises in the Brainport Region?

As seen in chapters four and five, until late in the 1990s Philips' retained earnings were the main source of finance for innovation in the region. This situation changed when Philips

started dismantling its vertically integrated supply chain, moved to concentrate its research facilities on the NatLab premises and went on to adopt a more open approach to innovation. With this, the regional economy diversified around multiple leader firms in related but varying high-tech sectors in a process of regional branching. This has created an open and knowledge rich regional innovation system in which public and private stakeholders collaborate in successful regional governance networks, a legacy of the regional response to the turbulent crisis of the 1990s.

In this context, SKIE creation and survival have become important for the growth and renewal of the regional innovation system. Equity based forms of finance commonly known as venture capital are vital for the growth and survival of SKIEs. Investments allow SKIEs to grow and develop their organisational and technological routines needed to bring innovative products to the market, since the financial capital lifts capital restraints. In the Philips dominated era, there was no need for a venture capital industry. The financial infrastructure in Brainport Region has not kept up with the fast and successful transformation of the region from the Philips dominated broad industrial economy, to the high value added and knowledge intensive regional innovation system which needs venture capital to fund the founding, growth and survival of SKIEs.

The provision of capital for SKIEs in the pre-seed phase of their corporate lifecycle in the Brainport Region is adequate. SKIEs can easily attract funds up to 50.000 euro from different government backed sources. Grants are successful in helping SKIEs developing technological routines, but have negative effects on the ability of SKIEs to develop organisational routines needed to bring those technological routines to the market. Equity investments by government backed seed funds provide SKIEs with more freedom in allocating the funds internally, allowing for the build-up of both organisational and technological routines. The assistance and help the seed fund managers provide to the SKIEs in finding follow-up investments transfers organisational and financial routines to the SKIEs.

SKIEs in the region have difficulty attracting the follow-up investments after the pre-seed phase. The informal venture capital market, or business angel market, is underdeveloped in the region. This is not necessarily due to the lack of wealthy individual in the region who can provide this capital. Getting in to contact with these individuals appears to be the largest problem. The informal, hidden nature is inherent to this part of the financial market globally, but the market is relatively underdeveloped in the Brainport region, exuberating the difficulties for SKIEs in the region. The absence of an Business Angel Network until recently has hampered the possibilities to solve this problem in the region. It is safe to say that the absence of a BAN in the region has damaged the ability of SKIEs to attract capital. The venture capital fund market in the region is weak, and dominated by underperforming government venture capital funds. The underperformance of the venture capital market in the region is negatively affecting the ability of SKIEs in the Brainport region to survive and grow.

This research shows that besides lifting capital constraints, venture capital investments have a strong positive effect on SKIE performance because they transfer successful organisational and financial routines from the investors to the SKIEs. Business Angels, Corporate and Independent Venture Capital fund managers are experienced entrepreneurs themselves, bringing with them a broad repertoire of organisational and financial routines and putting them to use for the benefit of the SKIEs in which they invested. Venture capital investors provide assistance in areas such as forming the business strategy, searching for additional funding, recruiting key staff, designing business plans and models and introducing the entrepreneur to professional networks of national and international origin. A well-developed venture capital market is a knowledge base in its own right, providing commercial, organisational and financial knowledge need to commercialise technological routines and innovations.

On a high level of abstraction, it can be argued that there is an overabundance of technological routines in the Brainport Region, negatively affecting the performance of the SKIE population in the region. The presence of the NatLab in the region, which evolved into the High Tech Campus and the regional innovation system with its tremendous knowledgegenerating capacity, has created an critical mass in researchers, scientist and skilled labour, well versed in developing advanced technological routines in their respective fields of science and industry. The larger firms in the region, such as Philips, ASML and FEI, etc. are able to capitalise on these routines by applying them into new and innovative products which have made world leaders in their sectors and fields. These large firms possess the necessary organisational and financial routines to bring these technological routines to the market and have even developed novel organisational and financial routines to foster innovation over the boundaries of firms. These organisational and financial routines, however, are underrepresented in the SKIEs that spin-out of the public and private laboratories and the Technical University in the region. These SKIEs are saturated by technological routines, allowing them to develop technologically sound products which fail to be successfully introduced onto the market, leading to the bankruptcy of the SKIE.

This distinct feature of the regional innovation system in the Brainport Region makes the absence of an well-developed venture capital industry even more felt. Besides providing SKIEs with investment capital needed to grow and expand, VC provides organisational routines which help SKIEs in commercialising their technological routines. The absence of a strong VC industry constitutes the absence of a potential commercial knowledge base in the region. This commercial knowledge base can act first as a counterbalance to the overabundant technological knowledge base and second as a catalyst for innovation in SKIEs.

Reflection

Looking back at my research internship, the data collection, the interviews, the analysis and the end result of this process, I can't help but think that this endeavour has reached its full potential. Even though I fully support the findings, the research is limited in its scientific value because of the shaky methodological foundation upon which the last empirical chapter rests. Due to personal circumstances the time of my internship was utilized less than optimally. During the analysis and writing process, time and time again, the limits of the data collected during the field work –better said; the missed chances- weighed heavily upon me. The dataset would have been more solid if a survey would have been taken under a sizable SKIE entrepreneurs who had received BA funding. Furthermore, the thesis would have gained in empirical robustness if in depth interviews would have been conducted with SKIE entrepreneurs who have received VC funding. These additional sources of data would have increased the validity of conclusions greatly. Writing is a creative process, and my creativity in writing an readable piece of academic text was blocked by this constant sense of unreached potential.

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Appendix One

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- Piet van de Wielen (Head SME Services Brainport Development)
- Eugene Kaerts (Project Manager NextOEM & Former CFO FEI)
- Emile Asselbergs (CEO Phenom world)
- Broos Bakens (EY & HightechXL)
- René Reijtenbagh (Meesters van de toekomst, NV Oost)
- Laurent Grandidier (CEO Xeltis, Zurich)
- Fränk de Jong (CEO EmulTech)
- Reginald Vossen (BAN Flanders)
- Martijn Cox (CEO Xeltis, Eindhoven)
- Abel Slippens (Business Angel)
- Ruben Baijens (Venture Capitalist)