Service innovation in an evolutionary perspective

SERVICE INNOVATION
IN AN EVOLUTIONARY PERSPECTIVE

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SUMMARY

Services have come to play a central part in modern economic life. While neoclassical economic theory can explain why services' supply and demand are growing, it leaves unclear how new services exactly come about. Also, it has little attention for the role of services in trajectories of technology and industry evolution. The objective of this thesis is to advance our understanding of the nature as well as the strategic and policy importance of service innovation.

Those scholars wishing to grasp the emergence of new services have followed different approaches. Service innovation can be treated just like goods-based innovation (the *assimilation* approach) or we can focus on what is peculiar about innovation in particular service contexts (*demarcation*). A widely shared ultimate aim is to develop theories in which the specificities of service and goods-based innovation are integrated (*synthesis*). Remarkably, none of these approaches places 'service innovation' at its core. In order to move towards all-encompassing innovation theory, we propose making a distinction between pre-synthesis and post-synthesis (the latter being similar to the traditional understanding of full synthesis). The newly introduced pre-synthesis approach has the following distinguishing characteristics: it *conciliates empirical findings retrieved from innovation efforts in a variety of service industries* and *interprets these findings through an evolutionary lens*, thereby also allowing us to *draw implications for the wider innovation literature*.

By taking service innovation activity as the unit of analysis, this thesis fundamentally recognizes the ubiquity of services. Rather than opposing services to goods, the pre-synthesis approach emphasizes identifying the interdependencies between the two. Evolutionary theories of technological and economic change are considered a sound but underexplored theoretical basis for shedding light on the role of services in (transforming) modern business environments and innovation systems. We build on product, firm and system level theories to investigate the following themes:

Part A: Nature (product level). The first two research chapters describe how innovation in services can be interpreted as the result of search in multidimensional design spaces. Since services are conceptually fuzzy, it is valuable to use multidimensional frameworks for describing where in a service product novelty takes place. We first develop measurement scales and a service innovation index suitable for comparative analyses (Chapter 2). To provide in-depth insights, we then map eight service innovations (developed by heterogeneous firms like TomTom and KLM) in a six-dimensional conceptualization, which is presented as a structure for applying complexity theory. We use so-called NK-logic to highlight interdependencies between dimensions, and how innovators can deal with them.

Part B: Management (firm level). The second part of this thesis is devoted to conceptualizing and measuring firm-level dynamic capabilities for service innovation. A review of the attempts to develop such a conceptualization results in the operationalization of one specific framework (Chapter 4). In Chapter 5, we apply the resulting measurement scale to investigate which capability is relatively most innovation-conducive, and whether this is affected by a service firm's openness. The finding that sensing user needs is the least discriminative capability forms the basis for Chapter 6. Using an NK-simulation model and building on the explorations in Part A, we show why too much focus on customer demand might have an adverse effect. This hypothesis is empirically validated by contrasting customizing service providers with firms that deliver standardized services.

Part C: Policy options (system level). This last part focuses on the question how policy makers can support service innovation. Using the functional perspective to innovation systems, we demonstrate that the three traditional service innovation approaches, as well as our own pre-synthesis approach, all form a basis for making policy mixes service-inclusive. In Chapter 8, we highlight how policy makers can use the pre-synthesis approach to guide economic transformation and regional diversification. Specifically, we suggest and illustrate the use of (service-based) 'cross-specialization'.

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Introduction

Chapter 1

Towards an enhanced understanding of service innovation

1.1 THE UPSURGE IN SERVICES, AND THE QUESTIONS THIS RAISES

The world around us, and especially its man-made elements, is changing at an unprecedented pace. At first glance, the most widespread and pervasive changes seem to be occurring in the domain of high-tech artefacts. Smartphones, solar cells, and robots are probably the first things coming to mind when comparing modern societies with past ones or with less technologically advanced regions. Taking a step back, however, we have to acknowledge that it is not just these types of products that are changing how firms and individuals behave. Increasingly higher on the lists of most innovative companies are firms that do not produce any physical goods whatsoever, and if we think about it, most of us probably know very few people who are actually producing 'material objects'.

A major development that has taken place in the past century is the rise of services (Bell, 1973; Illeris, 1996). Service activities have traditionally been defined as the purposive transformation of the condition of economic units like goods or persons (Hill, 1977; Gadrey, 2002).[1] According to an alternative definition, economic activities qualifying for the status of service, concern actions aimed at providing the actual solution or experience one aspires to (Gadrey et al., 1995). The contrast contained in this definition is that material objects or goods can be regarded as intermediary products not directly fulfilling a need, but allowing the buyer to produce the desired service himself.[2]

Although services are sometimes involved with the transformation of physical matter, all definitions and key characteristics stress that services themselves are disembodied. Because service products are not readily visible, this might obscure the fact that services nowadays account for the majority of economic activity in an increasing number of societies (Evangelista and Savona, 2003). The moment developed countries entered a phase of 'deindustrialization' or tertiarization is typically assumed to be the second half of the 20th century. Services became dominant already in the 1950s in the UK and in the USA, whereas countries such as France and Japan followed around the 1970s (Gallouj and Djellal, 2010). Over the past decades, nations around the entire globe have witnessed their previously agricultural and manufacturing-oriented industries making way for economies in which services account for between 70% and 80% of both employment and value added (OECD, 2013a; see Appendix A for more detailed and comparative statics on the rise of services). These figures do not just stem from 'pure'

1 As for goods, the emphasis is on modifying rather than manufacturing them. Typical services of this kind are maintenance and repair. Services can also concern the legal or proprietary status of a product (e.g. banking services, retail, insurance). Similarly, changes to a person can be literal (e.g. the services provided by a hairdresser) or metaphorical. The latter includes changes to an individual's cognitive state, which is why teaching, advising or entertaining also fulfill the definition.

2 In line with the definitions provided here, many scholars describe services with some of their key characteristics (Parasuraman et al., 1985; Sampson and Froehle, 2006). Apart from being intangible or perishable (non-stockable), services can also be distinguished by heterogeneity (e.g. personally delivered services), inseparability (i.e. simultaneous production and consumption), and co-production (fulfilling a need requires interaction with customers).

service industries; the transformation is also driven by diversification and relocation strategies of firms typically associated with the manufacturing sector (Lorentz and Savona, 2008; Gallouj et al., 2014; Chesbrough, 2011; Bowen et al., 1991).

The observed trend, leading some to talk about the emergence of 'post-industrial', 'new' or simply 'service' economies (Gershuny, 1977), begs a multitude of questions regarding the place of services in modern socio-economic systems. For instance, is a high share of service activity just a result, or also a driver of the ongoing economic transformations? This thesis focuses particularly on a set of issues relating to innovation: how exactly do novel service activities come about, and what is their role in the mechanisms underlying structural economic change? Before turning to these questions, we first consider traditional explanations for why services could become so ubiquitous.

1.2 EXPLAINING THE 'SERVICE ECONOMY'

1.2.1 The (neo-)classical economics behind the rise of services

Inquiries related to the rise of services pertain to, inter alia, the domain of economics. How to frame and study this phenomenon depends on the specific stream of economics one adheres to. We start by presenting views derived from mainstream neoclassical economics, so that later (section 1.1.3) we can argue why the relatively novel perspective of evolutionary economics provides a basis for advancing service studies. According to neoclassical economists, the quantity in which a certain product is produced – and for what price – is determined by the optimizing strategies of those who produce it and those who consume it.[3] An appropriate way to discuss traditional explanations for the shift towards service-orientated economies is thus by considering service demand and supply.

Demand-side explanations: growing markets for services

The statistician Engel observed already in 1857 that rich households are willing to spend relatively more on service consumption than less wealthy households (Illeris, 1996). This income elasticity of services is known as 'Engel's Law'. Fisher, in 1935, tried to explain the high growth-rates of services (compared to other sectors) by combining insights from the economist Malthus.[4] He argued that the hierarchy in consumer needs is related to the consumption of the output of different kinds of industrial activities. Primarily, people have basic needs like food, clothing and housing. Once these needs are met, they start consuming products that are less necessary (e.g. entertainment, travel).

3 Unless specified, we use the neutral term of products for referring to goods, services, or combinations thereof.

4 Allegedly, Malthus also has been a great inspiration for the biologist Charles Darwin (Vorzimmer, 1969). As the name suggests, Darwin's evolution theory in turn provided important foundations for the evolutionary school of economics that became an alternative to the stream of economics discussed here (Nelson & Winter, 1982; see also section 1.1.3).

Since the amount of food one can consume is limited, richer people will have more capital for products that give them non-necessary experiences. According to Fisher, also secondary-level needs (consisting of mainly manufactured goods) have a ceiling. Therefore, societies will consume more services as they get richer (Fisher, 1935). Figure A.3 in the Appendix confirms that households from almost all OECD countries predominantly consume services (OECD, 2013a, p. 257).

An alternative demand-side explanation for the upsurge in services has been proposed by, among others, neo-industrialists like Gershuny (1979). He argued that when households possess more capital, they are able to buy more goods. With these goods, people produce their own services; think of using your vacuum cleaner to tidy your own house instead of renting a cleaning service.[5] However, for expert services, economic actors are still dependent on professional suppliers. Since the services that remain on the market require well-educated knowledge workers, also the price level of services increases. If productivity is measured by taking product (service) value as output, and human effort (salary) as input, we see indeed that higher wages lead to lower productivity. Characteristic for neo-industrialists are their concerns about low productivity growth, which generally make them skeptical about the rise of service economies (Delaunay and Gadrey, 1992; Ciarli et al., 2012).

The growing importance of services is also based on increased service consumption by firms, something which became the topic of research after several decennia of household-studies (Illeris, 1996). Services that are delivered in professional markets are called producer services and include sub-sectors (industries) such as retail, transport, cleaning, leasing and "business services". In this last category we find knowledge intensive activities like accounting and consultancy. One (contested) explanation for growing employment and output of producer services in the past century is that many firms started outsourcing activities (OECD, 2013b). The high rate of developments within technology (notably ICT) and market demand led to the emergence of a knowledge society characterized by Smithian processes of differentiation and specialization. As a result, firms need to have more and more knowledge not just about their core products, but also about overreaching activities like marketing, advertising, innovation (R&D), knowledge and material acquirement, regulatory frameworks, etcetera. Managing the access to and the actual use of all these forms of knowledge is a complex task. A reaction to this trend is that firms leave some of their activities to external specialists, causing value chains to become more fragmented. If it were solely service firms who externalize, we would only observe an internal shift within the tertiary sector. However, manufacturing industries also engage in this option to outsource or complement their internal activities (Parrinello, 2004; Abreu et al., 2010).

5 It is important to note here that services can be produced by private and public organizations, but also by the consumers themselves. Capturing self-service or other activities in the informal economy is intrinsically difficult, but their role within economic systems is absolutely significant (Gershuny, 1979).

Supply-side explanations: growth in service employment

Instead of looking at the demand-side, Clark (1940) found an explanation on the supply-side He noted that as economies progressed, activity was shifting away from agriculture and manufacturing. More and more people were observed to be active in a heterogeneous set of occupations called the tertiary sector. According to Clark, the shift was caused by the fact that labor productivity in the secondary and tertiary sector was higher than in the primary sector. Therefore, employing human capital in higher sectors was thought to be more attractive for employers (and through good wages also for employees).

The post-industrialist Fourastié (1949), on the other hand, echoed claims by Adam Smith, stating that productivity growth in the tertiary sector was actually lower than in the other sectors. In fact, Fourastié went as far as defining the sectors by their growth rate. Instead of classifying services by the common characteristics they share, or simply as non-agricultural and non-industrial, he clustered those activities having a slow productivity growth. Fourastié stated that thanks to technological progress, a constant need for products from the primary and secondary sectors can be met by a smaller labor force. For this reason, the post-industrialists have a more positive attitude towards deindustrialization (Delaunay and Gadrey, 1992; Ciarli et al., 2012).

The fact that fewer employees are needed for goods production explains the labor shift towards the tertiary sector. As noted, not all economists regard this as positive. An influential theory on the implications of service dominance for the economy was proposed in the 1960s by neo-industrialist and Nobel-prize winner Baumol and his colleagues (Baumol, 1967). Agriculture and manufacturing industries were said to have a continuously increasing productivity thanks to improvements in technology. However, given the importance of human factors in service delivery, productivity in the tertiary sector can be expected to stagnate. Adoption of technology might contribute to a small amount of growth, but ultimately the performance level of humans has a ceiling. Costs within services can hardly be expected to decrease since the non-decreasing amount of human effort has to be paid. In fact, increasing wages result in higher costs, meaning that productivity (with respect to used financial capital) would drop over time. The structural problems of this seemingly ever-increasing productivity gap came to be known as the "cost-disease" of services (Baumol and Bowen, 1966). Since personal interaction is arguably so important for service delivery, the possibility for enjoying economies of scale was believed to be very modest.

Other reasons why services are said to have limited possibilities for productivity growth are given by Illeris (1996). When service activities are aimed at specific customers with unique characteristics, scaling up the service is difficult. Combining personalization and standardization is said to be intrinsically problematic. The important role of the service user also implies that productivity is dependent on the skills of the customer, and not just the provider. If we look at the co-production element, we also see that the need for personal interaction is hampering productivity growth. The fact that producer and consumer often have to be simultaneously at the same location, means that producers are facing planning problems of maximally using capacity. Sometimes they also have to travel to customers, what is time-consuming as well. Moreover, when proximity is required, it can also result in "local markets" that are less subject to pressure from competition (e.g. hairdressers). Reduced competition is also a consequence of the fact that services are hard to evaluate a priori, making people prefer services they are familiar with (due to high switching costs). Firms that experience low levels of competition have fewer incentives to increase their productivity. This argument is also applicable to public services (e.g. health care), although they might be exposed to other types of dynamics.

Supply-side explanations for rising employment in services are largely dependent on claims of lacking productivity growth. Even without switching to concurrent (economic) theories, there are reasons why the provided explanations fall short (Gallouj and Savona, 2009). The first one relates to the fact that service research suffers from problems around the measurement of productivity. Whereas in technology it can be easy to measure inputs and outputs, the characteristics of services make it extremely complex. There are several factors that make it difficult to cover everything that enters and leaves the process of service production. These factors include *subjectivity* (how good is the output of a particular teacher? Do we just count hours, or do we try to evaluate and incorporate quality?), *temporality* (when do we measure the value of a delivered service? Can we immediately evaluate the advice of a consultant, or do we have to reflect on it a year after the implementation?) and *co-production* (how can we measure the output of a consultant if his performance depends highly on the contribution of the consumer?). Furthermore, the distinction between direct output of a service delivery and the final (long-term) outcome can result in entirely different calculations of productivity. The productivity of a doctor can be measured by the number of patients he or she treats in a week, but also by counting the ones that are actually cured (and how well they were cured). Maximizing one of these productivity-measures can reduce the other one.

A second critique is that in reality there seem to be possibilities for increasing productivity, as can be concluded from productivity-statistics published after Baumol coined his cost disease. The productivity problem is only structural when one assumes that services always demand intensive personal interaction. However, the adoption and development of technologies like ICTs proved that the nature of many type of services can be changed (e.g. Cainelli et al., 2004; Savona and Steinmueller, 2013). Instead of looking at retailing formulas that involve more or less employees, one can also sell products online, and thereby exclude different types of service workers from the process. Possibilities to substitute people for technology allow service firms to enjoy economies of scale, just like manufacturing firms do.

All in all, the neoclassical paradigm is based on the assumption that the type and levels of economic activity found in a certain place (and time) are determined by equilibria-based laws. These laws assert that the profit-seeking behavior of economic agents results in price-balanced adaptations in market supply and demand. Service industries are generally thought to have increased in size because the growth of labor productivity in services is relatively slow, while the final as well as intermediate demand for services is growing faster than the demand for goods. The growth in business demand for services is to a large extent related to the increasing fragmentation of value chains, spurred by developments like the diffusion of ICT technologies.

1.2.2 Evolutionary economics as an alternative perspective

There is no doubt that neo-classical economics really help us to understand the place of services in modern economies: their macro- and meso-economic perspectives explain how economic mechanisms reward and thereby boost the growth of certain economic activities. Another question is how these new activities emerged in the first place: what are the processes underlying how firms acquire the skills and ideas to develop a service that indeed enables them to attract interest? And if shifts in economic activity are a function of productivity, shouldn't we try to better understand how the current state of technology is evolving, rather than only analyze its effects? In the explanations provided by a neoclassical view, with its focus on prices and markets, innovation plays only a minor role. Technological change is regarded as an important determinant of productivity growth, but where this change comes from is hardly addressed: it merely enters the picture as an exogenous factor that some sectors are just more sensitive to than others.

The evolutionary stream of economics, originating from the works of authors like Veblen (1898) and Schumpeter (1934), and outlined in the seminal works of Nelson and Winter (1982) and Dosi et al. (1988), proclaims a different angle.[6] Understanding how firms and industries renew themselves forms the core of its theoretical scope. Rather than treating technological change as an autonomous development actors are confronted with, it seeks to explain how such changes occur and how it affects socio-economic behavior. At the very heart of this stream lies the conviction that technological change is an endogenous rather than exogenous factor. That is, in order to be able to adapt to (or even enforce) changing market circumstances, economic agents themselves engage in entrepreneurial experimentation and the search for new value propositions. The discovery and exploitation of such propositions, for instance through R&D efforts,

6 Darwin's influence on evolutionary economics is reflected in for instance the use of notions like fitness and adaptability. Supporters of the 'Generalized Darwinism' movement believe that the Darwinistic principles of variation, selection and retention have explanatory power for a wide range of sociocultural phenomena (Schubert, 2014). It should be noted, however, that evolutionary economics consists of a body of theories that is substantially larger than just the three principles mentioned above.

might lead firms and industries to diversify in new directions, while possibly abandoning former activities. Since the novelty that firms come up with is often a modification of existing products or processes, we see technology developing along technological trajectories. Knowledge that is successfully applied in an organization's routines or in the goods and services it sells has a high probability of being transferred to other agents (be it through active sharing or imitation), whereas applications of unsuccessful knowledge might seriously struggle to survive market competition. Therefore, the discovery and exploitation of new propositions imply not just a shift in the activities deployed within an economy, but also a path-dependent process of industrial evolution.

Contrary to neoclassical economics, evolutionary approaches pay ample attention to the processes that lead firms to create variety. Importantly, the evolutionary perspective acknowledges that the quest for new market propositions is inherently uncertain, both with respect to complexity in the **product** itself (e.g. How does a modification to one element affect the functionality of another element?) as well as its commercial success (e.g. How will customers react to the innovation? To what extent is adoption influenced by the institutions and actors operating in the same system as a firm?). Moreover, **firms** are thought to be limited in their search for new possibilities. Rather than assuming that managers can collect, order, and process infinite amounts of information in order to optimize the outcomes a firm is pursuing, their cognitive capacities and rationality are believed to be bounded. Firms are also limited by the capabilities and knowledge stock they possess. The identification of a market opportunity does not automatically imply that a firm is able to deliver the required product. Instead, its resources and organizational configuration will have to be transformed. For employees, this means they might have to acquire new 'routines' like skills and knowledge. The claim that history (and location) matters is supported by the belief that such learning processes greatly depend on the knowledge agents already have, and on the knowledge available through interaction with parties active in the same networks or **systems**. As our brief description shows, evolutionary economists study economic change by developing theories concerned with various units of analysis (e.g. technologies, firms, and systems). Later, in section 1.3, we will elaborate on the questions these theories allow us to examine.

In sum, whereas mainstream economics leans towards predicting equilibria, the dynamic perspective of evolutionary economics is particularly interested in the dynamics that are actually preventing such equilibria to occur. Evolutionary economists study the evolution and transformation of industries, driven by the innovative behavior of private and public actors. Do firms really switch or diversify into services just because of considerations related to costs, prices and profits? Or, are their decisions also influenced by the capabilities they possess, the perceptions they have about unfulfilled market needs, the networks they engage in, etcetera. With its foundations in behavioral sciences, evolutionary economics focuses strongly on the drivers leading firms to experiment with new propositions. Its attention for complex mechanisms (underlying economic development and technological change) makes that the evolutionary stream is quickly gaining ground among scientists and policy makers alike (Fagerberg and Verspagen, 2009).

Scholars following the evolutionary approach have pointed out distinct reasons why services matter so much for the economic dynamics of modern societies. Research fitting this paradigm investigates, for example, how structural economic change itself (including the growth of service industries) gives rise to the growth of economic performance, employment or productivity that will in turn lead to further structural change (e.g. Lorentz and Savona, 2008; Castaldi, 2009). Instead of treating services as a lagging sector depending entirely on manufacturing industries, interest in autonomous forms of service innovation has grown over the past decades. The belief that service industries innovate, thereby yielding new services, provides an alternative explanation for why the service sector as a whole can keep expanding. Even if individual service industries do show little productivity growth, the continual emergence of new service varieties can attract the resources and profits that drive economic transformation known as tertiarization (Zagler, 2002).

Nowadays, some economists are convinced that it is actually the tertiary sector that provides the knowledge that is essential for the development and survival of manufacturing industries. This perspective usually tries to de-homogenize the tertiary sector by pointing out the roles of different individual service industries, or, at a more specific level, service activities. So-called knowledge intensive business services (KIBS) have been receiving considerable scholarly and policy attention, in the first place because they represent an industry with tremendous growth rates as well as innovation investments (Evangelista and Savona, 2003; Abreu et al., 2010). KIBS are also known for acting as a "secondary knowledge infrastructure" since they provide specialized knowledge parallel to the research output from universities (Miles, 1994). Some scholars claim that KIBS function as engines in complex socio-economic systems in which knowledge forms a key asset (e.g. Miles et al., 1995; Den Hertog, 2000). Even for many manufacturing firms, the most valuable resources are technological know-how and client information. Therefore, the secondary sector is often said to be highly dependent on service sub-sectors (industries) such as consultancy, accountancy, commercial research, and financial services (Muller and Zenker, 2001; Meliciani and Savona, 2014).

Considerations of firm-level behavior shed additional light on the question how we have arrived at a service-dominated economy: many firms could and can enhance their profits by becoming more service-oriented (Normann, 1983; Vandermerwe and Rada, 1988). Contrary to industrial activities focused on delivering commodities, services are essentially based on fulfilling customer needs. When a firm is able to adapt its output to individual user needs, and thereby deliver more added value, it often can also capture more profits.[7] Thus, an important point is that the emergence of services is partially found in manufacturing industries shifting towards service provision. Instead of selling products, they lease them and sell additional services like insurance and maintenance. Given the fact that knowledge is of key importance, the challenge is to develop a business model that enables the firm to create and capture value by commercializing this knowledge. Since competing on labor costs natural resources can be fierce, especially if low-wage countries are active in the market, competition in knowledge can be more attractive. Apart from providing solutions that fit better with actual market demand, such business models give a firm access to customer needs and knowledge, thereby allowing it to keep improving its products and sustaining its competiveness (Chesbrough, 2011). Storey and Easingwood (1999) summarized the strategic benefits of service provision as follows: it can enhance the profitability of existing services, it helps firms to attract new customers, it improves the loyalty of existing customers, and it can open entirely new markets.

1.2.3 Theoretical scope of this thesis

The two economic paradigms described above differ in their justification of investigation into service innovation. After all, there is a significant difference between perspectives regarding the tertiary sector as the bin for activities that are insensitive to technological improvements (Fourastié, 1949), versus views regarding services as highly competitive – and possibly innovative – forms of business activity (Norman, 1983; Chesbrough, 2011) as well as an indispensable part of innovation systems.

Reasoning from topics like search, capabilities, and knowledge accumulation, evolutionary theorizing provides fertile but far from fully exploited grounds for studying the nature and importance of service innovation. It is in the debate on services in an evolutionary perspective that this thesis aims to contribute. At a general level, our aim is to advance the understanding of how services emerge within firms and industries, and how this might affect economic change on a wider scale. Over the course of this chapter it will become clear which specific route is regarded as the most promising direction to realize these aims. Besides focusing on opportunities for improving our understanding of service innovation, this thesis also emphasizes that service innovation is relevant for anyone studying, governing or managing innovation. Accordingly, the ultimate objective of this thesis is to enrich the field of innovation studies as a whole.

7 Whereas the potential to add value used to be more or less equally spread across the economic activities involved in designing, manufacturing, and selling (or integrating) a product, nowadays activities in the first and final stage of the value chain are believed to provide more possibilities for adding value than the mere assembly of a product; this is commonly referred to by drawing Shih's 'smiling curve' (see OECD, 2013b, p. 216). As this leads firms to specialize in intangible pre- and post-production activities, we observe that the service proportion in economic statistics is increasing. Note that insights like these do not necessarily imply that goods are becoming less important; they merely point at shifts between economic activities related to the production cycle of those goods (Jansson, 2009).

The remaining content of this introductory chapter is as follows. First, we discuss why services traditionally have been overlooked by evolutionary economists (and innovation scholars in general).[8] Although there is a wide consensus that service innovation should be studied in more depth, there are different views on how this should be done. Section 1.2 contains an overview of various lines of thought in this respect. The innovation literature has dealt with services using three approaches: assimilation, demarcation, and synthesis. These approaches jointly mark the developments in service innovation thinking, with the final stage pertaining to theories in which service- and goods-based views on innovation are integrated. In order to advance innovation literature in that direction, we argue, it is essential to have a better understanding of how services-based innovation literature and goods-based innovation literature can enrich each other. We introduce a 'pre-synthesis' approach as the missing link between service-oriented studies and more comprehensive accounts of innovation. Section 1.3 describes in more detail how the research agenda of giving shape to this approach forms the objective of this thesis, and how the subsequent chapters contribute to the steps we wish to make.

1.3 THE CURRENT PLACE OF SERVICES IN INNOVATION LITERATURE

1.3.1 A story of omission

Innovation scholars view economic developments in relation to technological change. Theoretically, the notion of technology covers all types of knowledge required for producing economic output (Metcalfe, 1995). According to Schumpeter (1934), technological novelty can certainly manifest itself in other ways than only material artefacts. Specifically, he distinguishes between innovation in the form of the introduction of new goods, new forms of production (processes), discovery of a new source of raw materials or semi-elaborated products (input), opening of a new market, and creating new market structures (organization). As various authors have argued, especially the existence and continuing emergence of markets for services prove that services are encompassed by the concept of technological innovation (e.g. Windrum and Garciá-Goñi, 2008).

In practice, innovation studies have traditionally developed a strong focus on novelty in the form of goods. A possible explanation is that in the early days of innovation, many economies were still oriented towards manufacturing industries. Also, due to their tangible nature, developments in the sphere of goods are relatively better tractable than developments in services. Tangible objects lend themselves better to codification, for instance in the form of patents. By capturing details about the knowledge embodied in an invention, as well as references to similar existing physical artefacts

8 Together with scholars from fields like sociology, psychology, and business administration, evolutionary economists form the population of researchers engaged in innovation studies. This interdisciplinary discipline transcends the boundaries of its constituting domains (Fagerberg & Verspagen, 2009).

(symbolizing knowledge flows), patents are an immensely valuable source for studying innovation. Services, in turn, can at most be protected by trademarks (Flikkema et al., 2014). Another frequently consulted source of information on innovative behavior is questionnaires. The most important one on this subject is the Community Innovation Survey (CIS), which is bi-annually deployed in a large number of countries. The survey, being based on international standards for the definition and measurement of R&D (Frascati Manual) and innovation (Oslo Manual; OECD, 2005b), is also the starting point for many other studies on innovation. However, also this source has frequently been criticized for missing out on services (Miles, 2007). The use of indicators that are ill-fitted to measure service innovation is one of the reasons why services have long thought to be relatively less innovative than other industries (Abreu et al., 2010). Only recently have the manuals embraced the topic of services better, but the measurement of service innovation remains a difficult issue.

The fact that novelty in the form of services is so hard to study does not mean it is irrelevant for economists. As Baumol stated in a frequently cited quote, the interest in services appears to be inversely proportional to their evident economic importance (see foreword in Gallouj and Djellal, 2010). His claim still resonates in present-day studies on services. Although the status of an ill-researched topic improves slightly each time a new study is published, it is still true that services are relatively under-researched. Unfortunately, this is not because we already know all there is to know about service innovation. There is still a general consensus among innovation scholars that the nature of service innovation, and therefore the extent to which it can be governed and managed, remains ill-understood (Gallouj and Djellal, 2010).

The lack of insight on the nature of service innovation is probably the key reason for conflicting perceptions on its economic and strategic importance. Missing out on a topic of such enormous economic prominence is not only problematic for researchers trying to fathom economic and technological change. A poor understanding of what service innovation is, and why it matters, also hampers a wide range of professionals' activities. For instance, current policy debates concerning de-industrialization and re-industrialization are threatened by inconsistencies in the way manufacturing and services are related to each other (e.g. orthogonal, or as complements). Likewise, company managers might fail to see the opportunities offered by services when only thinking of classical services like maintenance, rather than smart ways to commercialize knowledge in the form of client-specific solutions. Moreover, those firms who do pursue service innovation often find themselves running into severe challenges (Sundbo, 1997; Visnjic and Van Looy, 2013). A consequence is that efforts to develop new services are often reported to be unsuccessful (Smith et al., 2007). All these factors explain the large number of calls for more insight into the emergence of novel services (e.g. Gallouj, 2002; Ganz, 2007; EPISIS; 2011; Den Hertog et al., 2010).

1.3.2 Ways to think of service innovation

Scientific inquiries into service innovation have traditionally been grouped into three main lines of thinking: assimilation, demarcation and synthesis (Gallouj, 1994; Coombs and Miles, 2000). Each approach takes a fundamentally different stand with respect to its relationship with existing literature on technological innovation. Together, these three conceptions are believed to represent the evolution that service innovation research has undergone (Gallouj and Savona, 2009; Carlborg et al., 2014). However, each new theoretical perspective supplements the discourse rather than entirely replace earlier ones.

The categorization of approaches lends itself to various purposes. In research, for instance, the respective conceptions form a lens through which we can determine what aspects of service innovation to investigate. The tendency to apply the categorization in different contexts has led to some variety in what scholars see as the key properties of each approach. Here, we concentrate on the most consistent and discriminative properties.

The *assimilation* approach is based on the assumption that 'most economic attributes of services are fundamentally similar to those of manufacturing sectors' (Miles, 2007, p. 262): all dissimilarities between the two domains can be thought of as matters of degree, rather than fundamental differences. Probably the most studied gradual difference concerns the allegedly low innovation intensity of services (Baumol, 1967). This finding emerges from the fact that most existing measurement instruments have proven ill-fitted to gauge service innovation activities (Miles, 2007). Apart from not being equipped to grasp novelty in the form of services, many statistical indicators are based on industry classification schemes like NACE. This limitation implies that early studies on the role of services in economic change (looking at trade, growth and productivity) were largely unable to cope with the ubiquitous nature of service activities. Even in current times, high impact studies of services are sometimes restricted to indicators based on service industries only. Examples of such studies, notably those performed by the OECD, are provided in appendix (A) attached to this chapter.

Partially because of the underestimated innovativeness of services, the assimilation approach can be traced back to Pavitt (Consoli, 2007). In his framework of sectoral patterns of innovation (Pavitt 1984), service industries became 'passive adopters'. Barras (1986) even went as far as arguing that service industries follow a reversed product life cycle (Abernathy and Utterback, 1978), in which service firms only renew their products after engaging in process innovation based on ICT adoption. Although the early years of service innovation research have seen attempts to adapt frameworks to the specific features of services (e.g. the taxonomy by Miozzo and Soete, 2001), most assimilation studies place services in existing frameworks and analyze them with the same concepts and methods used for analyzing manufacturing (Miles, 2005). As a result, this approach is generally found to be poor in its ability to shed light on what is special about services and service innovation.

The *demarcation* or *differentiation* approach resolves much of the critique concerning the assimilation approach. Rather than treating all forms of economic and especially innovative activity as similar, this approach focuses on identifying peculiarities of innovation in service firms or industries. Over the years, particular attention has been paid to implications following from the fact that services are intangible and co-produced (Parasuraman et al., 1985). With respect to innovation, this has increased the focus on topics like customer involvement in idea generation, service storage and transportation, provision and scaling up of immaterial offerings, service internationalization, measuring service innovation performance, service profitability or the deployment of service innovation personnel (Carlborg et al., 2014; Hipp & Grupp, 2005; Consoli, 2007).

Insights on the above-mentioned topics originate from studying innovation in industries like financial services, tourism, retail, web services, logistics or public services. As research progressed, scholars became increasingly aware that there is only limited value in studying 'the secondary sector' as a whole (Tether, 2003). This emphasis on heterogeneity within the domain of services redirected the literature towards a focus on specific service contexts. An example of such a narrow scope is found in a study on innovation in the retail industry, pointing at alternating cycles of specialization and de-specialization (Gallouj, 1994). This theory makes no claim to applicability beyond this specific context. Due to its focus on idiosyncrasies, the demarcation approach is sometimes accused of resulting in 'local theories' rather than contributing to a better understanding of innovation in general (Gallouj and Savona, 2009).

The *synthesis* approach, finally, is commonly regarded as the most promising research avenue (Coombs and Miles, 2000; Drejer, 2004). Rather than seeing service innovation as fundamentally equal or different from goods-oriented innovation, it integrates their characteristics into overarching theories and frameworks. An important reason for taking this perspective is that the boundaries between manufacturing and service activities are becoming hazy. There are numerous cases of manufacturing firms that shifted towards a service-oriented business model, a process known as servitization (Vandermerwe and Rada, 1988). Service innovation nowadays is not just conceived as an issue of pure service industries, but offers valuable opportunities for virtually all firms within an economy (Mina et al., 2014). Moreover, just as manufacturing is becoming more services-like, services increasingly resemble manufactured products (Miles, 2007). This convergence arises from trends like widespread use of ICT and adoption of organizational practices that allow firms to either standardize or customize the solutions and experiences they deliver. The necessity to keep up with rapidly changing user demand forces business to keep altering the value they deliver as well as the way they do this, thereby rendering a dualistic view on goods and services obsolete (Bryson and Taylor, 2010).

Viewing the domains of product and service-based innovation as strongly intermingled, the synthesis approach thus urges us not to see service innovation in isolation. Instead, services should be considered an inherent part of change processes in individual products as well as in the transformation of entire industries, value chains, clusters or other major elements of economic systems. The most extreme form of the synthesis approach goes even one step further. According to the foundational premises of service-dominant logic, all economic activity is essentially a matter of exchanging services (Vargo and Lusch, 2004). This perspective builds on earlier works in which goods and resources are only described by the services they render (Saviotti and Metcalfe, 1984). Somewhat less extreme are attempts to formulate frameworks where the characteristics of physical technology and services are still regarded as distinct, but also embedded in a unified framework. A key example here is the characteristics-based approach by Gallouj and Weinstein (1997), which has been applied extensively after its introduction (e.g. De Vries, 2006; Windrum and Garciá-Goñi, 2008; Savona and Steinmueller, 2013; Gallouj and Toivonen, 2011/2). Also the literature on transition studies offers frameworks in which technological and other forms of innovation are explicitly considered in relation to each other (e.g. Geels and Schot, 2007).

1.3.3 From three to four schools of thought

Although the aforementioned approaches arguably cover the diversity or even the evolution in service innovation thinking, it is perhaps remarkable that none of the individual viewpoints appears to adequately match the label of ‘service innovation’. To assimilationists, firstly, this notion seems meaningless because it does not acknowledge the value of comparing it to manufacturing. Conversely, the label is overly broad for a demarcation approach mainly looking at the peculiarities of certain individual service industries (e.g. retail or financial services) without stressing the relevance for other parts of the economy. For the synthesis approach, finally, service innovation is a hollow term as long as the phenomenon is simply regarded as an intrinsic and inextricable characteristic of innovation in general (Toivonen and Tuominen, 2009). This apparent contradiction within the classification of service innovation approaches, one could argue, eventually undermines the need for any research line, educational course, management strategy or policy explicitly devoted to service innovation: if none of the viewpoints acknowledges the existence of peculiarities at the service innovation level (covering heterogeneous service context and industries), why would anyone bother with it?

In our view, the current state-of-the-art literature lacks an appropriate label for contributions focusing on commonalities between instances of service innovation (i.e. service innovation *per se*) and the relationship between service innovation and other forms of innovation in general. The extensive body of literature with such a scope now falls exactly on the (arguably overly large) borderline between demarcation and complete synthesis. We will explain why these two should be distinguished more clearly.

An often-heard reason to emphasize the need for fully integrated perspectives is that, as manufacturing-services boundaries in products, value chains or industries start to blur, services are practically everywhere around us (Boden and Miles, 2000). However, simply observing that services are ubiquitous and nested – possibly informed by the efforts of demarcation studies – does not tell us anything about their specific role in wealth creation. The risk of adopting all-encompassing views only because services and goods are often found to be intermingled, is that the acclaimed peculiarities of service innovation dynamics are not adequately taken into account after all: ignorance of such peculiarities would then obscure the difference between a 'service-agnostic' assimilation approach on the one hand, and on the other hand a broad synthesis approach that neglects differences but also complementarities between goods and services in economic life (see Antonelli, 1998; Howells, 2004). This is not what real synthesis is about.

To achieve scientific progress, it is essential that theories and findings within a given scientific field are condensed in a solid body of knowledge. The literature on research synthesis has identified different approaches for structuring such knowledge accumulation, commonly separated into interpretive and integrative methods (Noblit and Hare, 1988). Integrative methods focus on summarizing empirical evidence, for instance by pooling (often quantitative) data and using meta-analysis techniques, whereas interpretative synthesis aims to generate new theoretical perspectives (Dixon-Woods et al., 2006). The widely shared aim to turn the assimilation and demarcation approach into one all-encompassing line of thinking, also covering other forms of innovation, matches this interpretive synthesis. Particularly relevant in this context is the method of meta-ethnography. By linking themes, perspectives, and ideas from different studies, meta-ethnography gives a holistic account of a certain phenomenon (Suri, 1999; Denyer and Tranfield, 2006). This method is sometimes criticized for resulting in subjective abstractions, possibly specific to the world of the 'translator' (Noblit and Hare, 1988). For service innovation scholars, though, it seems at least relatively clear what the contours of an ideal holistic account look like: an integrative innovation theory. The main question is how to get there.

Especially when diversity in content and methods is high, like in management and organization studies, aggregating distinct discourses is thought to be challenging (Denyer et al., 2008). The key to research synthesis, aimed at merging literatures previously developing in parallel, is to overcome the epistemological and ontological differences between such disconnected research streams (Denyer and Tranfield, 2006). Kuhn's notion of incommensurability refers directly to the problem that findings from distinct paradigms are difficult to synthesize (1962). This barrier is very much an issue for the domain of services. As the emergence and importance of novel services are studied by various disciplines, each adhering to its own concepts and methods, it is not straightforward how to incorporate distinct contributions into an integrated account of service innovation (let alone an integrated theory of innovation). Merely acknowledging that services matter is therefore not sufficient to make them part of our innovation thinking: instead of shifting the preference from manufacturing-oriented to service-oriented studies, both domains should evolve into one single domain that is richer than its individual components.

Despite hardly referring to general debates on research synthesis, service innovation scholars have often made claims in a similar vein. They have called for findings from innovation efforts in specific contexts to be carefully integrated in a broader perspective – one in which innovation dynamics from other contexts also have a place (Gallouj and Djellal, 2010; Bryson and Monnoyer, 2002). A perspective like this does not emphasize from which domains it has emerged, but ensures the peculiarities of these domains are captured in systemic views on value creation: "a proper integration should by no means overlook the specificity of services or the concern for the purely technological aspects of innovation in services" (Gallouj and Savona, 2009, p. 156).[9] For instance, the notion of product-service bundles and the increasing tendency to look at products *and* services when dealing with innovation, correspond to synthesis principles. Also when a non-specific concept like a business model is regarded as stretching over both the technological and service-side of an offering, it can fit into the synthesis approach. In an analogy with debates on emancipation, we could state that the mission of 'overcoming technology and manufacturing bias' in innovation studies will only be fully achieved once services are no longer treated as something special. However, as long as many researchers, managers and policy makers continue to be ignorant of what is peculiar about services, this last stage remains out of sight.

Over the past decade, it has increasingly been acknowledged that the real opportunities for innovation research (still) explicitly focusing on services, lie in using the insights they generate for understanding and informing also innovation efforts by non-service firms (Drejer, 2004). Provided some aspects of innovation are more pronounced in services, studying the latter might increase the overall scope of research on innovation dynamics. As Miles puts it in his discussion on developments in innovation thinking: "One value of a focus on services is that it can bring to the fore neglected features of economic activity that may be becoming more prevalent and widely distributed across the economy" (2007, p. 263). Although complete synthesis might for many be the final goal of service innovation studies, it takes profound and well-embedded insights on the

9 Note that this quote is symmetrical in that it argues for a perspective focusing not only on the role of services in economic and technological change, but also on how technology matters for service innovation. It is widely agreed that technology is indeed a key driver for innovation in service firms (see Cainelli et al., 2004). In fact, the assimilation approach is also called 'technologists' approach because of its large focus on innovation through adoption. As the demarcation approach is oriented towards autonomous innovation by service firms, the synthesis approach should cover both interactions.

dynamics of service activities to actually develop the desired integrated theories and frameworks. In fact, many who urge moving towards integrative theory actually plea for better insight on service innovation reality, rather than immediately jumping to all-encompassing perspectives (Rubalcaba et al., 2012). Thus, while debates on the life cycle of service innovation thinking tend to state that the integrative scope of the synthesis approach is preceded by industry-based studies of the demarcation approach (Carlborg et al., 2014), we find it useful to discriminate an intermediate stage.

The above-mentioned considerations imply a two-step procedure for research synthesis in the service innovation literature: first a synthesis of research streams focusing on innovation in and by services, followed by a synthesis of the resulting service innovation insights and the wider innovation literature. On this basis, we propose separating the existing synthesis approach into a 'pre-synthesis' and a 'post-synthesis' line. Since our interpretation of post-synthesis refers to the notion of full synthesis as discussed above - in which services are an integrated and therefore relatively un-emphasized issue - we will concentrate on pre-synthesis.

The pre-synthesis approach can be understood as the line of thought aiming to incorporate service-specific insights in a larger body of service innovation knowledge. It attempts to overcome the apparent heterogeneity between service industries by developing theories, frameworks or practices that are valid (and applicable) in a wide variety of contexts where service innovation is the common denominator. Apart from merely collecting insights from various *empirical* services contexts, we present pre-synthesis as the approach in which these insights are also *theoretically* unified. The production, improvement, and branding of services have traditionally been studied by diverse fields like marketing, business operation, organizational theory, and new product development, all with their own perspectives. In order to build on this vast body of valuable research, it is essential to interpret their contributions on the basis of a coherent and consistent theory (Denyer and Tranfield, 2006).

As argued already in section 1.1, evolutionary economic theory seems to be a very suitable candidate when aiming to understand and better position the emergence of novel services. While one could perhaps also imagine a synthesis of assimilation and demarcation studies from e.g. just the service marketing literature, most scholars referring to the synthesis approach place it exclusively in the evolutionary tradition (Gallouj and Weinstein, 1997; Windrum and Garcia-Goñi, 2008, Drejer, 2004).[10] Consoli, for instance, states that the synthesis approach 'paves the way for new understanding of innovation in services as the endogenous outcome of knowledge growth within

10 Since the seminal works by Gallouj (1994) and Coombs and Miles (2000), the assimilation, demarcation and synthesis (A-D-S) approaches have been forming the cornerstones of service innovation literature. Given the widespread adoption of this distinction, it is remarkable how little scholars have been reflecting on these three phases from a more general level; references to the broader literature on research synthesis are scarce. This fact that the A-D-S stages became inherently linked to innovation thinking implies that innovation theory automatically is the most obvious (or only) candidate for being selected as the theory for synthesizing research findings.

and across technologies, organizations, and institutions' (2007, p. 71). In order to move towards theories able to explain how services, goods, organizations and institutions co-evolve, Consoli argues that it is essential not just to focus on diversity in the services-versus-innovation relationships. Instead, scholars of economics and business studies are advised to adopt a synthesis perspective in which theoretical elements from neo-Schumpeterian-like innovation studies are 'blended' with empirical analyses drawn from detailed case studies (Consoli, 2007, p. 76).

An approach still concerned with the idiosyncrasies of services, be it with a cross-sectoral rather than sectoral orientation, does not fit yet with our notion of 'full synthesis'. The perspectives proposed by Consoli (2007), however, do correspond to the statement that achieving integrated theory starts with interpreting diverse forms of economic activity with the same theoretical frameworks (Denyer and Tranfield, 2006). This stage of theoretical conversion is what we refer to as pre-synthesis. When selecting a coherent and consistent theory for developing a service-inclusive account of innovation, it appears worthwhile to benefit from the richness of evolutionary economics (covering dynamics in technology development, firms' search processes, industry evolution and system interactions). The very combination of gathering service innovation insights and interpreting them from an evolutionary perspective allows us to examine how service (innovation) activities affect the dynamics of innovation in other firms or industries (see Daniels and Bryson, 2002; Castellacci, 2008; Cusumano et al., 2014).[11] Only once such dynamics are better understood, scholars can proceed towards innovation theory in which services are no longer treated as something extraordinary.[12]

In sum, the pre-synthesis approach features the following properties: it *conciliates empirical findings* retrieved from innovation efforts in a variety of service contexts and *interprets these findings through an evolutionary lens;* thereby allowing us to *draw implications for the wider innovation literature*. By taking service innovation activity as the unit of analysis, regardless of the type of organization (and especially industry) in which it is performed, pre-synthesis can be a link between demarcation and complete synthesis.[13] Also, we consider that this approach qualifies best as a genuine 'service innovation' perspective.

11 If the focus was only on collecting service innovation characteristics that differ from innovation in manufacturing (see the 'United Service Theory' by Sampson & Froehle, 2006), the label 'post-demarcation' would be more appropriate. 'Pre-synthesis' is the preferred option, as this approach aims to form the step towards fully integrated frameworks and concepts.

12 To clarify the distinction and therefore connection between the two forms of synthesis once more: the pre-synthesis approach is explicitly engaged with the relation between innovation-related service activities and other forms of innovation. It is the outcome of pre-synthesis research that enables one to take a service-informed post-synthesis perspective. In this last approach, the peculiarities of service innovation are taken into account without still emphasizing them. Post-synthesis is neither service-ignorant nor service-specific; it is service-aware.

13 Alternatively we could say that pre-synthesis integrates findings from an assimilation and demarcation viewpoint, after which these findings in turn feed into the wider innovation literature (resulting in the post-synthesis phase). Note that only the labels we introduce are new, not the content of the approaches. For instance, previous research has generated plenty of studies fitting the pre-synthesis approach, but probably grouped them into either demarcation or full synthesis. Our interpretation of the approaches not only suggests a distinction in the previously uniform synthesis approach, but also demands that demarcation is (re)defined according to the view which stresses its focus on differences.

Figure 1.1, below, illustrates how to position this additional approach (or actually separation) within the existing lines of thought. Following the pioneering work by Gallouj and Weinstein (1997), we use a simplified version of the characteristics-based approach to visualize the respective assumptions on how goods and service-based innovations interrelate.[14] For each approach, the perceived attributes of innovation in a domain are depicted as vectors of characteristics ($Y_{1, Y2, \ldots}$).

According to the assimilation approach, goods and service-based innovations essentially share the same characteristics: both types of innovation can be studied, governed and managed in a similar way. The two vectors in Figure 1.1 being equal reflects that when looking at service innovation, topics like R&D, productivity measurement, and innovation management are not fundamentally different from goods-based innovation. Of course there might be certain contrasts, but these are mostly seen as gradual differences with respect to qualitatively similar properties.

The demarcation approach mainly looks at the idiosyncrasies of particular services. In Figure 1.1 this is reflected by unique characteristics for different specific services contexts, such as (pure) service industries. Distinctive is the emphasis on heterogeneity. Characteristic properties of innovation in a certain service context are scarcely related to other manifestations of service innovation. Instead, the primary focus is on opposing those characteristics to properties of technological innovation as a whole (hence still depicted as a single vector). The fact that demarcation often emphasizes the unicity of services is shown by the 'goods versus service' arrows.

Before clarifying how pre-synthesis enters the picture, we first jump to the traditional interpretation of the (full) synthesis approach. This line of thinking, we prefer to refer to as post-synthesis, considers that innovation in goods and services are inherently interwoven. Such a view acknowledges that many products rely on a combination of hardware and services. Our visualization illustrates this by placing the characteristics of goods and service-based innovation in one single vector. The integrative perspective covers service innovation peculiarities, unlike the assimilation approach, but does not stress (anymore) why these peculiarities should receive special attention. Studies and also policies matching this approach tend to be entirely service-inclusive or service-friendly rather than service-specific (Den Hertog et al., 2008; Rubalcaba et al., 2010). With respect to innovation policy, Den Hertog et al. (2010, p. 349) characterize the synthesis approach by stating that resulting instruments have 'passed the services/manufacturing distinction' and 'should deal with the service dimension in any sector'. Post-synthesis, being the final step in an emancipation-like trajectory, thereby marks the stage where service innovation thinking has fully matured.

14 The simplification refers to our omission of any differences between technological and service characteristics. Figure 1.1 only presents the characteristics of innovation processes.

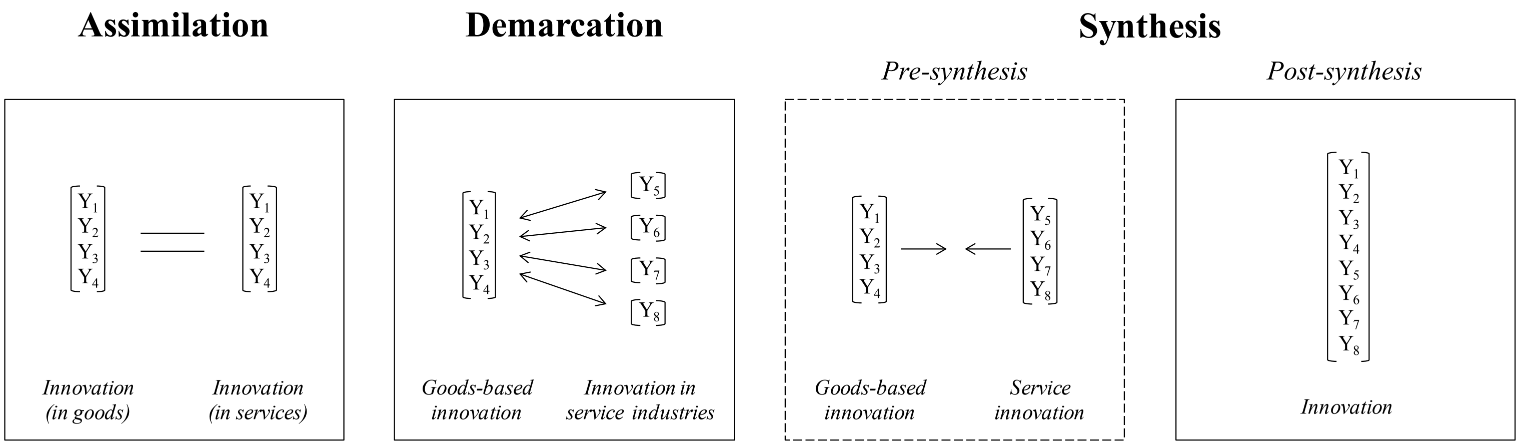


Figure 1.1: A renewed classification of views on the nature of goods-based and service-based innovation.

Finally, taking the middle way between demarcation and full synthesis, the pre-synthesis approach focuses explicitly on the *similarities across multiple service innovation activities* and *how they relate to other innovation dynamics*. Because of these properties, the pre-synthesis approach can lead scholars to contemplate the role of services (as products) or service providers (the firms who deliver service products) within socio-economic systems, for instance to shed light on the interdependencies and synergies between manufacturing and services (e.g. Consoli, 2005; Castellacci, 2008; Cusumano et al., 2014). Moreover, seeing service innovation features in relation to goods-based innovation also provides the much-needed basis for determining which characteristics of service innovation are relevant for integration in more wide-scoped innovation (Miles, 2007; Drejer, 2004).

The contrasts between the proposed points of view on service innovation may not always be clear-cut. What might at first sight seem particularly difficult to categorize, for instance, are studies on an aggregate of several (but not all) service industries. A popular research topic is knowledge intensive business services, abbreviated as KIBS (Miles, 1994). Covering firms in ICT industries as well as those engaged in professional, scientific and technical activities, KIBS represent neither a single industry nor a feature of service firms in general (Miles et al., 1995). The typology of service innovation approaches, however, does not so much pertain to the choice of the concept that is being reflected on, but rather to the way it is looked at. We exemplify this for the selected topic of KIBS.

When adhering to the assimilation approach, it is common to investigate a manufacturing-based topic like R&D intensity in KIBS (e.g. Leiponen, 2012). A demarcation approach, on the other hand, would be more inclined to investigate to what extent the notion of R&D is actually meaningful in a particular domain like KIBS (or even its various subindustries). An example here is the study by Miles (2007), who argues that KIBS can deploy innovative activities without attaching formal structures or budgets. Looking at the topic again from a pre-synthesis perspective, we could explore how insights in the innovation processes in KIBS can clarify or even guide the behavior of manufacturers. Shearmur and Doloreux (2013), for instance, have explored what KIBS contribute to innovation in manufacturing establishments. Or, from a make-or-buy perspective, we can ask which services a manufacturing firm can outsource to KIBS, and which services it should produce in-house. Scholars following a pre-synthesis approach could study whether the tendency of customizing service firms to interact intensively with users (like KIBS do) can somehow shed new light on concepts like open innovation. The results of such research could then feed into broader synthesis perspectives, in which it is reflected that KIBS have non-service equivalents whose innovation efforts display striking similarities.

To conclude, it should be noted that the transition from one approach to the next merely reflects an evolution in *thinking*. In other words: managers or policy makers might replace their assimilative perception of service innovation with a more synthesized one, without necessarily going through a phase of focusing on what is different about services.

1.4 RESEARCH QUESTION

1.4.1 Recapitulation of literature review

In section 1.2 and 1.3, we described major developments in the domains of economics and service innovation thinking (respectively). The developments within each of these domains do not mark entire shifts from one paradigm to another: they merely point at the emergence of relatively new lines of thoughts complementing existing ones. Whereas nowadays the synthesis approach is widely strived for (yet far from fully practiced), it should be noted that the evolutionary school of economics did by no means replace neoclassical economics. Although building on decennia of contributions, it can still be regarded as a fairly nascent alternative to mainstream economic thinking.

The developments depicted in Figure 1.2 do not occur in splendid isolation; many parallels can be found when regarding them in relation to each other. Perhaps the field of service innovation thinking might be largely driven by innovation scholars, but contributions now assigned to the assimilation or demarcation ways of approaching 'the relation between services and innovation' often rely on a rather neoclassical perspective. After all, the assimilation or technologist approach is characterized by its focus on adoption of new technologies, supposedly created by other industries (and thus exogenous from the perspective of service firms). Moreover, those neoclassical economists who do assign a substantive role to innovation - by incorporating it in endogenous growth models – generally seem to have the tendency to reduce innovation efforts to R&D investments. This narrowing is exactly what the assimilation approach to service innovation has been criticized for (e.g. Miles, 2007). Also the demarcation approach still relies to a certain extent on neoclassical thinking. The focus on service industries reminds us of the perspectives taken in neoclassical models, or at least it is markedly different from a focus on the innovations and experimenting firms themselves. Of course there are also plenty of assimilation and demarcation studies fitting the evolutionary perspective; take for instance the effort to turn Pavitt's taxonomy to services (Miozzo and Soete, 2001), or of all those studies focused on identifying how innovation processes look in service industries. Nevertheless, despite these nuances, we can safely state that the urge for an all-encompassing account of innovation is inherently linked to evolutionary thinking (see section 1.2.3). To our knowledge, this urge has never been echoed by a neoclassical economist.

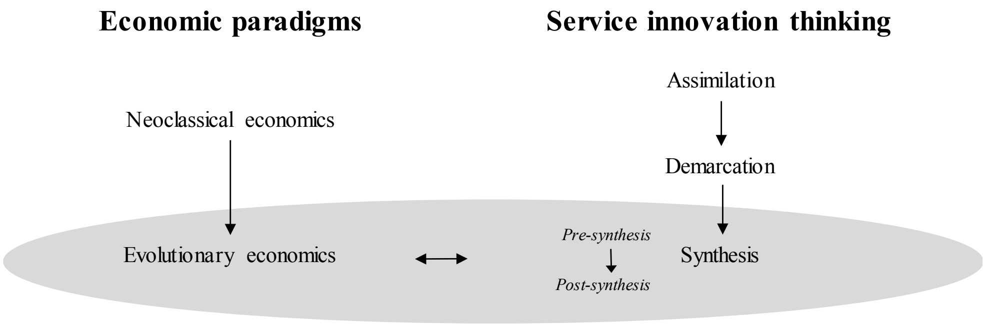


Figure 1.2: Developments in the fields of economics and service innovation thinking.

As noted in criticisms on neoclassical economics as well as on the assimilation approach, studying services from an innovation perspective requires us to go beyond views in which service providers are only considered as mere adopters of new technologies. Neither is it considered fruitful to keep focusing on what is different about innovation in particular service contexts (like demarcationists do): scholars rather welcome more insights in the general properties of service innovation activities, as such insights also allow us to explore synergies between innovative service activities and other forms of innovation. The synthesis approach is inherently embedded in evolutionary thinking, but it is during the pre-synthesis approach that this interpretation is established. The pre-synthesis approach, we believe, forms the key for better linking the evolutionary and service innovation traditions together (hence the two-headed arrow in Figure 1.2).

1.4.2 Research question and sub-questions

The objective of this thesis is to advance our understanding of the emergence and importance of novel services. Our claim that service innovation studies are in need of a pre-synthesis approach provides a structure for doing so. Uniting disparate findings on service innovation in a coherent body of knowledge can improve insights into how new services generally come about. We have argued that, now that demarcation studies have successfully highlighted the idiosyncrasies of services, the moment has come to explore how these findings fit in generally utilized innovation theories. Therefore, our research question is as follows[15]:

"How can evolutionary economics help to develop a synthesis approach on service innovation?"

15 In our view, synthesis consists of pre- and post-synthesis. As both of them rest on an evolutionary interpretation of service activities, there is no need to incorporate this distinction explicitly in the research question. The fact that we strive for a development towards an integrated account of innovation already implies that we are mostly concerned with pre-synthesis.

As noted in section 1.1.3, the field of evolutionary economics consists of theories concerned with different units of analysis. Evolutionary scholars have studied innovation at the level of products (often also referred to as the level of technologies), at the level of entrepreneurs (be it an individual or a firm), and at the level of systems of actors and institutions (for an example of a study touching upon all these levels, see Metcalfe, 1995). The different levels of analysis have relevance for various audiences and applications. Although the research objective formulated above might sound highly theory-driven, we note that there are several pressing practical questions waiting to be resolved.

Looking at the **nature** of service activities, the fact that services account for such a large and diverse share of economic activity first poses the question how we can accurately describe and analyze the various *forms* (new) services can take. Secondly, acknowledging that services are virtually everywhere makes us wonder where they come from: what do we know about the *processes* leading to the development and implementation of all these new solutions and experiences? We shed light on these issues by turning towards theories at the level of products and the search through design spaces.

The rise of services allegedly brings a host of business opportunities as well as challenges. Considering services from a **management** mindset therefore demands a comprehensive understanding of how firms can organize the delivery and renewal of service-based business propositions. This will be examined by drawing upon evolutionary firm-level theories, and in particular the dynamic capability view.

Finally, turning the strategic scope towards a **policy** perspective, we ask what opportunities there are for policy makers to support the development of – and benefit from – novel services. Given that policy makers intervene in configurations of private and public actors, we venture into this issue by building upon innovation theories at the system-level.

In section 1.3.3 we describe in detail on which specific evolutionary theories we rely to answer the following three sub-questions:

- Nature: *"How can we use evolutionary economics to conceptualize service design options and processes?"*

- Management: *"Which capabilities matter most when seeking successful service solutions?"*

- Policy: *"How can policy makers steer and exploit service innovation?"*

While many previous studies have examined 'service innovation in general', it is less common to combine such a broad scope with explicit efforts to embed services in evolutionary theory. Given that evolutionary theory offers theories and frameworks suitable for analyzing innovation, we take the opportunity to borrow a few (see next section). At the same time, considering widely varying service innovation efforts in the light of such theories is also a step towards finally achieving more integrated innovation science in which the economic importance of services is more adequately reflected. It is for this aim of advancing service innovation thinking by specifically drawing on – and making services part of – evolutionary innovation theories, that this thesis carries its ambiguous title.

1.4.3 Outline of content

The current section introduces the specific research questions, theories, methods, and empirics covered in this thesis. Jointly, the chapters summarized in Table 1.1 contribute to our overarching objective of spurring the development of a synthesis approach on service innovation. More information on the various data sources, mentioned in the last column of Table 1.1, is included in general appendix at the back of this thesis ('Data sources and Co-authorships)'.

The nature of service innovation: Design options and search processes (Part A)

The service innovation process has often been described with terms like unorganized, unstructured, inefficient, or imprecise (Menor et al., 2002; Sundbo and Gallouj, 2000; Froehle et al., 2000), presumably mostly depending on intuition, flair and luck (Langeard et al., 1986). The undeniable fact that innovative services keep appearing, and are even of great strategic importance, nurtures the need to examine whether new services really 'just happen' (Menor et al., 2002). It is likely that a poor account of service innovation processes is partially related to the fact that also services themselves (the products) are relatively fuzzy in nature (Alam, 2006; Den Hertog et al., 2010). To embark on our quest for a better understanding of the nature of service innovation, we first explore possible ways to conceptualize both the service product as well as the processes leading to its emergence.

One way to get a more comprehensive grip on what is being innovated, and how this is done, is to consider service innovation as a modification of the dimensions of services. Multidimensional representations of services have been around for a while. Traditionally, such frameworks merely serve descriptive purposes; they allow for characterizing where novelty occurs when a service is being innovated (cf. a service-specific equivalent of a business model canvas, Osterwalder and Pigneur, 2010). Why, which and how many dimensions are affected when innovating are questions rarely asked.

By drawing on evolutionary theory, we suggest that multidimensional frameworks can be used as a basis for conceptualizing the **design space** of services. Design spaces represent the collection of all possible (combinations of) design options for each dimension of a product. Importantly, the notion of design space acknowledges that some configurations are commercially more viable then others. This represents the

evolutionary fitness of a particular configuration. Rather than presuming the fitness of configurations is determined randomly, scholars have found that product dimensions are often **interdependent**: mutating one dimension can impact the fitness of one or multiple other dimensions, thereby altering the overall (i.e. average) product's fitness. Since each position in a design space has its own fitness, firms can be considered to face a **'fitness landscape'** (Levinthal, 1997). Exploring this landscape is a matter of mutating one or multiple dimensions at a time. Therefore, the act of entrepreneurial experimentation can be regarded as a **search process**. The dynamics caused by interdependencies in a design space can be understood with the help of so-called **NK-logic**. Inspired by biology and complexity (or complex systems) theory, NK-logic represents an analytical structure that allows us to formalize and model search processes (Kauffman, 1993).

Interpreting service innovation as a search process provides several research opportunities. In order to benefit from these opportunities, it is helpful to have a method for defining the design space service innovators are confronted with. In Chapter 2 we answer the question where novelty can take place when renewing services. Our literature review leads us to identify a multidimensional framework suitable for representing distinct service elements. Using survey data, we develop a measurement scale for each of these dimensions. On the basis of these dimensions we also propose a way for constructing a service innovation index.

In Chapter 3, we explore the proposed multidimensional perspective in more depth. This time, rather than following a quantitative approach, we use a multidimensional representation of services to map the novelty that characterizes eight particular services.[16] The case studies forming the input for this analysis originate from distinct firms, including TomTom, KLM, Achmea and the Port of Amsterdam, each of them belonging to a different industry. By mapping the novelty of these eight innovations, we obtain a basis for comparing the kind, number, and combination of affected dimensions. The use of qualitative case studies also allows us to observe *how* a certain service dimension has changed. In some dimensions you can find a greater variety of modifications than in others. As we will argue, using one framework to compare mutations in heterogeneous services provides a basis for assessing the originality of such mutations.

16 This order indeed is unconventional, as it is more common to engage in qualitative studies assessing face validity before actually operationalizing a measurement scale. Our motivation for the reverse order is that Chapter 2 only serves to select a multidimensional framework already proposed and applied in the service innovation literature. As its validity has been determined before, we can directly move towards the development of measurement scales and a service innovation index we will use in Chapter 5. Chapter 3 sets out to examine the high degree of correlation between the measured dimensions, and follows the advice to do so by using a qualitative research holding the "middle ground between individual case studies and large-sample research" (Porter and Sikkelkow, 2008, p. 52).

Table 1.1: Overview of thesis' content.

Part	*Chapter*	*Aim / Research question*	*Evolutionary foundations*	*Methods**	*Data*
	1. Towards an enhanced understanding of service innovation	Increasing our understanding of service innovation by advancing a pre-synthesis approach	-	-	-
A. The nature of service innovation: Design options and search processes	2. The challenge of characterizing service innovation	Where does novelty occur in service innovation?	Design spaces	CFA, SEM	Survey
	3. Service innovation as search in multidimensional design spaces: Conceptual opportunities and empirical examination	(How) can we think of service innovation as a recombinant search process?	NK-logic, evolutionary search	Qualitative mapping	Case studies: eight innovations from eight industries
B. Management of service innovation: A capability perspective	4. Dynamic capabilities for service innovation: Conceptualization and measurement	Which capabilities are useful for measuring firms' abilities to engage in service innovation?	Dynamic capability view, knowledge-based theory of the firm	EFA, CFA, SEM	Survey
	5. In the vanguard of openness: Which capabilities do open KIBS need?	Which capabilities are important for being innovative, and is this affected by openness?	Open innovation, Resource-based view, Innovation value chain	Hierarchical linear regressions	Survey, and one case study
	6. The sensing paradox in service innovation: Too much user-producer interaction?	To what extent does a sensing user needs capability positively or negatively affect innovation?	Open innovation, user-producer interaction, NK-logic	Agent-based modelling; Tobit-regressions (floodlight approach)	Survey
C. Policy options concerning services and innovation	7. Developing service-inclusive systemic policy: Four approaches	How can services be made part of systemic innovation policy?	Innovation systems (esp. functional perspective)	Comparative case study (mapping service-inclusiveness)	Case studies: policy mixes in two regions
	8. Cross-specialization: (using services for) Making unrelated strengths related	How can stronghold industries form a basis for sustaining economic performance, and what is the role of services?	Evolutionary economic geography: related variety, industrial evolution	Conceptual (Appendix K: network analysis)	(Appendix K: skill-relatedness, economic statistics)
	9. Conclusions: Where to go from here?	Outlook for future evolution of service innovation thinking	-	-	-

* Abbreviations: CFA = confirmatory factor analysis, EFA = exploratory factor analysis, SEM = structural equation modelling.

In order to explain why most innovations cover multiple dimensions, we highlight the notion of interdependencies. The fact that firms cannot be certain about the effect of a modification implies there are several **search strategies** they can follow. For instance, they can explore new options by making incremental changes in a sequential way (a strategy called 'hill-climbing' in the fitness landscape), by changing multiple dimensions simultaneously ('leaping'), or by pursuing modular change (Frenken, 2006). Using our qualitative evidence, we illustrate these strategies empirically.

Managing service innovation: A capability perspective (Part B)

The second part of this thesis is devoted to organizational aspects of service innovation: which capabilities are most useful for managing the processes of knowledge acquisition, transformation, and application that ultimately result in the introduction of new services?

Typically, investigation of an organization's ability to generate and recombine knowledge starts by looking at its R&D efforts (Nerkar and Paruchuri, 2005). One of the key problems in the services context is that the notion of R&D is only to a limited extent applicable to the development of new solutions and experiences (Miles, 2007). Compared to strictly 'technological' R&D, the search for new service solutions is hardly organized in a formalized manner, which can for example be concluded from the fact that R&D budgets are scarce amongst service industries (Miles, 2005). Rather, the development of services often occurs through implicit and possibly non-systematic ways (Thomke, 2003).

Apart from being modestly relevant for service innovation, R&D figures alone are also a very poor indication of how much an organization is engaged in staying adaptive and renewing its output. In fact, such figures hardly give any insight in a firm's strengths or weaknesses concerning the different types of activities required for generating and implementing new products. Hence, innovation and management scholars have embraced the idea of examining a firm's capabilities for processing knowledge and seizing opportunities (Teece et al., 1997). In response to critique that such dynamic capabilities are hard to measure, contributions to the **dynamic capability view** (DCV) have pointed at the importance of looking at the *micro-foundations* of *common sets of capabilities* (Teece, 2007). Contrary to studies aimed at identifying firm-specific capabilities, this modern approach enables inter-firm comparison of processes related to **knowledge sourcing, transformation and exploitation** (Barreto, 2010).

The DCV is heavily rooted in evolutionary theories of novelty creation. Not surprisingly, most capability studies focus on goods-based innovation (Hogan et al., 2011). This is regrettable, considering that looking at dynamic capabilities might also be a promising alternative for gauging an organization's ability to develop and implement new services (Den Hertog et al., 2010; Teirlinck and Spithoven, 2013; Leiponen, 2012).

Chapter 4 aims to operationalize a set of dynamic capabilities for service innovation that is general enough to be relevant across different industries, yet sufficiently specific to capture the salient evolutionary properties of individual firms' innovation efforts.

With the latter, we refer to firms' abilities to introduce new or improved services by engaging in knowledge processing activities.

Based on a literature review, we first show how the framework of dynamic service innovation capabilities (DSICs) devised by Den Hertog et al. (2010) has the aforementioned properties and how it relates to earlier attempts to capture dynamic capabilities in service contexts. Using two subsamples of a multi-industry survey, we then separately purify and validate an actual measurement scale. These consecutive steps involve exploratory factor analysis (EFA) on a randomly composed subsample of the data, followed by confirmatory factor analysis (CFA) on the other half. Also, we deploy structural equation modelling (SEM) techniques to assess to what extent the capabilities complement each other consistent with the sequential mechanism underlying the evolutionary processes of novelty creation (first knowledge acquisition, then knowledge transformation, and then knowledge dissemination).[17] Finally, we relate the capability strengths to output measures to get a basic impression of the relationship between relative firm and innovation performance. This exercise also draws upon the measurement scales and service innovation index developed in Chapter 2. The chapter's main contribution, a validated scale for five complementary DSICs, paves the way for comparative analyses relevant for further research, management, and policy development.

Chapter 5 examines which capabilities are relatively most important for creating new services, and to what extent this is affected by a firm's openness. The latter question is deemed relevant due to the coproduced nature of service provision, which implies a degree of customer interaction (and possibly knowledge flows) that is less common in firms who just produce material artefacts (Edvardsson et al., 2001; Mina et al., 2014). The inherently open production mode is especially found in KIBS (Miles, 1994; Den Hertog, 2000). It is therefore remarkable that KIBS, typically interacting intensively with a multitude of partners, have largely been ignored by studies on **open innovation**. Indeed, the promises of opening up might appeal most to firms managing their innovation processes in a closed way. Yet, to understand better how openness is relevant to innovation efforts, we consider it worthwhile to examine its importance in firms that are by nature highly open.

The core of Chapter 5 is examining how routine-based and innovation-oriented openness affects the respective importance of KIBS' innovation capabilities. We take the conceptualization from Chapter 4 again as representation of firms' abilities to perform the three phases of the **innovation value chain**. According to the **resource-based view**, innovation-pursuing firms have less need to develop these capabilities internally when there are ample opportunities to rely on the skills and knowledge of external partners (Love and Roper, 2001; Love et al., 2013). Our literature review

17 These stages are in fact highly analogous to the three phases of the innovation value chain. See also Chapter 5.

suggests that such opportunities pertain especially to the acts of knowledge acquisition and application, while the intermediate stage of knowledge transformation is regarded as something KIBS need to organize internally. We therefore hypothesize that the corresponding conceptualizing capability is of most relevance for the innovation efforts of highly open KIBS. This expectation is verified with 'floodlight' regression analyses based on survey data from 125 Dutch KIBS.

By contributing to the emerging research regarding open service innovation, we shed light on strategic considerations with respect to balancing capability development and external knowledge sourcing. In order to exemplify the notion of open innovation practices in services, Chapter 5 also contains a brief case-study of in- and outward knowledge flows in a Dutch KIBS firm (the Eye Care Network Rotterdam, renowned for its innovative services aimed at improving safety and hospitality).

The last chapter of Part B focuses on one particular innovation capability, namely the sensing user needs capability and its contested value. For firms trying to satisfy user needs through the provision of services rather than mere physical artefacts and commodities, the importance of sensing user needs might at first glance seem rather evident. However, contrary logic may also apply: precisely because these firms interact closely with their clients, the value of a sensing capability is relatively limited.[18] There are even theoretical reasons to believe that adhering too much to the needs of specific customers prevents firms from developing innovations with a wider applicability (Christensen and Bower, 1996). Such a caveat seems to apply particularly when firms customize their solutions rather than deliver them in a standardized way.

We build on the conceptual and theoretical explorations of Part A to shed light on the question why KIBS should actively source user knowledge if their users are already providing some extent of feedback by themselves. Using the previously introduced NK-logic, we construct formal models for the conjunction of firm and user behavior (being the four combinations we can retrieve from low/high user feedback and low/high sensing user needs capability). This formalization allows us to perform a simulation study in which agents apply one of the four search strategies to find optimal design configurations in a six-dimensional fitness landscape. After running the simulation several times, conform a Monte-Carlo experiment, we obtain a pattern telling us which strategy ranks best, and which one ranks worst. The simulation results therefore enable us to formulate a hypothesis regarding the interaction of user feedback intensity on the one hand, and the strength of a firm's sensing user needs capability on the other hand. In the remainder of Chapter 6, the hypothesis is tested by using regression analyses for estimating the direct and combined effects of these factors. To put the results in

18 This is exactly what the other chapters suggest: while the sensing user needs capability is normally correlated with innovation measures (Chapter 4), regression analyses reveal it is the only capability that does not discriminate KIBS' innovativeness (Chapter 5).

perspective, we test a group of customizing service providers against a sample of non-customizing service providers.

Policy options concerning services and innovation (Part C)

After studying service innovation at the firm level, the third part of this thesis takes a policy perspective. Due to the variety of meanings going under the label of service innovation, there are many ways policy makers can interpret – or misinterpret – the opportunities offered by (developing novel) service activities. The policy part first provides an analytical framework for classifying the service-inclusiveness of policy options, followed by an argumentation for how to make strategic use of service innovation policy according to (in particular) the pre-synthesis approach.

The evolutionary imperative of pursuing fitness and adaptability is equally applicable to individual organizations as it is to entire societies. Whether these societies are local, regional or national economies, they still have to find ways to generate and apply knowledge. The tasks for doing so are distributed over various actors, together making up an **innovation system** (Lundvall, 1988; Freeman, 1988; Borrás and Edquist, 2013). According to the **functional perspective** to (technological) innovation systems, an economy's ability to generate and process knowledge depends on its ability to perform a certain number of functions. Such a set of system functions, to be executed by both public and private parties, can for instance be: entrepreneurial activities, knowledge development, knowledge diffusion, guidance of the search, market formation, mobilization of resources, and creation of legitimacy (Hekkert et al., 2007).

Following a bottle-neck-principle, governments need to balance the variety of instruments within a **policy mix** by intervening whenever a system function is only weakly developed. Chapter 7 describes how to consider services when striving for a well-functioning innovation system. By adhering to the four approaches to service innovation (assimilation, demarcation, pre-synthesis and post-synthesis), we distinguish four ways to deal with an economies' manufacturing and service domains when addressing system functions.

The four approaches we propose provide a basis for analyzing to what extent manufacturing and service domains are covered by innovation policy, and to what extent this is done in a systemic way. We illustrate this with a comparative case study of the policy mixes of two regions with a similar (manufacturing-oriented) background: Upper Austria (Austria) and Limburg (the Netherlands). Mapping the similarities and contrasts in their policy mixes serves to identify which instruments from one region could complement the instruments of the other, and on what account mutual policy learning can take place.

While Chapter 7 follows a merely analytical and descriptive approach, Chapter 8 goes one step further. The conceptual chapter provides theoretical arguments, mainly drawing from evolutionary economic geography (Boschma and Frenken, 2011) for why governments should scrutinize pre-synthesis policy to guide industrial evolution and economic diversification.

The key question in Chapter 8 is how stronghold industries can form a basis for sustaining economic competiveness. Looking at past results, policy makers sometimes have the tendency to deploy 'vertical' policy measures aimed at supporting successful industries. Although such industries might be competitive in existing business conditions, future success is seldom guaranteed. In order to continue capitalizing on the competiveness of historically developed assets, even industries with a stronghold position might have to transform to some extent (Asheim et al., 2011). As noted, the mechanisms behind **economic transformation and industrial evolution** can be interpreted as **processes of knowledge recombination**: whether a competitive industry can develop further is largely determined by the availability of knowledge that could enrich the industry's current knowledge base. Since knowledge is most likely to spill over between similar industries, opportunities to exploit and expand idiosyncratic strongholds typically arise from industries with a high degree of **technological relatedness** (Frenken et al., 2007). This implies that policy makers should shift their support from the stronghold itself, which is already performing rather well, to adjacent domains that might either strengthen the stronghold or become strongholds themselves. Yet, even if policy support is aimed at **related variety**, one pitfall remains. Whereas such a strategy reduces the risk of selecting the wrong industries, recent studies show that true breakthroughs are most likely to stem from recombining notably unrelated types of knowledge (Castaldi et al., 2014). The probability that actors within an economy find original trajectories for sustaining their advantageous position increases when knowledge from disparate fields is combined. However, it is also widely acknowledged that knowledge exchange is difficult when parties are cognitively remote (Nooteboom, 2000).

We argue that policy makers should concentrate on the links between strongholds rather than on the strongholds (and related activities) themselves. Although firms from unrelated specializations are unlikely to collaborate, we stress that policy makers do have the means to facilitate 'cross-specialization'. Essentially, our argument is based on the idea that cognitive distance (and thus technological relatedness) is a malleable rather than a static condition. This is because certain technological and non-technological developments can bring the knowledge bases of disparate industries closer together. A 'convergence factor' of particular interest is the ubiquitous need for knowledge on service-based business models and service delivery. Building upon the findings from Chapter 2 to 7, we discuss how policy makers can use attention for services to govern the interface between unrelated strongholds, thereby enabling knowledge recombination that might eventually spawn promising niches. To make our recommendations more readily applicable, Chapter 8 contains an appendix in which we clarify how exactly to identify cross-over knowledge domains. We use data about intra-industry skill-relatedness (Neffke et al., 2011) and economic statistics about the Dutch Topsectors to illustrate several methods for determining which industries have a central position in the industry space. Insight in the composition of stronghold sectors, and in particular the relatedness with industries from other sectors, is of considerable importance when designing cross-specialization policy interventions (be it service-based or not).

APPENDIX A: STATISTICS ON THE ROLE OF SERVICES IN MODERN ECONOMIES

The rising economic importance of services is typically illustrated by indicators based on a hard distinction between the manufacturing and service sector. For instance, the OECD often relies on the manufacturing-versus-services dichotomy when describing trends in science, technology and innovation (as in its alternating STI Scoreboards and STI Outlooks). We will draw on these statistics to briefly describe the role of services in modern economies.

A primary indicator of the importance of an economic activity is its share in gross domestic product (GDP). As Figure A.1 shows, services account for the lion's share of GDP in most OECD countries (OECD, 2013a). Currently, the GDP contribution of services in the OECD area amounts on average to 70%, with 30%-50% stemming from business services. While BRIIC countries are still lagging behind on this account, also there service dominance is on its way. Generally, the GDP-share of services initially decreases when less advanced countries make their first steps towards economic development (McKinsey, 2012). As soon as they reach the middle-income status, typically corresponding to a manufacturing share in GDP of about 25% and 35%, the importance of services starts to take over again. This is also demonstrated in Figure A.2, based on World Bank data (2014). Despite the still significant gap between high-income and low-income countries, and despite minor stagnation in recent years, the rise in services thus appears to be a global trend. As Figure A.3 shows, such a conclusion can also be drawn when looking at household consumption of services.

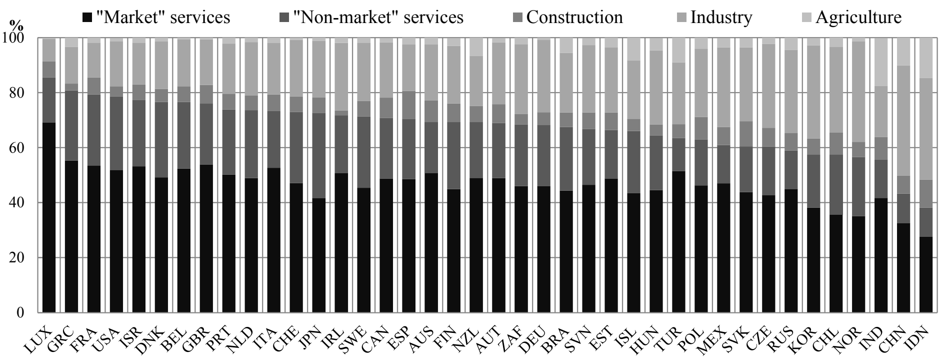


Figure A.1: Composition of GDP in OECD and BRIICS countries, 2011 (OECD, 2013a, p. 46).

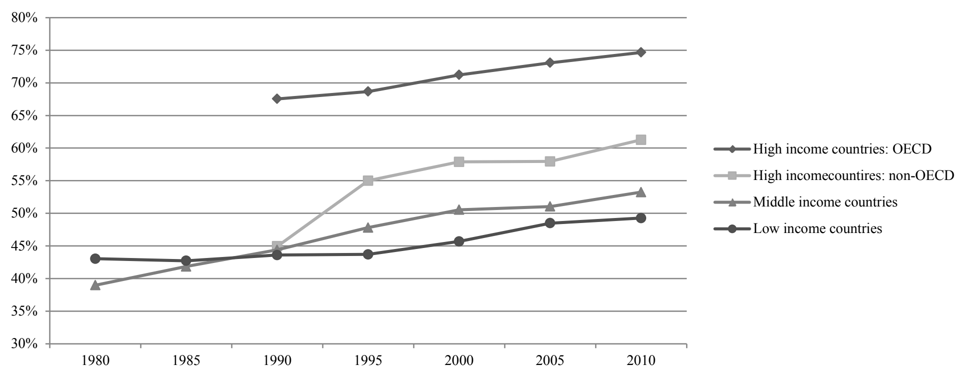


Figure A.2: Value added by service industries (as a % of GDP), by income-level (The World Bank / World DataBank, accessed October 27, 2014, own adaptation. See World DataBank for definition of income groups).

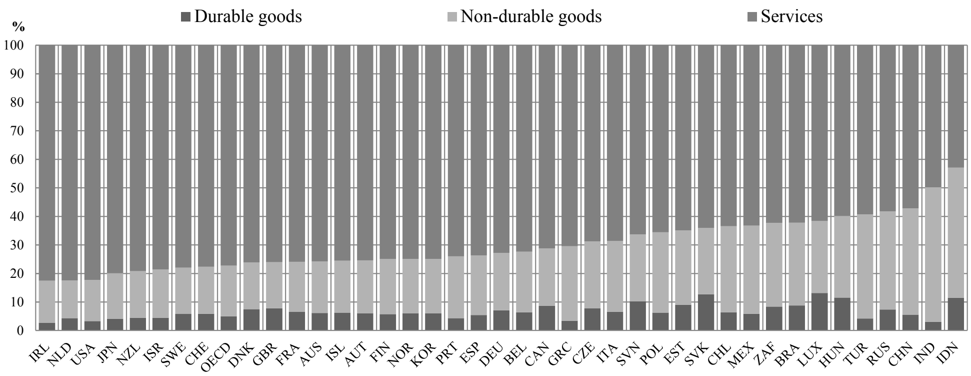


Figure A.3: Composition of household consumption, by type of product (as a % of total household consumption), 2009 (OECD 2013a, p. 257).

Developments in employment tend to follow a pattern which is roughly similar to the above-mentioned trends in GDP composition. The OECD's average share of employment in service activities grew to 74% by 2011 (OECD, 2013a). Like in Figure A.1, the service share can be disaggregated into a market and a non-market component. In the OECD area, public services make up 40% of service employment (OECD, 2013a). Figure A.4 shows per country how employment in 2011 was distributed over the three main knowledge-intensive classes underlying the category of market services (OECD, 2013a). Employees of these types are of major importance for innovation to emerge.

In general, the proportion of occupations earmarked as creators of knowledge-based capital (KBC) is found to vary more in manufacturing than in services (OECD 2013a, p.

88). While some countries' manufacturing industries contain a slightly higher percentage of KBC-contributors, the reverse is more often the case for OECD countries. Likewise, the percentage of employees categorized as human resources in science and technology (HRST) is commonly higher in business sector services than in manufacturing (OECD 2013a, p. 93). Adhering to the manufacturing-services dichotomy, the OECD also reports how the two domains differ in job creation and job destruction (OECD 2013a, p. 21).

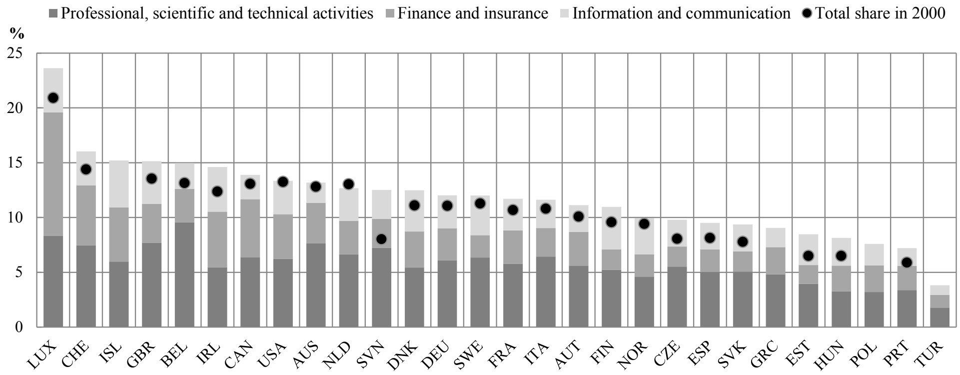


Figure A.4: Employment in knowledge-intensive market services (as a % of total employment), 2000 and 2011 (OECD, 2013a, p. 241).

When considering performance, labor productivity is another key indicator. Till the onset of the economic crisis, labor productivity in most OECD countries grew thanks to the manufacturing industries (despite shrinkage in terms of GDP and employment) and thanks to business-sector services (OECD 2013a, p. 36). Many countries also experienced a positive contribution from services like wholesale, retail, hotels, and transport. The scarce productivity growth observed since 2008 mainly stems from information and communication as well as finance and insurance services.

The observation that especially (knowledge-intensive) business services are important for economic dynamics is also reflected in export figures. According to the Innovation Union Scoreboard about 45% of total service exports stems from knowledge-intensive services (European Union, 2014). The reason this percentage is considered an indicator of the economic effects of innovative activities is that it marks the clear difference with exports based on service industries like leisure and travel. Using WTO statistics on Trade in Value Added, the OECD showed that all sorts of services together account for more than half of total gross exports in countries like Germany, the USA and the UK (OECD, 2013b). Indeed, these are largely the same countries in which knowledge-intensity of service exports is high.

Stylized facts based on a manufacturing-services distinction are also used when dealing with topics like R&D and innovation. A major source of data on these themes is the Community Innovation Survey (CIS), which national statistics agencies perform at least every other year. Results are collected and merged by Eurostat. Respondents are asked to indicate whether they introduced new products or services. Based on the CIS 2010, the OECD (2013a, p. 182) concludes that many innovative manufacturers introduced both kinds of novelty, and a small percentage even introduced service innovations only. Similarly, for most of the innovative firms classified in service industries, new services only form half of the innovations they introduced: the other half is composed of hybrid or pure goods-based products.

The proportion of product or process innovative firms investing in R&D varies highly across OECD countries: from about 80% in Finland to less than 20% in Brazil (OECD, 2013a, p. 183). A comparison between manufacturing and services reveals this percentage is slightly higher in manufacturing firms. Also, innovative manufacturers report receiving more frequent public support for their innovative activities. Again the percentages differ greatly per country, but the proportion of innovative service firms receiving innovation support lies at a half to two-thirds of their manufacturing equivalents.

Finally, the OECD notes that in the majority of member countries, services account for 30% or more of the R&D performed by businesses (OECD, 2013a, p. 220). For most countries where more than half of total BERD comes from services, especially R&D services play an important role in this.

In addition to sector-based data aggregations, statistics are increasingly being collected at the level of service jobs, service innovation, or added value through services (regardless the industry in which they occur). The ubiquitous nature of services is illustrated by services-manufacturing linkages with respect to, for instance, occupation types and trade figures.

Indicators by the OECD (2013a, p.242) show that the proportion of employees in manufacturing industries with a service occupation (management, business, finance, legislation) is increasing. In 2012, the OECD average was 41% of all employees working in manufacturing firms. For countries like France, the Netherlands and the UK, even more than half of all employees active in manufacturing industries had a services job.

The strong linkage between services and manufacturing (or the blurring of the boundaries) can also be observed in the type of economic activities delivering added value; between 30% and 35% of value added in the 2009 manufacturing exports of OECD countries was derived from services (2013a, p. 43). For most manufacturing industries this is about 5 percentage points more than in 1995. The variance within these industries can sometimes be high. The services value added in the export of electrical equipment, for instance, lies below 10% in Chile compared to almost 60% in the Netherlands. A substantial share of services content in manufactured exports increases the total amount of service exports significantly. In the case of many Western countries, this services content in turn originates to a large extent (20% up to more than half) from services imported from other countries (OECD, 2013a, p. 243). While logistic services like transport and telecommunications are typical export services, their share in the service content of manufactured exports is only slightly larger than the share of financial intermediation. The top two of embodied service exports consist of 'wholesale, retail trade, hotels and restaurants' and 'business services'.

To conclude, the earlier discussed CIS-data is also used to examine whether goods and service innovations come about in different ways. Such investigations take the novel good or services as the unit of analysis, instead of the sector performing those types of innovation. It turns out that those firms engaging in service innovation rely more often on (one or more) external knowledge sources than firms introducing goods-based innovations; the difference is 35% versus 30% respectively (OECD 2013a, p. 124).

PART A:

The nature of service innovation - Design options and search processes

Chapter 2

The challenge of characterizing service innovation

2.1 INTRODUCTION

Due to their immaterial and 'fuzzy' nature, (new) service offerings are hard to characterize precisely (Gallouj and Weinstein, 1997; Gallouj and Savona, 2009). Compared to physical goods, intangible products tend to rely on a high share of tacit rather than codified knowledge. As a result, describing in detail how a technical artefact should behave is commonly thought to be easier than defining accurately how a front-office employee should act (Djellal and Gallouj, 2008). Listing specifications, for instance, is far more common in the domain of goods than in the domain of services: the more a product is intangible, up to a 'pure service', the more one experiences difficulties in giving a comprehensive description of what the product exactly entails (Shostack, 1977). However, identifying what exactly makes a new or improved service innovative is an important prerequisite for studying service innovation. In absence of a comprehensive overview of the possible ways services can be renewed, scholars will be limited in their ability to engage in in-depth studies of the phenomenon (Toivonen and Tuominen, 2009).

Currently, there is a general consensus that the novelty of new offerings cannot be described sufficiently using narrow classification schemes, indicating to what extent newness concerns product versus process innovation (Djellal and Gallouj, 2001a; Hauknes, 1998), or service- versus goods-based innovation (Drejer, 2004) or a combination of both elements added with strategic aspects of service innovation (Voss and Zomerdijk, 2007; Agarwal and Selen, 2011). Given the frequently expressed criticism that these types of characterizations are too limited for capturing adequately the distinctive features that make services innovative, the last five years have been coined as the "multidimensional phase" of service innovation research (Carlborg et al., 2014).

Adhering to a more differentiated representation of what services are allows for deeper insights in where and how novelty can be introduced when engaging in the design of new services (Den Hertog, 2000). Moreover, the use of conceptualizations relying on abstract dimensions opens the way to comparative analyses. Due to the apparent heterogeneity of services, opportunities for interorganizational and cross-sectoral learning remain largely unexploited (Consoli, 2007). So far, only few authors attempted to develop multidimensional conceptualizations fitting these purposes (Agarwal and Selen, 2011; Salunke et al., 2011; Droege et al., 2009; Bryson et al., 2012).

In this chapter, we describe how scholars approached the challenge of characterizing typical properties of specific service innovations. Our literature review shows the multidimensional conceptualization by Den Hertog et al. (2010) to be particularly useful for grasping the elements in which renewal can take place; the six well-defined dimensions it consists of allow for comparisons across various instances of service innovation. Using survey data, we develop a measurement scale for each of the dimensions. On the basis of these scales we also construct a service innovation index.

2.2 WHERE IN SERVICES DOES NOVELTY OCCUR?

Innovation, according to commonly accepted definitions, is the successful diffusion of new or improved processes or products: be it in the domain of goods, services, or a combination thereof. It is evident that services differ in many respects from purely material goods (Miles, 1993). An essential property of services is that they concern the delivery of an actual experience or solution, rather than an intermediate artefact with which users themselves can produce the fulfilment of their needs (Den Hertog et al., 2010). Since many types of services are delivered by personnel like front office employees, the involvement of professionals is one of the aspects driving service production. The importance of the individual also holds for the customer side, as services tend to be coproduced by their consumers. Service particularities, notably inseparability (production and consumption occur simultaneously), heterogeneity, perishability, and intangibility, make it difficult to signal changes in the final output or even the delivery (Parasuraman et al., 1985; Sampson and Froehle, 2006). How can we determine if innovation took place, if it involves more than just clearly perceivable transformations in physical objects?

Due to the fuzzy nature of services, defining service innovation has proven to be quite a challenge (Gallouj and Savona, 2009). Commonly, a service innovation is considered to be a new or significantly improved service concept that is effectively taken into practice. Aiming to give a comprehensive account of the forms a service offering can take, a wide range of service typologies has been proposed over the past decennia (Cook et al., 1999). These typologies, however, tend to focus entirely on the proposition that is finally offered. Just like in the case of physical goods, it is possible that the functional properties of a product (i.e. the service experiences it renders) remain equal while aspects of the delivery or cost-structure are largely improved. A traditional way to identify the specific elements of novelty in an innovative service, therefore, draws on adaptation of the notions of product and process innovation. This well-known distinction forms the basis for Barras' (1986) Reverse Product Cycle theory, stating that in services, product innovation often follows process innovation. Some scholars have tried to examine the relationship between the two empirically (Boone, 2000; Nijssen et al., 2006). Others, however, question the validity of this basis for characterizing where novelty occurs (Hauknes, 1998; Djellal and Gallouj, 2001a; Van der Aa and Elfring, 2002; Tether, 2005), arguing that the act of service delivery is both a product and process at the same time. Moreover, even if one could state accurately whether novelty concerns the service offering or its delivery process, it would still say little about what is really new.

A related and a very contemporary debate relying on a unidimensional conceptualization of innovation concerns the relation between services and goods, both of them forming the extremes of a continuum between tangible and intangible products (Shostack, 1977). Decades of research on service innovation have been devoted to how renewal in particularly 'pure' services differs from innovation in the domain of technology and goods. However, in their initial attempt to apply Lancasterian thinking to services, Gallouj and Weinstein (1997) already emphasized that material artefacts and services are often hard to distinguish from each other. Indeed, it is increasingly acknowledged that many new products contain features of both goods and services (Drejer, 2004), as evidence by the fact that value added of manufactured goods increasingly relies on service activity (OECD, 2012). This trend is driven, inter alia, by manufacturers realizing they can better compete on selling their knowledge through consultancy, rather than on the price of labour or natural resources (Chesbrough, 2011). Another influential development is the ever-continuing rise of ICTs, which enables many new forms of service delivery (Cainelli et al., 2004). Inspired by these observations, scholars and policy makers have started to devote attention to all-encompassing topics ranging from 'product service systems' (Rapaccini et al., 2013; Baines et al., 2007), 'service value networks' (Agarwal and Selen, 2009), 'integrated solutions' (Davies, 2004) and 'service systems' (Ng and Andreu, 2012) to 'large-scale demonstrator projects' (Expert Panel on Service Innovation in the EU, 2011). These terms relate to theories, debates or policies in which both services and technologies are regarded as elements of integrated offerings.

Especially over the past few years, scholars have increasingly acknowledged the multidimensional and varied nature of service innovation (Agarwal and Selen, 2011). In the currently emerging holistic perspective on innovation, known as the 'synthesis' approach, narrow distinctions as discussed above are no longer valid (Rubalcaba et al., 2012). Instead, scholars of service innovation search for conceptualizations that embrace not only the 'pure' service aspects of an innovation, such as the final offering (the solution or experience) or how it is delivered, but also give room to the technology it involves (Gallouj and Savona, 2009; Windrum and Garcia-Goñi, 2008). By stressing the relevance of previously neglected topics (besides the concept itself), a 'multidimensional phase' of service innovation research has emerged (Carlborg et al., 2014).

Despite a growing consensus with respect to the limitations of traditional definitions, service innovation remains a poorly conceptualized phenomenon (Salunke et al., 2011). Current academic studies, innovation surveys (such as the European Community Innovation Survey) and policy reports keep focusing on different types of innovation rather than investigating in detail the various elements constituting a single innovation (Gallouj and Djellal, 2010). Albeit increasingly differentiated (e.g. Trigo, 2013; Amara et al., 2009), most measurements concern an extension of traditional measures rather than a reconceptualization of service innovation itself. A plausible explanation lies in the observation that only few authors attempted to capture the entire 'dimensionality of service innovation' in a single framework (Salunke et al., 2011, p. 1253). Indeed, the fact that service innovation is multidimensional has been stressed extensively, but *how* these dimensions could look like remains largely unaddressed (Carlborg et al., 2014; Droege et al., 2009; Bryson et al., 2012). Uncovering the exact modifications determining the novelty of a service thus requires the availability of differentiated conceptualizations for precisely describing which elements of a service offering are new in comparison to existing services (Toivonen and Tuominen, 2009).

2.3 A MULTIDIMENSIONAL APPROACH TO SERVICES

A first class of frameworks allowing for detailed descriptions of where novelty occurs, concerns the set of tools commonly used in service management. For instance, a framework for characterizing distinct service aspects could be recognized in studies concerning the design of the service encounter (Tansik and Smith, 2000), or tools such as the service innovation triangle (Cuthbertson and Furseth, 2012). Similarly, for characterizing the novelty of an innovative service, one could use practices like 'service mapping' and 'service blueprinting' (Bitner et al., 2008), both originating in service operations management. Since these perspectives aim to provide a basis for detailing and balancing the organizational processes associated with the delivery of a (new) service, they are also useful for indicating in which respect a new service differs from existing offerings. Other lines of literature, devoted to innovation in general, proposed frameworks for characterizing products as well (possibly in the domain of services). For instance, the nine dimensions of business models, developed by Osterwalder and Pigneur (2010), have inspired many scholars and managers dealing with the holistic redesign of their (service) offer. These dimensions can be regarded as an alternative for representing the generally recognizable dimensions of a product (good or service). However, a limitation of these frameworks is that they are commonly associated with highly context-specific applications, which limits their usefulness for comparing innovation in different types of services.[19]

Addressing this weakness, a second way to locate novelty in services draws on differentiated frameworks of a more conceptual nature. Attempts to capture the dimensionality of services with conceptualizations containing common elements (of services in general) allow for a rare type of comparative analysis. Characteristic for services, indeed, is that their intangible and heterogeneous nature makes it hard to learn from similarities (Den Hertog, 2010). Compared to the domain of goods and technologies, service-based products possess relatively few characteristics that facilitate

19 For instance, there is not much to learn from comparing the service blueprints from a restaurant visit with the service blueprint of consulting a financial advisor. Only within these specific contexts, detailed mappings can point out differences and similarities that might lead to improvements.

the observation and exploitation of commonalities. Take, for example, material artefacts containing common elements such as an energy source, transmission system or electric circuit. Knowledge about these aspects can be used in the contexts of widely differing products. A certain level of comparability, enabled by abstraction from specific domains, allows for learning to occur. In services, possible common elements are less clearly pronounced (Nelson, 2003). This is reflected, for instance, in the fact that goods tend to be associated with standardization, contrary to the variability of intangible products (Anderson et al., 1997). By describing a wide range of services on the basis of the same set of dimensions, the limited possibilities for observing similarities (and benefitting from associated learning opportunities) can be overcome (Gallouj and Djellal, 2010). As such, a multidimensional conceptualization of services could deliver substantial contributions to the increasingly dominant synthesis approach, which tries to analyse innovation in highly different industries with the same tools and frameworks (Rubalcaba et al., 2012; Carlborg et al., 2014).[20]

With their adaptation of the Lancasterian approach (Saviotti and Metcalfe, 1984), Gallouj and Weinstein (1997) were one of the first to characterize in an abstract way different common elements of a (service) product. In their pioneering contribution, the authors describe any type of product as a system of provider competencies, client competencies, outcome characteristics, and provider technology. Vectors of these four types of characteristics accordingly provide a basis for describing what aspect of a new product is innovative. In later adoptions of this representation, which is particularly used in service innovation literature, the original dimensions have been modified or supplemented (Djellal and Gallouj, 2001a, 2008; De Vries, 2006; Gallouj and Toivonen, 2011/2). Windrum and Garcia-Goñi (2008) demonstrate how the model by Gallouj and Weinstein provides a suitable basis for developing a neo-Schumpeterian account of innovation, in which all forms through which innovation can manifest itself are represented.

Although often not referring explicitly to (vectors of) characteristics, also other approaches for conceptualizing properties of services, and changes therein, have been proposed. In line with the urge by Salunke et al. (2011), many of these alternatives rely on a discrete number of dimensions as well. An excellent overview is provided by Droege et al. (2009, p. 138), who list the service innovation dimensions mentioned in more than ten innovation classification frameworks. Amongst them, we find Sundbo (2003), discriminating product innovation, process innovation, market innovation, organizational innovation, later supplemented with technological innovation and widened service (Sundbo et al., 2007).[21] A differentiating perspective is also clearly

20 As noted in chapter 1, this dominant synthesis approach matches what we reclassified as post-synthesis.

21 One could argue that these aspects pertain to types of innovation rather than dimensions of one single service innovation.

present in the work by Edvardsson and Olsson (1996), who conceptualize service innovation as comprising a service concept, service process, and service system.

The framework overview by Droege et al. (2009) shows how existing attempts differ in their scope (in terms of industry) and level of detail regarding the dimensions they differentiate. Especially noteworthy is the conceptual framework by Den Hertog (2000) and Den Hertog et al. (2010), which is commonly recognized as one of the few attempts to capture distinctive features of services in a single conceptualization valid for service innovation in general, irrespective of the sectoral context (Salunke et al., 2011; Rubalcaba et al., 2012). These properties make it not only useful for pinpointing where novelty takes place, but also for making comparisons across different instances of service innovation.

Being explicitly devoted to disentangling the multidimensional nature of service innovation, the original 4-dimensional conceptualization by Den Hertog (2000) regards service novelty as a change in the service concept, service delivery practices, client interfaces, and/or service delivery technologies. By discriminating these various elements where renewal can take place, the model provides a fruitful basis for a multidimensional conceptualization of services. The operationalization of the multidimensional Elevated Service Offering construct (Agarwal and Selen, 2011), for instance, is largely based on the four dimensions by Den Hertog (2000). In this operationalization, the dimension of technological options was amended to reflect the wider management and organisational aspects of strategic and operational innovation in services (Agarwal and Selen, 2011). Building on new insights, partially originating from applications by other scholars, the original model was recently broadened with the dimensions 'new value system/business partners' and 'new revenue model' (Den Hertog et al., 2010). By relying on this ensemble of dimensions, a service innovation can be defined as "a new service experience of service solution that consists of a new (or considerably changed) service concept, new customer interaction, new value system, new revenue model, or new organizational or technological service delivery system". Although the extended framework and associated definition is starting to spread throughout particularly service innovation literature (D'Alvano and Hidalgo, 2011; Salunke et al., 2011), more empirical illustration is still required (Droege et al., 2009; Den Hertog et al., 2010). In order to enable large scale investigation of changes in each of the service dimensions, we will now develop a set of measurement scales.

2.4 MEASURING SERVICE INNOVATION

2.4.1 Scale development for individual dimensions

The quantitative study described here is based on data collected through a survey conducted amongst Dutch firms (see general Appendix 'Data sources and co-authorships'). Our sampling profile only contains managers of firms having more than 10 employees. Although distributed amongst a multi-industry sample, warranting sufficient variance, about 80% of the responding firms indicate that most of their turnover stems from services.[22] From 341 firms, we obtained complete data for all variables in our model.

As measurement scales for the dimensions proposed in Den Hertog et al. (2010) are not readily available (Droege et al., 2009)[23], we have taken up the challenge of operationalizing a multi-item scale for each of them. Given the fact that the selected multidimensional conceptualization and its predecessor have already been applied and reflected upon in various contexts (e.g. Agarwal and Selen, 2011; Den Hertog, 2010; see also our qualitative investigations reported in Chapter 3), we are confident that content validity is sufficiently ensured (Churchill, 1979). By building on the available range of theoretical discussions and empirical applications, we generated a pool of items that covered the domain of each dimension. From this pool of items, we selected unique items for inclusion in initial scales. We interviewed fellow researchers and respondents from different types of firms asking them to complete the scales and indicate any ambiguity regarding the phrasing of the items. After these pre-tests, we further enhanced the phrasing which resulted in the final version of the scales (Table 2.1). Using a 7-point Likert scale ranging from "strongly disagree" to "strongly agree", participants were requested to answer to what extent each statement was relevant for the service innovations developed in their firm over the preceding three years.

Since we are interested in verifying whether our items are suitable for measuring a pre-determined set of dimensions, we directly conducted a confirmatory factor analysis (CFA) to assess psychometric properties like construct validity and reliability (following Anderson and Gerbing, 1988). Using a structural equation model allowed us to test the quality of all measurement scales simultaneously (Diamantopoulos and Winklhofer, 2001).

As the results reported in the table below indicate, our six factor congeneric model fits the data structure reasonably well. The chi-square/degrees of freedom ($\chi2/df$), the goodness-of-fit index (GFI), the Tucker-Lewis coefficient (TLI), the normed fit index (NFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were all above the respective acceptance levels commonly used in the literature (e.g. Hair et al., 1998; Hooper et al., 2008).

22 This calculation is based on respondent evaluation of the question: "Our turnover mainly stems from services". Using a 7-point Likert-scale, we counted firms with a response of 4 or higher as service providers.

23 An exception is the measurement scale for Elevated Service Offerings (Agarwal and Selen, 2011). However, being based on the older 4D-model and focused on collaboratively developed services, it is less suitable than the enhanced 6D-model by Den Hertog et al. (2010).

Table 2.1: Scales and items of service innovation dimensions[a].

Construct with underlying items
New Service Concept (NSC)
• NSC1: Our organisation developed new (service) experiences or solutions for customers.
• NSC2: We combined existing services into a new formula.
• NSC3: We developed a new way of creating value for ourselves and our customers.
New Customer Interaction (NCI)
• NCI1: Our organisation developed new channels for communicating with her customers.
• NCI2: The way we have contact with our customers is renewed.
• NCI3: We changed the task distribution between ourselves and our customers.*
New Value System /Business Partners (NBP)
• NBP1: The role of external parties in producing our services is renewed.
• NBP2: We involved new partners in the delivery of our services.
New Revenue Model (NRM)
• NRM1: By introducing new services we changed the way we generate revenues.
• NRM2: The way we get paid (financial construction) is altered.
New Organisational Delivery System (NODS)
• NODS1: We changed our organisation in order to produce our new services.
• NODS2: Our production of new services requires new skills from our employees.**
New Technological Delivery System (NTDS)
• NTDS1: Technology plays an important role in the renewed production of our services.
• NTDS2: We renewed our service offerings by new or different use of ICTs.

a All items were measured on a seven-point scale from 1 (“completely disagree”) to 7 (“completely agree”).
* Removing this item improves the quality of the measurement scale (see main text).
** Removing this item improves the quality of the measurement scale (see footnote 24)

Following the advice by Diamantopolous and Siguaw (2006, p. 269), we inspected the modification indices of each scale in order to identify opportunities for improving the model. Doing so revealed that in particular removing item NCI3 yields a substantial increase in model fit. Indeed, as the last column in Table 2.2 shows, without item NCI3 the model turns from reasonable into excellent.

Table 2.3 reports the results for convergent and discriminant validity of the remaining measurement scales. As for composite reliability, the measurement scale for each dimension surpasses the critical threshold of a Cronbach’s alpha value of at least 0.6, and preferably 0.7 (Nunally, 1978). Also do we observe the average variance extracted for each construct to be above the threshold of 0.5 (Fornell and Larcker, 1981). All of the individual scales are thus found to be internally consistent.

Table 2.2: Model fit values of CFA on six-factor model (n=341)

Model fit indicator	Acceptable level of reasonable fit*	Acceptable level of excellent fit*	Value in original model	Value after removing item NCI3
Df			62	50
χ^2			167.92	99.43
χ^2/df	<5	<3	2.708	1.989
GFI	>0.90	>0.95	0.937	0.958
TLI	>0.90	>0.95	0.923	0.960
NFI	>0.90	>0.95	0.920	0.950
CFI	>0.90	>0.95	0.947	0.974
RMSEA	<0.10	<0.05	0.071	0.054

* Source: Hooper et al. (2008).

With regard to the results for discriminant validity, for three out of six constructs (NBP, NRM, NODS) the square root of the average variance explained is just below the absolute value of the correlation with another dimension. This finding suggests that the different dimensions tend to be quite strongly correlated with each other.[24]

Table 2.3: Results for analyses on convergent and discriminant validity [a], after removing item NCI3 (n = 341).

	CR	AVE	Standardized correlations, $\sqrt{\text{AVE}}$ on diagonal						Multi-collinearity Statistics	
			NSC	*NCI*	*NBP*	*NRM*	*NODS*	*NTDS*	Tolerance	VIF
NSC	0.851	0.656	*0.810*						0.628	1.593
NCI	0.823	0.701	0.493	*0.837*					0.785	1.273
NBP	0.668	0.502	0.624	0.416	*0.709*				0.630	1.587
NRM	0.714	0.558	0.591	0.455	0.745	*0.747*			0.538	1.860
NODS	0.733	0.578	0.586	0.390	0.741	0.813	*0.761*		0.640	1.562
NTDS	0.814	0.687	0.557	0.382	0.552	0.471	0.698	*0.829*	0.735	1.360

a: Composite reliability (CR), average variance extracted (AVE), standardized correlations matrix, and square root of variance extracted (on diagonal, in italics). VIF stands for variance inflation factor.

2.4.2 Constructing a service innovation index

While we are primarily interested in having a measurement scale for each of the service dimensions, we recognize that having one single index for service innovativeness might occasionally be of more use. Contrary to reflective approach followed for

24 Additional tests reveal that removing item NRM2, having the lowest squared multiple correlations value, would enhance the discriminant validity of two constructs sufficiently. This would also lead to a better overall model fit ($\chi2$/df = 1 .7; RMSEA = 0.045).

measuring the distinct dimensions, constructing an index requires a formative approach (Diamantopoulos and Winklhofer, 2001; Diamantopoulos and Siguaw, 2006). The difference here is that a reflective approach is used when multiple observed variables are indicators of one underlying construct. In our case, each service innovation dimension is measured by two or three items reflecting this specific dimension. If a firm introduces changes in a certain dimension, we expect all of the related (and interchangeable) items to be affected. In a formatively specified model the causal relations run the other way around. As each of the dimensions by Den Hertog et al. (2010) grasps a distinct aspect of what a new or improved service entails, it is the very combination of dimensions that forms the concept of 'service innovativeness'. If a firm develops or renews a service, it is not likely that this is manifested in a score on all of the qualitatively very different dimensions. In fact, a key idea underlying the selected multidimensional conceptualization is that firms changing a higher number of dimensions can be considered as more innovative (see also the next chapter). This implies that the six dimensions, themselves measured reflectively, can be regarded as formative indicators for an overall service innovation index.

Developing an index requires its underlying indicators (here: the dimensions) to be sufficiently distinct from each other (Diamantopoulos and Winklhofer, 2001). This is primarily a matter of differences in what the constituents stand for (i.e. variety in the conceptual content). Decisions on which indicators to include or omit when constructing an index should in the first place be based on theoretical grounds. Whether the appropriate indicators correlate positively, negatively, or not at all is only of minor importance (Bollen, 1984; Nunally and Bernstein, 1994). Because we have strong theoretical reasons for adhering to a total of six conceptually distinct dimensions, there appears to be no opportunity for making the index more parsimonious. Nevertheless, it is generally advised to check if the indicators are also empirically distinct. In line with the methodology proclaimed by Diamantopoulos and colleagues (2001, 2006), we inspect this by calculating multi-collinearity statistics. The results presented in the two last columns of Table 2.3 reveal that the variance inflation factors are well below the threshold of 10 (Diamantopoulos and Winklhofer, 2001), just like the tolerance values are far above the critical threshold of 0.35 (Diamantopoulos and Siguaw, 2006). Therefore, it seems safe to use the combined measurement scales as an indication for service innovativeness.

Following Bagozzi (1994), we constructed our index by summing the scores on each of the dimensions jointly producing the construct of service innovativeness. Besides the fact that composite reliability is largely irrelevant in the construction of indicators (Diamantopoulos and Winklhofer, 2001), the earlier identified correlations between the dimensions already revealed that the different dimensions generally do point in the same direction. Indeed, if we would calculate composite reliability at the level of our (second-order) service innovation index, the retrieved Cronbach's alpha of 0.819 is well above the threshold of 0.7 (Nunally, 1978).

The figure below shows our final measurement model, consisting of reflectively measured dimensions jointly giving shape to a formative index. As such combinations are used for abstract constructs (Diamantopoulos and Siguaw, 2006) we consider it appropriate for operationalizing the notion of service innovativeness. Apart from containing first-order reflective constructs and a second-order formative construct, the model also includes two variables for validation purposes. A common way to assess external validity is by relating an index to variables we expect to be related. We developed a so-called 'multiple indicators and multiple causes' (MIMIC) model (Hauser and Goldberger, 1971) by linking the index to survey-items regarding the percentage of sales stemming from improved products or entirely new propositions.[25] As these variables are only available for 325 of our cases, the CFA-results in Figure 2.1 differ slightly from those presented in Table 2.3. Our service innovation index turns out to be significantly related to both of these measures for innovation-based turnover. Moreover, the overall MIMIC model has an excellent fit.[26]

2.4.3 External validity

At this point we have operationalized and validated measurement scales as well as a service innovation index, based on the work by Den Hertog et al. (2010). We finalize this empirical section by discussing the external validity of our constructs: we inspect how the scales and index behave in relation to other variables, and assess whether this delivers sensible patterns (Anderson and Gerbing, 1988). Doing so allows us to assess whether the constructs are suitable for actually researching phenomena for which service innovation is a relevant issue.

Table 2.4 first lists the mean values for each of the six service dimensions and the overall service innovation index. The service concept and the technological delivery system appear on average to be the most affected dimensions. A relatively large standard deviation for NTDS suggests that firms either base their service innovation a lot on new technology, or not at all. The business partner (value system) and especially revenue model are generally the least intensively modified dimensions. This might reflect that firms introducing novel service offerings are more inclined to focus on the concept and the client they provide to, while having less attention for how to organize the costs and revenues associated with it (see Chapter 3). Another explanation is that these dimensions are more difficult to alter.

25 Items retrieved from the Oslo Manual for measuring innovation (OECD, 2005). These items, also included in the Community Innovation Survey, are commonly used for studying the innovative performance of firms.

26 The figure shows again how item NRM2 has a low loading, as measured by its squared multiple correlations value. Item NBP1, which has a similar loading in Figure 2.1 (when rounded to two decimals), would be another candidate to eliminate.

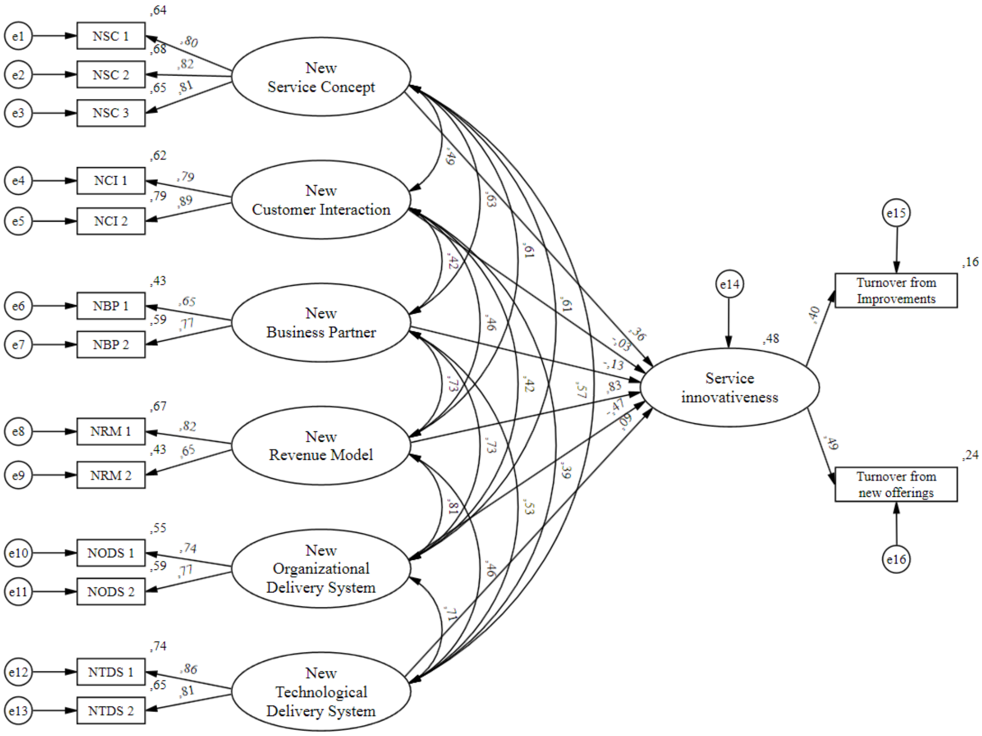


Figure 2.1: MIMIC model for the construction and validation of measurement scales for service innovaiton dimensions (first-order) and a service innovation index (second-order). Standardized coefficients. N = 325.

The remainder of Table 2.4 consists of correlations with other variables retrieved from our survey. Although the measurement scales were found to be far from divergent, the results do point at some remarkable inter-dimensional differences. For instance, half of the dimensions appear to be negatively correlated with firm age: younger firms have a higher score on NSC, NODS and NTDS, and thereby also on the overall index. Larger firms introduce significantly more new service concepts. We have also asked respondents about some general business characteristics. The fact that the service concept dimension (NSC) is positively correlated with the extent a firm is obtaining turnover from services is not surprising, but it is less evident why service-oriented firms score lower on the revenue model dimension (NBP). On average the score on NSC is also higher when firms tailor their services, but lower when their services are linked to physical goods or when they mainly serve final users rather than other businesses. As business-to-consumer firms also score lower on the NTDS dimension, the correlation with the overall service innovation index is negative as well.

Finally, if we look again at the three variables for turnover composition, almost every dimension appears to be positively correlated with innovation-based sales. Renewing the form of customer interaction (NCI) does not correlate significantly with turnover from improved products, but we do observe a positive correlation with turnover from entirely novel products. The opposite is true for changes in the organizational and technological delivery systems (NODS and NTDS); these are only positively correlated with turnover coming from improvements. Remarkable is that while changes in the NRM dimension occur least often (or intensively), they do happen to be very significantly related to revenues coming from new-to-the-firm innovations. When all dimensions were regressed simultaneously on the service innovation index, in Figure 2.1, it was indeed the NRM dimension having the highest standardized regression coefficient. Of great importance here is the finding that also the overall service innovation index is positively correlated with innovation-based sales. This observation, consistent with what we would theoretically expect, confirms that this second-order construct is valuable for future investigation as well.

Table 2.4: Results for analyses on external validity

	Mean	Std. Dev.	NSC	NCI	NBP	NRM	NODS	NTDS	Service innovation index
Mean			4,786	4,321	3,865	3,554	4,148	4,760	4,239
Standard Deviation			1,418	1,443	1,524	1,531	1,526	1,714	1,107
Correlations[a]:									
Firm age	27,53	25,09	-,194**	-,008	-,055	-,106	-,132*	-,184**	-,158**
Firm size (fte)	103,79	387,99	,126*	-,025	,089	,083	,103	-,020	,079
This statement holds for my firm[b]:									
Our turnover mainly stems from services	6,41[c]	0,96	,131*	-,020	-,082	-,135*	-,048	,023	-,031
Our services are linked to the physical goods we are delivering	3,35	2,36	-,201**	,017	,086	,022	-,032	-,096	-,047
We provide services to a large number of clients	5,30	1,67	-,032	,118*	-,013	-,037	-,028	-,083	-,021
We tailor our services to customers' needs	5,94	1,31	,200**	,085	,088	-,021	,031	,027	,091
We mostly deliver our services to consumers (B2C)	2,72	2,20	-,191**	,104	-,069	-,067	-,061	-,168**	-,107*
Percentage of revenues coming from ... (100% in total)									
…unchanged goods and/or services	67,64	22,81	-,300**	-,147**	-,201**	-,276**	-,209**	-,166**	-,296**
… improved goods and/or services	20,46	16,87	,261**	,095	,179**	,160**	,205**	,189**	,249**
… new goods and/or services	11,90	12,42	,198**	,141*	,126*	,291**	,106	,049	,205**

a: Pearson's correlations, ** = significant at the 0.01 level (2-tailed). * = significant at the 0.05 level (2-tailed).

b: These items were measured on a seven-point scale from 1 ("completely disagree") to 7 ("completely agree").

c: This mean is relatively high, as we excluded firms not retrieving any turnover from services at all.

2.5 THE FUTURE OF MULTIDIMENSIONAL CONCEPTUALIZATIONS

In the preceding sections, we discussed attempts to describe what aspect of a service is novel. In the context of a specific type of service, renewal can be identified by characterizing a service using tools such as service blueprinting or service mapping. Those instruments are especially suitable for understanding what aspect of service production is improved, and how that might affect other elements of the particular service at hand.

When looking at services that differ highly in their nature, the tools mentioned before are too limited or context-specific to allow for comparative analyses. A solution provided over the past years of service innovation research, is adhering to a framework of common dimensions. The dimensions in the multidimensional conceptualization by Den Hertog et al. (2010) can be regarded as different 'places' or loci (cf. Toivonen and Tuominen, 2009) where changes can occur when engaging in innovation. Using empirical data from 341 Dutch firms, we measured the extent to which their innovations covered the various dimensions. Until now, measurement scales capturing the dimensionality of services have been scarce (Agarwal and Selen, 2011; Droege et al., 2009; Salunke et al., 2011). The availability of operationalized and validated measurement scales also allowed us to construct an overall service innovation index.

The results of our scale and index development have several implications for future research. First of all, adhering to a more differentiated representation of service innovation contributes to attempts of developing indicators for service innovativeness. Despite various attempts in this regard (e.g. NESTA, 2009; EPISIS, 2011), no consensus was reached so far: improving measurement of service innovation remains a key issue (OECD, 2012). Whereas renewal in the service concept is relatively well perceivable, changes in other elements of the service elements might be easily overlooked. Operationalization of a multidimensional conceptualization, if sufficiently illustrated with qualitative evidence as well, provides fertile grounds for capturing a high variety of changes that can be considered as novel. As such, it also allows for research on success factors other than the final offering itself (Droege et al., 2009).

According to our first statistics, changes in the service concept dimension are found to occur relatively often. Whether a change in just this (or any other) single dimension is sufficient for service innovation to be perceived remains unclear. It also begs the question whether changes within individual service innovations can cover other dimensions without affecting the service concept itself (as perceived by the final customer). The other dimension frequently involved in innovation is New Technological Delivery System. A simple statistical count does not reveal whether involvement of technology truly causes changes in other parts of the system (as expected by Barras, 1986; Windrum and Garcia-Goñi, 2008), or whether they get involved as a modification initiated in another dimension starts to induce further changes. The fact that discriminant validity between the measured dimensions is found to be relatively low suggests that some dimensions indeed might be interdependent. Hypotheses for which combinations of changes are likely to be common are provided by Den Hertog (2010). However, so far the existence and explanation for certain dimensional patterns has not been explored empirically. Whereas a multidimensional conceptualization seems the end of the quest for the nature of service innovation, we thus can conclude by stating it also is a promising beginning for obtaining more insight in how novel services come about. In the next chapter, we will explore in more depth how a multidimensional conceptualization allows us to develop an evolutionary interpretation of service innovation processes. Such an interpretation, along with the scales (index) developed here, will also reappear in later chapters.

Chapter 3

Service innovation as search in multidimensional design spaces: Conceptual opportunities and empirical examination

3.1 INTRODUCTION

Research on service innovation is evolving along different lines (Droege et al., 2009). The latest part of this development has been described as the 'multidimensional phase' (Carlborg et al., 2014): the act of service innovation is increasingly recognized as the design of multidimensional and complex systems (Gallouj and Weinstein, 1997; Windrum and Garcia-Goñi, 2008; Roth and Menor, 2003; Maglio and Spohrer, 2008). Typically, a multidimensional appreciation of service innovation goes beyond simple and frequently criticized distinctions like process versus product innovation (Djellal and Gallouj, 2001) or technological versus organizational renewal (Drejer, 2004). By conceptualizing services as being composed of various dimensions, we define service innovation as the modification of one or more of these dimensions (Den Hertog, 2000; Den Hertog et al., 2010).

Over the years, numerous authors have presumed the existence of interdependencies between the individual dimensions that make up a service (Gallouj and Weinstein, 1997; Briscoe et al., 2012; Maglio et al., 2009; Van Riel et al., 2013). However, theoretical foundation and empirical investigation of the mechanisms underlying these interdependencies remain scarce (Droege et al., 2009). Consequently, the lack of knowledge regarding complexity in the development of new services obscures the nature of service innovation as an outcome as well as a process, both frequently being reported as ill-understood (Gallouj and Djellal, 2010; Bryson et al., 2012).

The current chapter aims to advance the multidimensional approach to service innovation by exploring how it can guide the development of new service solutions. We adopt an evolutionary interpretation of innovation (Nelson and Winter, 1982) in order to shed light on the search process that leads firms to develop new services. Specifically, we rely on complexity theory in the form of the NK-model (Kauffman, 1993, 1995). In this particular analytical structure, innovation involves the deliberate manipulation of one or more dimensions within a design space. Due to the presence of interdependencies, changing one dimension affects the fitness of other dimensions, thereby introducing complexity in the search process. Over the years, extensive theorizing and simulation efforts revealed valuable strategic and managerial insights on how to deal with such complexity (Levinthal, 1997; Porter and Siggelkow, 2008; Frenken, 2006).

With some rare exceptions (e.g. Chae, 2012a, 2012b; Desmarchelier et al., 2013), NK-logic has mainly been applied to change in material artefacts. Recognizing NK-logic's potential to enrich the multidimensional approach to services, prompts us to make two contributions.

First, we propose how service design spaces can be defined on the basis of multidimensional conceptualizations as devised by Den Hertog et al. (2010). We use this particular framework to map eight qualitatively studied innovations and assess which mutations occur in every dimension, thereby also addressing the void of empirical examination on this topic (Salunke et al., 2011; Droege et al., 2009). Some of the observed modifications seem to be archetypical, reflecting a relatively standard way of modifying a dimension. Gaining familiarity with design space dimensions and common mutations could be a valuable way to reduce complexity and optimize innovation processes.

Guided by complexity theory, we examine interdependencies between the separate dimensions. We argue that, in order to interpret service innovation as an act of evolutionary search, it is essential to understand the extent to which changes in various dimensions can have a knock-on effect on other dimensions. Rather than presenting services as an aggregation of dimensions to be optimized independently, we use our case evidence to explain why most innovations seem to involve several simultaneous changes. We illustrate how sequential transformations resemble the explorative and exploitative facets of adaptive search in services (Chae, 2012a), and how the complexity-reducing notion of modularity can be interpreted in a multidimensional conception of services (Rahikka et al., 2011; Carlborg et al., 2014). Applying complex systems methodology to services, as demonstrated in our case analysis, has several research and managerial implications.

3.2 BACKGROUND: APPLYING COMPLEX SYSTEMS THEORY TO SERVICES

3.2.1 Innovation as multidimensional search

The innovation and management literature offers several theories and tools that improve our understanding of how new value propositions come about. From an evolutionary perspective, the act of entrepreneurial experimentation can be thought of as a search process (Nelson and Winter, 1982; Metcalfe, 1995). Firms engaging in innovation face the challenge of configuring resources (including organizational routines) in such a way that they can provide novel solutions or deliver existing ones more efficiently. In their pursuit of competitive offerings, firms have to decide how to mutate and align different aspects of the business model they are exploring.[27]

Stemming from complex systems theory, Kauffman's NK-model (1993, 1995) sheds light on search processes within multidimensional, interactive design spaces. The concept of design space implies the hypothetical collection of resource combinations available to a firm. Each configuration within the design space is associated with a fitness-value, representing to what extent it is appreciated by the market. Besides being induced by exogenous changes, better configurations can emerge from a firm's own efforts to deliberately manipulate the dimensions within the design space it explores

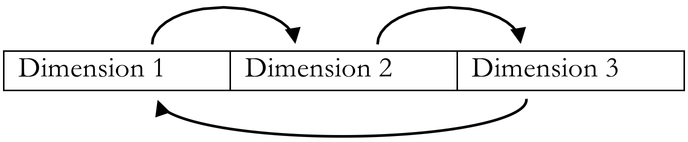
27 For discussion on the links between business models and the multidimensional conceptualization of services: see § 9.1.1.

(Axelrod and Cohen, 2000). The presence of dependencies between dimensions makes innovation a complex process.

The formal NK-model representing the dynamics of combinatorial search processes centers around two parameters (Kauffman, 1993). *N,* to start with, denotes the number of dimensions that can be manipulated when developing or improving a product. In the example of automobiles, firms have the option to modify dimensions such as energy sources, car fuel, and vehicle type (Alkemade et al., 2009). The various ways each separate dimension can be changed, is captured by the concept of 'alleles'. For a car's vehicle type, the basis alleles include the internal combustion engine (ICEV), hybrid-ICEV and fuel cell vehicles (Alkemade et al., 2009). The collection of all alleles belonging to every dimension of a system corresponds with the entire design space of that product. While each dimension has its own fitness, the overall fitness of a specific design configuration is typically considered the (weighted) average fitness of all the dimensions that make up the configuration.

The second property of NK-models, *K,* refers to the degree of interdependencies between a system's dimensions. If changes in different dimensions of a system do not affect any other dimension's fitness ($K = 0$), optimizing a design is relatively straightforward. Because each mutation can be evaluated independently, a search journey is bound to ultimately reach the global optimum or 'peak' in a fitness landscape. The power of NK-logic, however, lies in its ability to model interactions between the different dimensions, i.e. the various attributes of an organization or product ($K > 0$). Due to the presence of interdependencies, a single mutation within a product can increase the fitness of one particular dimension while reducing the fitness of others. On average, an apparent improvement in one dimension could thus result in an overall reduction in fitness. The degree of interdependence in a system is at its maximum when a change in one dimension affects all the other dimensions ($K = N$-1). When searching in the 'rugged' fitness landscape, associated with such a high level of dependencies, firms might perceive difficulties in enhancing the fitness of their products (Levinthal, 1997). Because of the far-stretching consequences of every mutation, it is hard to predict whether taking a step in the fitness landscape results in any improvement at all (Beinhocker, 2006).

Figure 3.1 is an NK representation of a certain product's architecture, where $N = 3$ and $K = 1$. The columns in the table below show that when one dimension changes, this affects both the fitness of the dimension itself as well as the fitness values f_n of (in this example) on average one other dimension. In this simplified illustration, all the interdependencies are directed. It is also possible that interdependencies work both ways, which would imply double-headed arrows between dimensions.



	Dimension 1	Dimension 2	Dimension 3
f_1	X		X
f_2	X	X	
f_3		X	X

Figure 3.1: Architecture of a product with N =3 and K = 1 (adapted from Frenken, 2006). The crosses in the lower table indicate which fitness values (f_n) get affected when changing dimension n.

Complex systems theory in the form of NK-models has been used in contexts like organizational level change, corporate strategy, transitions, and innovation (Levinthal, 1997; Frenken, 2006). Supported by simulations of actors exploring fitness landscapes, Porter and Siggelkow (2008) argue that the dynamics of the model help to identify which search strategies are likely to result in competitive positions.

3.2.2 The design space of services

NK-logic is normally applied to products or 'technological systems' of a more physical nature (Frenken, 2006; Alkemade et al., 2009). The notion of interdependencies is perhaps most intuitive when the system-wide consequences of a mutation depend on uncontested physical laws. For producing intangible products, it is less obvious what causes dimensions to be interdependent. This is by no means a reason to ignore the analytical clarity NK-logic offers. As long as a product can be represented as a system of interdependent dimensions, there is a need to cope with the uncertainty a certain change can provoke (regardless of where the interdependency comes from). One could even argue that NK-logic is *especially* relevant in situations where the nature and implications of interdependencies are difficult to grasp, as its main merit lies in helping innovators to deal with unforeseen consequences (Porter and Siggelkow, 2008; Levinthal, 1997).

Despite its potential to shed light on pressing strategic and management issues, the sketched interpretation of evolutionary search has hardly been applied in the context of services. Exceptions are studies like the one by Desmarchelier et al. (2013), where NK-logic is applied in a very general setting. Only in two recent studies by Chae (2012a, 2012b), an attempt was made to interpret new solution development in a services context as an evolutionary search process. Chae proposes distinct search strategies for an organization's approach to which and how many dimensions to change. As for the dimensions themselves, he illustrated his perspective by discriminating between a supply side dimension, a demand side dimension, and a geographical dimension (based on Sidhu et al., 2007). Although appropriate for stressing the key principles, the chosen dimensions are hardly specific or readily observable (Chae, 2012b). Indeed, they are in stark contrast to the relatively hands-on dimensions typically used when applying NK-theory in practical settings (like in the aforementioned example of Alkemade et al., 2009). This type of study suggests a clear direction for translating Chae's propositions into empirically verifiable statements and practical tools for service innovation management (Chae, 2012a, 2012b).

Generally, services are associated with ill-defined design spaces (Nelson, 2003; Frenken, 2006). Due to service characteristics like intangibility, heterogeneity, and perishability (Parasuraman et al. 1985), it is relatively hard to get a grip on all the (promising) mutations that could be introduced when altering the design of a service (Toivonen and Tuominen, 2009). Of crucial importance here is the notion that in services, design options tend to be fluid rather than discrete: product boundaries are characterized as blurred or fuzzy (Gallouj and Savona, 2009). Indeed, most services are not offered as a set of clearly defined products one can comprehensively list in a catalogue, which is why firms might sometimes experience difficulties when trying to formulate their propositions into distinctive concepts (Goldstein et al., 2002). Moreover, the fuzzy nature of services might obscure similarities across different kinds of service solutions. This poses a challenge to scholars wishing to widen their insights on search strategies. When design options are fluid, there is little basis to conduct comparative analyses on service innovation activities.

The multidimensional approach to service innovation, which we aim to advance, constitutes an excellent basis for representing the limits of a design space wherein interactive mutations can take place (see Chapter 2). Over the years, various authors (Gallouj and Windrum, 2009; Windrum and Garcia-Goñi, 2008; Maglio and Spohrer, 2008) have been propagating an evolutionary approach to service innovation by providing frameworks in which services are regarded as combinations of different dimensions such as provider and user resources, or tangible and intangible dimensions needed for the actual service solution (Miles, 1993; Maglio et al., 2009). When it comes to designing new or improving existing services, innovation can happen in any dimension of the service in question (Ahuja and Katila, 2004; Zolnowski et al., 2013).

An excellent overview of frameworks is provided by Droege et al. (2009, p. 138), highlighting how existing attempts differ in their scope (in terms of industry) and level of detail regarding the dimensions they differentiate. Especially noteworthy is the conceptual framework by Den Hertog et al. (2010), commonly recognized as one of the few attempts to capture distinctive features of services in a single conceptualization valid for service innovation in general, irrespective of the sectoral context (Salunke et al., 2011; Rubalcaba et al., 2012). As discussed in Chapter 2, this framework covers six dimensions, reflecting: novelty of the service concept, customer interaction, value system (business partners), revenue model, organizational delivery system, and technological delivery system. Changes to one of these dimensions are expected to prompt other changes in turn (Den Hertog, 2000; Den Hertog et al., 2010; Agarwal and Selen, 2011; D'Alvano and Hidalgo, 2011), but empirical verification as well as theoretical explanations remain scarce (Droege et al., 2009).

Adhering to common but clearly delineated dimensions when describing services, and changes therein, would greatly help us to understand the generally cluttered design spaces service innovators are confronted with (Gallouj and Toivonen, 2011/2). Being abstract yet well-defined and discriminant notions, the dimensions in the conceptualization by Den Hertog et al. (2010) can be regarded as the boundaries of service design spaces. Each of the six dimensions covers a distinct range of changes corresponding to the notion of alleles. Actual innovation efforts, in this interpretation, consist of choosing alleles for a maximum of six dimensions.

We should note that the multidimensional framework by Den Hertog et al. (2010), despite its service-specific origins, is not relevant for 'pure' services only. Its broad scope is highly similar to the one Gallouj and Weinstein (1997) had in mind when proposing their characteristics-based approach. According to an integrative perspective on innovation (Coombs and Miles, 2000), both frameworks have the potential to characterize (changes in) various organizational elements required for (co)producing value. A key difference, however, is that the characteristics-based approach invites researchers to identify new elements each time a product-service system is studied, while the framework construed by Den Hertog et al. (2010) always consists of the same key dimensions. This property is exactly what makes it suitable for collecting and comparing insights from various (service) contexts.

3.2.3 Questions arising from multidimensional representations

Defining design spaces on the basis of a multidimensional conceptualization of services highlights issues hardly addressed so far in service innovation literature. In particular, few studies have examined whether service innovations are characterized by change(s) in just a single dimension or always cover multiple up to all dimensions (Droege et al., 2009); whether there is any evidence (and explanation) for the emergence of specific combinations of affected dimensions (Den Hertog et al., 2010); and most importantly: how the presumed interdependencies between dimensions affect processes and strategies concerning the actual design and implementation of a new solution (Carlborg et al., 2014; Chae, 2012b).

Due to the scarce availability of empirical examination of frameworks, it is still not clear to what extent complex systems theory provides meaningful solutions for designing multidimensional service innovations. Exploration of the explanatory potential of NK-logic requires empirical evidence of a rare kind, even for the broader innovation literature, stemming from qualitative research in the "middle ground between individual case studies and large-sample research" (Porter and Siggelkow, 2008, p. 52).

In the next sections, we first use the multidimensional conceptualization by Den Hertog et al. (2010) to capture distinctive features of novelty in intangibles. Mapping various service innovations in a six-dimensional design space provides a so far unavailable impression of the dimensionality of innovations (Droege et al., 2009).[28] Secondly, at the level of individual service innovations, we examine the issue of interdependencies between the affected dimensions and discuss coping strategies.

3.3 AN EMPIRICAL EXPLORATION OF THE MULTIDIMENSIONAL NATURE OF SERVICE INNOVATION

3.3.1 Research methodology

The objective of our empirical exploration is to use a single multidimensional framework to 'map' the changes making up the renewal in a certain service proposition. Although the mapping can be done just by relying on documented data, we reckon that initial (exploratory) mapping requires deeper insights. In order to grasp the actual changes that constitute a renewed service offering, we performed several case studies at the level of concrete service innovations (products) or service innovation projects. A critical validation of a multidimensional conceptualization requires a multi-industry approach, in which service innovations from various industries are represented.

In the context of a two-year research program on open service innovation in the Netherlands, we performed a multitude of case studies between March 2010 and February 2012. Besides involving collaborative research effort, cases were required to include some extent of novelty in order to count as an innovation. Table 3.1 gives a brief description of eight innovations, studied in firms of different sizes and active in different markets. Following a case study protocol developed at the start of our research project, we conducted between 5 and 10 semi-structured interviews per firm, each conversation lasting on average 75 minutes. In virtually all cases, triangulation of our data was enabled by (often publicly available) documents, such as newspaper articles, business journals, websites, flyers, manuals, and scientific publications. Besides establishing the novelty of the service being studied, these sources provided additional insights in how the innovations came about.

28 An implication is that we are not seeking possibilities to add or change dimensions in the framework itself. Our contribution lies in providing an empirical application based on comparisons across various cases. Changing the framework would inhibit comparability.

In the post-visit stage, the recorded interviews were transcribed and non-relevant data was cancelled out (Bryman and Bell, 2007). This first interpretative round resulted in summaries to reduce the material to its relevant core. For verification purposes, those summaries were returned to the interviewees, generating some minor adaptations. Subsequently, the texts in the transcripts were coded on the basis of topic (following Miles and Huberman, 1994; Kvale 1996). The coded texts then allowed for a comprehensive case analysis, including the data retrieved from all interviewees and external sources.

After completion of a case, narratives of about twenty pages were returned to the participating firms. On several occasions, the delivery of the narrative was supported with a presentation. Finally, all the cases were discussed at a seminar where every participating firm was represented. It is fair to say that the various communication activities gave the participants ample opportunity for feedback.

3.3.2 Description of 8 service innovations

In the table below, the shading indicates to what extent a dimension of the innovative service reflects differences with respect to services originally provided by the focal firm. Our focus lies on how organizations adapt by seeking novel service propositions and ways to produce them. The mapping thus does not contain some ‘absolute’ characterization of which dimensions are most prominently involved in a service: it is a qualitative indication of where we can find resources and routines that are different from the ones deployed before the innovation was introduced. The shading gives an impression of the extent to which an organization had to reconfigure itself. For each particular dimension (the columns), we briefly discuss which changes led us to assign a certain score.

The introduction of a new *service concept* denotes the delivery of a solution or experience the firm has not provided before. A clear example of a new proposition offered to (new or existing) customers is the Taxi service for passengers who can now book their pre- and post-flight transportation as well as their flight. For KLM, arranging taxi services that complement its core business (aviation) denotes a tremendous change, allowing it to reposition itself as a ‘one-stop-shop’ for travel. There are cases, however, where the essence of an existing service remains less (or not) affected while especially its other dimensions are manipulated. For instance, TomTom’s real-time navigation services are still about traffic innovation (albeit more accurate and recent), Achmea’s Online communities for elderly people are still about providing insurance, and in the case of the Shuttle service, the Port of Amsterdam is still facilitating container transit.

Table 3.1: Description of cases.

Case nr.	Firm name	Industry	Innovation	Description*
1	DHV	Engineering	Asset management model	Model in which engineering agency takes over the clients tasks related to asset management. Instead of just operational planning, the firm also provides more strategic management. Service is operationalized through a partnership in which the agency carries risk, but is awarded for performance.
2	Achmea	Insurances	Online community for elderly people	Together with two software developers, the focal firm created a community platform for elderly people. Through the platform, she facilitates discussions and communicates with customers. Thereby, it is a channel for following users and offering insurances.
3	Trade Mart Utrecht	Exhibitions	Joint concept development	Besides renting surface to exhibitioners, this trade mart now interacts with them in a commission that develops new concepts for fairs. Moreover, they jointly organize activities for attracting more visitors.
4	Vitae (now Experis)	HRM services	Trained secondees	By joining forces with an engineering agency, this HRM service provider is able to provide her clients secondees that received relevant (on-site) training and client-specific expertise. On-site account manager generates extra leads. Offered as an integrated service.
5	Port of Amsterdam	Logistics	Shuttle service	In order to improve capacity and efficiency of inland shipping, a Dutch port organized a shuttle service for transportation of containers. The approach is more reliable and prevents suboptimal (half-loaded) transportation moves. Actual execution of the reorganized transport is performed by the ports' clients.
6	TomTom	Navigation services	Real time navigation	Instead of selling personal navigation devices (PND's), the focal firm increasingly offers real time traffic information to registered customers paying a monthly fee. Live data is gathered by and distributed over telephone network.
7	KLM	Aviation	Taxi service	Digital application for booking taxi trips (in addition to flight tickets) from and to the airport. Partner is involved for development of software algorithms scanning databases of taxi companies all over the world.
8	Rabobank	Financial services	Digital payment system	This bank pioneered the domain of mobile banking by developing a mobile wallet (not normal bank account), which is linked to various applications, such as NFC-paying systems and digital ordering/paying application.

* Detailed information about each of the case studies can also be found in Van der Aa et al. (2012). In Dutch.

Table 3.2: Mapping the changes that underlie a service innovation.

Case		Affected dimensions of service innovation: *New service concept*	*New form of customer interaction*	*New value system / business partner*	*New revenue model*	*New organizational delivery system*	*New technological delivery system*
1	Asset management model	Still asset management, but now as 'total solution'	Partnership with client allows transfer of responsi-bilities		Revenues now % of budget and based on performance	Client-specific and management knowledge now more required	
2	Online community for elderly people		Direct customer-interaction through platform	Partner developed and runs websites	Other insurances offered over platform	Provision of expertise via online communi-cation	Online community via webbased platform
3	Joint concept development	Firm offers more than surface: also events	Marketing commission for coop. with client	External partner facilitates joint concept develop.		Focus on collaboration instead of on selling	
4	Trained secondees	On-site training results in trained secondees		Engineering agency trains secondees	Secondees are located at partner and its clients	Firm sends account manager to site of client	
5	Shuttle service		Transport is executed by clients	Shuttle service is mainly run by freighters	Shuttle has fixed schedule with fixed tariffs	Port has to be operationally involved now	Only technology is a ship with mounted crane
6	Real time navigation	Still navigation services, but better (live)		Traffic info comes from mobile network	Bundle of services, offered via registration	Firm acquired partners for tech. knowledge	Tech. for live communicatio n with PND's
7	Taxi service	Aviation firm offers taxi services	Customers can book plane and taxi at same time	Partner provides algorithms for booking taxis	One-stop-shop for door-to-door transportation		Algorithms connect taxi databases
8	Digital payment system		Customer can access money differently	Partners use digital wallet in new apps	Customer pay fee each time they use service		Service relies on new soft- and hardware

Legend: Not shaded = no change, Light shaded = minor change, Dark shaded = major change.

The dimension *customer interaction* concerns the activities a firm deploys to engage its customers in value creation. Typical for various cases where this dimension was mutated, is that new interaction modes are enabled through digital platforms (notably the Online communities, the Taxi services, and Rabobank's Digital payment system). Other cases characterized by changes in this dimension demonstrate an altered task allocation. Whereas customers are awarded more influence and involvement in the Joint concept development case, allowing them to engage actively in co-creation, the Asset management model is based on taking over tasks from the client firm.

Firms can alter their *value system* by changing their practices to involving a set of *business partners* in the production and delivery of a service. This dimension turns out to be affected relatively often in the cases we studied. Obviously, this is inherent to the criteria guiding the selection of cases: they are all part of a study on open (service) innovation. Important to note, however, is that the focus was on jointly developed projects; whether the resulting service was also delivered through a partnership constellation was not a requirement. The case of Trained secondees, for instance, only involves a limited level of collaborative innovation effort, although the service itself relies entirely on the complementary activities of both parties. Moreover, not every studied service is delivered through collaboration with third parties. The Asset management model relies on a new type of partnership, established between just the engineering agency and its client.[29] This difference is expressed through a high score on the dimension 'new client interaction'. If we look at what roles the external parties play in our cases, it becomes clear that they are relatively often related to the technology constituting the innovation. Especially in the cases of the insurance agency and the bank, there is some correlation between the presence of a partner and the importance of technology.[30]

A firm's *revenue model* describes how it organizes cost and revenue streams. The models deployed in the Online communities and Real time navigation involve registration for a service. Especially in the latter case, continuous payments mark a clear shift with the usually more incidental purchase of navigation hard or software (i.e. map updates). Also the Asset management model involves a revenue model innovation regarding the payment structure. Instead of getting paid per hour, the engineering agency fulfils a risk-taking role for which it is rewarded for saving maintenance costs and increasing asset quality. Finally, in the case of the Shuttle service, transporters are not always accustomed to dealing with fixed tariffs for shipping containers.

Concerning delivery system dimensions, a *technological delivery system* pertains to a firm's routines in the use of technology (often ICTs) to provide a service solution. It can be both the core of a new service (e.g. online community and live communication with personal navigation devices or PNDs), as well as acting as support for a new proposition (e.g. the crane which enables the shuttle service). In our cases, the technological component appears not to be as central as suggested by the original 4D-model (Den Hertog, 2000; Agarwal and Selen, 2011). The cases in the domain of HRM (Human Resources Management) services and exhibitions demonstrate various elements of novelty, technology not being one of them. In these instances, especially new forms of *organizational delivery systems* are prominent. This dimension covers the organizational

29 In the initial phase of this partnership, the asset owner (an industry site or local government) and the engineering agency jointly invest a period of about one year to develop a long-term maintenance plan. During the actual fulfilment, the engineering agency carries all the financial risks for meeting the agreed targets. Instead of charging on an hourly basis, the engineering agency is encouraged to save costs and increase asset quality. Providing full transparency to the client creates mutual trust, which is why parties consider they are engaging in a partnership rather than a supplier-relationship. From the engineering agency's side, this form of management requires them to acquire new skills and competences they formerly did not possess.

30 Also in the case of the manufacturer of navigation devices, the external partner brings in technological expertise. In this situation, however, the correlation is less clear because the focal firm itself is to a large extent responsible for the renewal of the technological delivery system.

structure (including management activities) required for providing a service. In the case of the Asset management model, renewal in internal competences, skills and culture was required to fulfil the services guaranteed in the contract with the client firm. Next to acquiring legal and technological expertise, the engineering agency also had to adapt its internal processes regarding the organization of client administration and billing. The latter types of modifications were also encountered in providers of HRM services.

3.4 INTERPRETATION

3.4.1 Exploring the service design space

Performing a multi-industry study illustrates the general applicability of a single multidimensional conceptualization to map the mutations that characterize a service innovation. It also enables comparisons between searches in distinct industries.

Firstly, our exploration of the dimensions constituting a service design space provides grounds for describing where innovation is taking place if it is not solely in the final offering (Droege et al., 2009). Although absence of change in the service concept might suggest that Online communities, Shuttle service and the Digital payment system are process innovations (from the focal firm's perspective), the findings summarized in Table 3.2 indicate they are essentially different from each other. Even without affecting the service concept, the cases concern a unique combination of service characteristics, reflecting the idiosyncratic ways in which the respective firms introduce improvements in the various dimensions. Also for other cases, the analysis demonstrates how distinctive features of various service innovations are captured relatively well by the dimensions of the framework we applied (Den Hertog et al., 2010). This observation provides valuable qualitative evidence that the six abstract 'pillars' characterizing innovation in intangibles can represent the dimensions within the design space associated with new service development.

Apart from allowing characterization of where novelty occurs, a validated multidimensional design space also has the potential to provide guidance in the design of service innovations (Gallouj and Toivonen, 2011/2; Zolnowski et al., 2013). When searching for potentially successful modifications of an existing service, or even when trying to configure an entirely new proposition, service innovators might consider a holistic set of dimensions as a 'map' that delimits the range of possibilities to explore. For instance, in the case of the Asset management model, the dimensions suggest further development of the innovation. Focusing on the previously unaffected dimensions would highlight the possibility to include a new business partner (e.g. collaboration with or certification of contractors), introducing a new technological delivery system (digital monitoring), or further modification of the organizational delivery system (acquiring additional legal/financial competences).

Our empirical evidence shows that not all steps within the design space are truly unprecedented mutations. Instead, some innovations demonstrate changes that we consider archetypical for a certain dimension: they reflect a relatively standard way of modifying a dimension. When designing a new revenue model, for instance, 'common alleles' include the choice to make incidental deals (e.g. charging a fixed fee each time the Shuttle service is used), to provide services on a registration basis (e.g. the Real time navigation), or to base the cost structure on the savings a service provider realizes (in the Asset management model). Similarly, an archetypical mutation in technological delivery systems is to introduce a web-based communication channel (Online communities) or to connect various databases (Taxi service). When identifying common mutations for designing an altered value system, we could think of all the potential roles for a new partner; supplying technology (e.g. Online communities, Digital payment systems) or information (Real time navigation), providing complementary services (Trained secondees) or covering part of the execution of the new service (Shuttle service). Typical alternatives for new forms of customer interaction, to conclude our examples, are ways to take over some of their tasks (Asset management model) or to let them do more themselves (Taxi service, Joint concept development).

3.4.2 Explaining why innovations involve changes in multiple dimensions

An awareness of the various ways of construing a new service might contribute to a firm's perceived control when engaging in service innovation. To what extent a mutation in one or more dimensions enhances the quality or fitness of a service, is yet another issue. The success of service innovation arguably depends on a better understanding of the mechanisms determining how changes in various dimensions affect each other (Chae, 2012b). As noted earlier, authors stating that multiple dimensions should be aligned hardly place their views in an analytical framework (Den Hertog et al., 2010; Gallouj and Weinstein, 1997; Agarwal and Selen, 2011). Table 3.2 shows that the cases studied in this chapter indeed encompass an intermediate number of dimensions. Although the change that really defines a service innovation might be found in just a single dimension, the mapping exercise highlights the co-occurrence of modifications. Why is this the case?

According to NK-logic, the explanation lies in the interdependencies in a service's design space. Theoretically it might be possible to introduce changes in just a single dimension, but the question is whether a firm will truly improve its position by taking such incremental steps. If interdependencies are present, a fitness-enhancing mutation of one dimension can reduce the fitness of another. A common reaction, following the principle of 'problem solving', is to change the affected dimensions as well. The innovation a firm ultimately achieves will be characterized by adjustments in multiple dimensions, as if it had made one big 'leap'.

A striking example is the Asset management service, where we cannot or only scarcely imagine the innovation without a change in all the dimensions eventually affected. In this specific proposition, relatively unknown in the market of engineering agencies, the focal firm takes over some of its client's tasks by creating partnerships. Introducing a responsibility-based business model in which the engineering agency bears substantial risks (but is rewarded according to performance), instead of the current less attractive option of an hourly fee, is inherently connected to the creation of those partnerships. Only through creating high levels of trust, is the client willing to outsource even the strategic (rather than operational) planning of its asset management. According to the interviewees, mutation of the organizational delivery system turned out to be necessary once the first experimental steps were taken: the novel service requires so many new competences that external employees had to be employed (for acquiring skills in project management and finance) or taken over from the client (for relevant technical knowledge).

The graph in Figure 3.2 depicts the search for a new asset management model. For each of the six dimensions in the service design space, the graph shows the fitness values corresponding to particular service design configurations. The existing form of asset management marks the starting point for the search journey, which is why the fitness values for all dimensions are set as equal.[31] Adapting solely the service concept (by changing the allele of 'operational management' to 'strategic management') was perhaps an improvement in that specific dimension, but rendered other parts of the existing service unsuitable. For instance, it is practically impossible to provide strategic asset management without collaborating closely with the client. Consequently, such kinds of interdependencies (dotted lines between the dimensions) also affect the fitness of unchanged dimensions. Thus, in the scenario where only the service concept dimension is manipulated, we see that the change of fitness values leads to a reduction in overall fitness. Similar patterns might occur if any of the other interrelated dimensions were manipulated. In the last scenario, four out of six dimensions are manipulated, resulting in an overall fitness value that exceeds the starting position.

An innovation like the Asset management service would probably not be feasible if any of the changes did not materialize. Also in other cases, we observe how one or two key modifications required other dimensions to be modified in turn. For instance, in order to set up a shuttle service, the Port of Amsterdam had to change its organizational delivery system. While it could previously handle all its tasks with the organizational features at its disposal, the Port suddenly faced the fact that it had to alter the competences and tasks of the employees orchestrating the shuttle service. Likewise, in another case, offering real time navigation was perceived to reduce the attractiveness of the

31 Just like when scoring the changes in Table 3.2, we are only interested in changes relating to the starting position here. Note that Table 3.2 shows which dimensions were manipulated to what extent, whereas Figure 3.2 focusses on the fitness values of dimensions (which can also change due to the manipulation of an interrelated dimension).

previously appropriate selling-strategy. Instead of demanding clients pay an incidental fee for unlimited access to the renewed solution (like when offering PNDs), TomTom decided to correct the apparent unattractiveness of this revenue model by adjusting this dimension as well. In sum, our cases demonstrate how firms might end up with an innovation based on multiple changes when sequentially modifying the dimensions affected by design space interdependencies. The search strategy based on introducing incremental changes one-by-one is known as 'local search' or 'hill-climbing'.

3.4.3 Illustration of search strategies

Dependencies within services introduce a level of complexity with respect to balancing changes in multiple interdependent dimensions at the same time. Our cases provide two illustrations of strategies that can be used for dealing with this.

Service innovation through adaptive change

In addition to sequentially introducing mutations, as described above, there is also another route to new propositions based on mutations in multiple rather than one dimension.

By experimenting with resource configurations requiring just a single change, firms in a given market will eventually converge on an optimum within the fitness landscape. Some firms might try to imitate the identified peak, whereas those firms occupying worse local optima are likely to disappear from that market. The only way to outperform competitors is to discover even better combinations of activities, which requires firms to change several dimensions simultaneously. Rather than following an exploitative approach in which changes to a product are induced incrementally, this explorative approach is based on making 'leaps' in the fitness landscape. In the absence of accurate insights into the impact of certain mutations on other dimensions, the results of a leap are inherently uncertain. This implies that in the event a firm leaps successfully towards a radically new proposition, this long jump is often followed by improvements based on relatively minor adjustments. The innovation strategy whereby firms combine risky long jumps with more secure short walks, similar to alternating exploration and exploitation (March, 1991), is known as adaptive search (Levinthal, 1997; Beinhocker, 1999).[32] Figure 3.3 illustrates the notions of local and adaptive search in an evolutionary fitness landscape.

32 When shifting the scope from innovation at the firm-level towards technological trajectories as a whole, the combination of long jumps and subsequent incremental changes results in a pattern referred to as 'punctuated equilibrium' (Abernathy and Utterback, 1978; Mokyr, 1990).

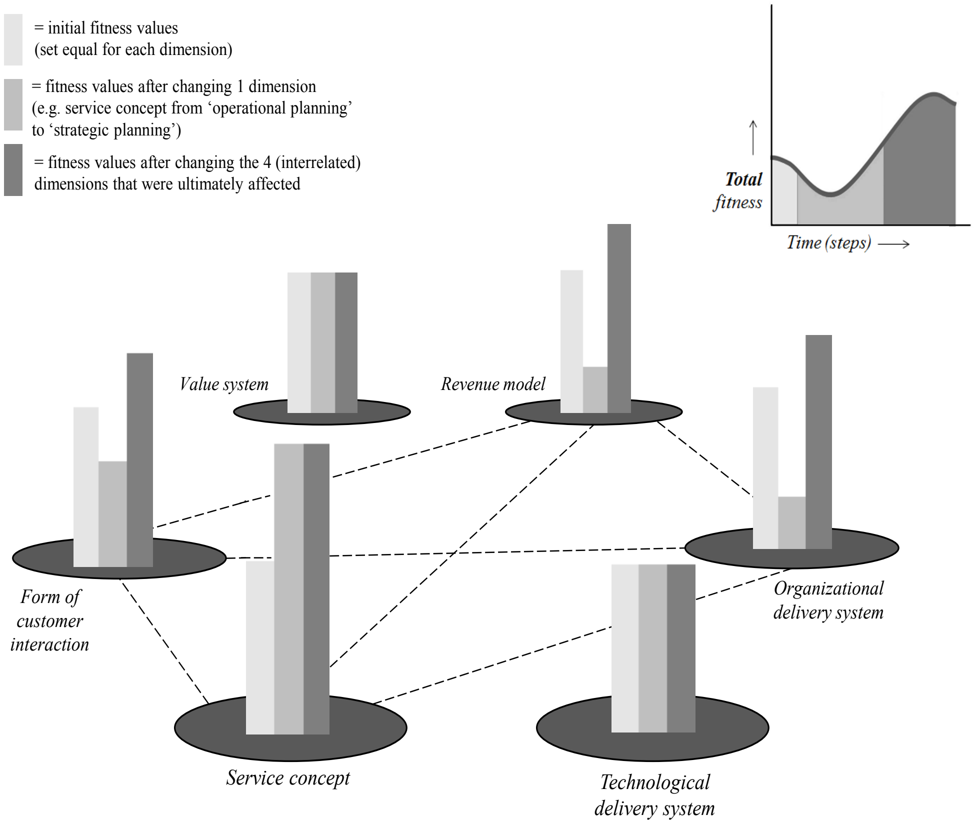


Figure 3.2: Service design space in the case of asset management, with fitness values (per dimension and total) corresponding with no modifications, one modification and four modifications.

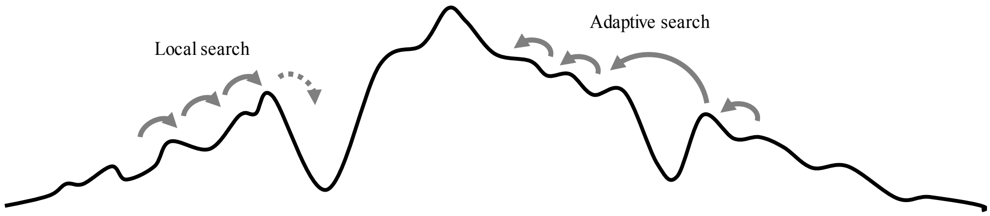


Figure 3.3: Local search and adaptive search in an evolutionary fitness landscape (based on Beinhocker, 1999, p. 100).

Looking at our mapping exercise, we see an excellent illustration of the adaptive search strategy in the case of the Online community developed by the insurance provider and its partners. The original platform, aimed at elderly people, was merely a different channel for communicating with customers. Subsequently, the insurance provider launched a platform aimed at freelancers. In exchange for a membership fee (i.e. different revenue model), the insurance provider started offering advisory services over the platform as well (i.e. new service concept).

These innovative steps highlight consecutive developments, as shown in Table 3.3. The small latter mutations build on the larger initial one, but are not a reaction to the negatively affected fitness of other dimensions (like the cases discussed in section 3.4.2). Creating the platform in the first place required the insurance provider to introduce changes in many aspects of its regular business. Apart from involving costly investments, this process also carried substantial risks. Failure to align technical developments with mutations in other dimensions could have resulted in a defect or unused platform. However, once the radical step was made, involving many dimensions, it presented the insurance provider with a basis for further development. The steps to deliver advisory services were relatively small, but did result in an additional stream of revenues.

The advantage of a strategy based on making risky leaps now and then is that it can provide a competitive edge with respect to imitators (Porter and Siggelkow, 2008). Competitors wishing to copy the ultimately identified configuration cannot simply implement the seemingly most lucrative part of the innovation because these latter mutations actually build on a series of interdependent changes (Bryson and Taylor, 2010).

Table 3.3: Example of service innovation through a large leap, followed by a smaller one.

		Affected dimensions of service innovation					
Case		*New service concept*	*New form of customer interaction*	*New value system / business partner*	*New revenue model*	*New organizational delivery system*	*New technological delivery system*
2.1	Online community for elderly people		Direct customer-interaction through platform	Partner developed and runs websites	Other insurances offered over platform	Provision of expertise via online commu-nication	Online community via web based platform
2.2 (extra)	*Additional* changes for Only community for freelancers	Insurance provider now delivers advice to community			Customers pay fee for membership		
2.2 (total)	Only community for freelancers	Insurance provider now delivers advice to community	Direct customer-interaction and advice through platform	Partner developed and runs websites	Customers pay fee for membership	Provision of expertise via online commu-nication	Online community via webbased platform

Service innovation through modular changes

In Figure 3.1 we showed how the architecture of a multidimensional product could look like. An alternative configuration occurs when one mutation impacts a couple of dimensions whereas another mutation affects distinct set of dimensions. Characteristic for a modular design is the presence of strong interdependencies within modules, but none or few between them (Frenken and Mendritzki, 2012). The Joint concept development by the trade mart exemplifies how modular design in services can be organized.

The core of this innovation lies at the establishment of a commission in which the trade mart cooperates with her clients. By introducing this permanent partnership, the trade mart created a structure for continuously staying up to date of the exhibitioners' needs. This helped her to improve the quality of her services, but also led to loyalty amongst the clients.

A second development concerns the trade marts' decision to offer more than just the rental of her facilities (notably: floor space). The trade mart started deploying activities to attract more visitors to her fairs, like organizing events and improving her visitor administration so she could send directed invitations. In order to arrange these events and enhance her image, she collaborated with an external partner that assisted in the process of concept development.

The reason both of these developments were grouped together in Table 3.2, is that they occurred simultaneously. However, when taking a closer look, one could observe that the two steps are not necessarily interrelated. Although the client commission does happen to be involved in the concept development, those two sets of mutations are distinct and could have occurred without each other. Introduction of a slightly altered service concept (events in addition to ordinary trade exhibition) only required the involvement of a partner, whereas establishment of the marketing commission was mainly an intra-organizational issue (Table 3.4).

Because the various modules involved do not have an impact on each other, search efforts can benefit from ample possibilities to engage in hill-climbing rather than being required to make risky long jumps (Frenken and Mendritzki, 2012). So far, only few studies examined how modularity can reduce complexity in service innovation (Carlborg et al., 2014; Rahikka et al., 2011; Zolnowski et al., 2013). Our mapping analysis shows how modular designs in services can be examined.

Table 3.4: Example of service innovation through two modular transformations, each of them involving multiple but distinct dimensions.

Case		Affected dimensions of service innovation					
		New service concept	*New form of customer interaction*	*New value system / business partner*	*New revenue model*	*New organizational delivery system*	*New technological delivery system*
3a	Joint decision making		Marketing commission for cooperation with client			Focus on collaboration instead of on selling	
3b	Event organizing	Firm offers more than surface: also events		External partner facilitates joint concept development			

3.5 CONCLUSIONS

The purpose of this chapter is to advance the multidimensional approach to service innovation (Carlborg et al., 2014). According to evolutionary theorizing, service innovation can be interpreted as the deliberate variation of elements in a multidimensional design space (Chae, 2012a, 2012b). We operationalized this line of thinking by enriching it with insights stemming from the debate on how to conceptualize multidimensional services (Den Hertog et al., 2010; Agarwal and Selen, 2011; Den Hertog, 2000). Besides providing an empirical examination based on mapping service innovations in such a multidimensional conceptualization, we illustrated how to investigate search strategies for mutating those interrelated dimensions.

3.5.1 Qualitative assessment of dimensionality in service innovation

Our empirical illustration of the conceptualization by Den Hertog et al. (2010) gives a qualitative impression of the dimensionality of service innovation. Highlighting the commonalities and differences in eight highly distinct cases, the described applications provide guidance during a firm's search process: which service aspects can be changed, and how (Rubalcaba et al., 2012)?

A substantial advantage of adhering to a single conceptualization to delimit the dimensions of a service design space, rather than identifying new ones over and over again, is that it provides a solid basis for comparative analysis (Gallouj and Toivonen, 2011/2; Chapter 2). From the increasingly adopted synthesis perspective to innovation (Coombs and Miles, 2000; Carlborg et al., 2014), aiming to develop all-encompassing innovation theory, there is ample interest in frameworks allowing scholars to learn from service innovation efforts in a wide variety of industries. Whereas intangibility might make innovations hardly comparable, even within industries, representing them in a single design space gives a more comprehensive view on what an innovation exactly entails and what elements could be useful in other circumstances as well.

A comparison of the various mutations that occur in certain dimensions points to the existence of archetypical modifications. Familiarity with such common modifications, regardless of where their context originated, can support firms considering which changes to introduce in which dimensions. Especially once these mutations become commonly known and are codified (Nonaka and Takeuchi, 1995) or formalized adequately (Gallouj and Weinstein, 1997), the perceived transparency of design options can be increased. Besides enhancing possibilities for innovation through recombining standard mutations (following Schumpeter, 1934), the proven success of a particular mutation could also result in less organizational resistance to adopting it (Schilling et al., 2012).

3.5.2 Dealing with interdependencies between dimensions

The mapping technique we introduce provides a structure for analyzing the co-occurrence of changes in multiple dimensions (see Den Hertog et al., 2010). Building on NK-logic and our case evidence, we argue that it is due to interdependencies in the design space that substantial fitness increases depend on series of related modifications. Occasionally it might be 'technically' possible to modify just a single dimension, but the associated risk is that the usability (or evolutionary fitness) of the resulting service will turn out to be weak.

The observation that most innovations involve simultaneous changes in multiple dimensions illustrates the complexity of the search process service innovators engage in. A search strategy for dealing with this is adaptive search, which relies on a combination of explorative and exploitative innovations. The observation that firms can develop new services by making long jumps gives us a basis for determining when radical service innovation is prevalent. This is not necessarily only a matter of the relative novelty of a certain mutation (Chae, 2012a), but also the number of dimensions involved. Conceptualizing the extent of radicalness in service innovation according to these two alternative perspectives paves the way to verification of expectations regarding the relationship with organizational performance or environmental characteristics (Droege et al., 2009; Chae, 2012b). Besides distinguishing genuinely new mutations from common mutations, a 'giant leap' can also be interpreted as a service innovation in which multiple dimensions are changed simultaneously. In a modular search strategy, it is possible to mutate multiple dimensions without affecting other ones. This strategy thus allows firms to follow a relatively controlled search journey (focusing on blocks of dimensions that only have internal interdependencies) for arriving at radically new positions.

3.5.3 Reflections on the scope of this study

Our empirical exercise was essentially exploratory: as empirical strategy, we opted for studying multiple cases (following recommendations by Porter and Siggelkow, 2008) instead of focusing on a single in-depth case. Applying the well-delineated multidimensional conceptualization by Den Hertog et al. (2010) to heterogeneous service innovations illustrated its relevance for the wide spectrum of service solutions. The corresponding possibilities for comparative research, in turn, contribute to the development of an integrated rather than a sector-based account of service innovation reality (Rubalcaba et al., 2012).

The observed correlations between affected dimensions tell us something about interdependencies in the innovations' design space. Just as none of them relied on change in only one single dimension, none of the innovations covered all dimensions. Our sample is not large enough to interpret the case results as sound statistical data, but there is some evidence that most cases only encompass an intermediate number of dimensions. Such a finding is common for other studies of real-world examples as well (Simon, 2002). Counting major changes as entire mutations, and minor changes as half a mutation, the examined cases typically demonstrate 3 or sometimes 4 interrelated changes. In terms of the NK-model, we can state that our cases tell us something about the degree of interdependence ($K \approx 2$) commonly associated with the respective design spaces ($N = 6$) based on the framework by Den Hertog et al. (2010).[33] Our findings allow scholars to experiment with calibrated NK models in studies simulating how firms can benefit from different search strategies when exploring a service design space.

Another observation, regarding the various investigated cases, is that there are no coherent patterns of interdependencies across innovations. Technology is not central (Den Hertog, 2000; Agarwal and Selen, 2011), and the service concept can change without requiring every other dimension to change (and vice versa). These findings indicate that the interactions between dimensions indeed vary across innovations (Den Hertog et al., 2010), which will have to be verified by statistical studies. On the other hand, it should be noted that the investigated cases differ greatly, as is to be expected considering the variety of industries they represent. Naturally, this limits the likelihood of encountering regularities in the interdependencies between mutations. The value of the present study, however, lies exactly in our demonstration of how a single conceptualization can be applied to analyze modifications in the design of very heterogeneous intangibles.

33 Note that the number of dimensions involved is always 1 dimension higher than the level of interdependencies; the maximum value for K is N-1.

3.5.4 Limitations and further research

Our approach is based on the assumption that firms face a range of design options when deciding what forms of novelty to introduce. Customer demands and changing market circumstances can be a major driver of innovation, but ultimately, it is up to the firms creating the innovations to determine which ones will emerge. Nevertheless, we acknowledge that our approach mainly applies to contexts where firms innovate by making (one or more) archetypical or original modifications to an existing offering. This suggests that the proposed interpretation of innovation does not hold for breakthrough innovations. Then again, our evolutionary perspective regards all innovation as a matter of recombination.

Now that the applicability of our approach has been established in different contexts, one of the natural extensions of the current study concerns a detailed and comprehensive investigation of the development of individual services over time. Tracking the sequence of mutations within a certain type of service is likely to reveal how consistently certain combinations of mutations occur, and which contextual factors cause these interdependencies. Examples here are: analyzing the array of mutations that led knowledge-intensive business services (KIBS) to interact increasingly closely with their customers, mapping the consecutive steps which retailers take to implement self-service concepts, or identifying the various paths through which new services like search engine optimization originate from existing services.

An important challenge for this type of research is identifying a useful unit of analysis. The proposed sequencing approach can be applied to map the different mutations that occur during the development of a service within a single firm, as well as the mutations that a particular type of service (delivered by multiple market parties) undergoes. Thereby, the approach provides access to promising lines of inquiry such as investigation of the factors that determine why there are regularities in the architecture of a certain service. One possible explanation for mutations to follow a certain pattern is found in the concept that path dependency stretches beyond the influence of technological and physical rigidities only: according to Thrane et al., (2010, p. 943), "firms may be locked-in to an innovation approach favouring some types of innovations over others". In the context of services, this might be translated to cognitive myopia with respect to the dimensions being considered at a given point in time.

By building on the literature dealing with innovation management and entrepreneurial experimentation, this study focuses on the way firms explore a design space. It should be noted that this search process is often inspired by the feedback from intense client-interaction during service delivery (Gustafsson et al., 2012). How this client interaction is organized is one dimension of the service design space, but additional research is required on how innovating firms deal with all the insights they obtain from their customers. Touching upon the issue of radicalness again, for instance, it is questionable whether listening carefully to customers' suggestions truly increases firms' ability to introduce highly novel innovations (Droege et al., 2009). NK-logic enables us to examine whether relying on user feedback changes the probability that firms identify global rather than local optima in the fitness landscape.

3.5.5 Managerial implications

Interpreting service innovation as a combinatorial search process in complex multidimensional spaces has important implications for how firms can enhance their competiveness. In the current study, we contributed to the validation of a practical technique for mapping and comparing the modifications that shape a certain service innovation. Existing research suggests that abstract representations of a product, for instance in the form of a business model canvas, do help firms to align foreseen modifications in order to develop successful innovations (Osterwalder and Pigneur, 2010). Applying such methods for the (re)design of services requires the availability of a comprehensive framework (Witell and Löfgren, 2013; Zolnowski et al., 2013). Our examination of the multidimensional conceptualization by Den Hertog et al. (2010) should be seen as a step in this direction.

On the one hand, the use of common dimensions opens the door to inter-organizational learning in the context of non-competing and seemingly very heterogeneous services. Our efforts highlight a form of local search we refer to as identifying archetypical mutations (new to the firm, but not new for the domain of service innovation as such). Analogous to cross-fertilization enabled by the observation of successful technological elements (Björkdahl, 2009), the discovery of those archetypical mutations allows service innovators to base a newly designed proposition on the adaptation of proven service features. Future research applying our concept of a service design space in more settings could lead to an extended and more detailed view of standard 'alleles', how they can be implemented, and in what combinations they tend to occur.

On the other hand, we stress that managers should use the presented mapping exercise merely for the purpose of generating ideas. Intangibility and the presence of many or ill-understood interdependencies arguably create circumstances in which it is difficult to learn about successful service configurations (Chae, 2012b). As such, these characteristics hamper the possibilities to adopt a potentially interesting mutation straight away, and even the mere replication of a (newly developed) service proposition (Bowen and Ford, 2002). However, to conclude on a positive note, they also imply that the opportunities for competitors to imitate a successful configuration are limited (Porter and Siggelkow, 2008; Bryson and Taylor, 2010).

PART B:

Management of service innovation - A capability perspective

Chapter 4

Dynamic capabilities for service innovation: Conceptualization and measurement

4.1 INTRODUCTION

According to evolutionary theorizing, the continuous creation of novelty and variety in economic activity is a key driver for development and prosperity (Schumpeter, 1934). To a large extent, the mechanisms behind economic and technological change rely on firm-level entrepreneurial experimentation (Nelson and Winter, 1982; Dosi et al., 2010). By developing dynamic capabilities, firms are able to generate, adopt and apply new knowledge that can power innovative output (Teece and Pisano, 1994). The issue is also of concern to policy makers, as organizations having weak dynamic capabilities might hamper the processes of knowledge production and dissemination that characterize a well-functioning innovation system (Edquist, 2011).

Recent research has explored the nature and forms of these capabilities in different contexts, focusing on specific organizational processes and structures that represent capability micro-foundations (Teece, 2007; Foss, 2011). While identifying dynamic capabilities has been addressed extensively within the context of technological innovation, the discussion is fairly nascent in the service innovation literature. This is regrettable, as innovation in the domain of services plays an essential role within economies (Leiponen, 2012): not only do professional and knowledge intensive business services spur innovation in other industries (Muller and Zenker, 2001), but novel services are regarded as a source of competitive advantage for virtually all industries (Vargo and Lusch, 2004, Consoli, 2007).

Many firms experience severe problems when developing new services and their attempts often fail (Smith et al., 2007). Prescriptive instruments for service innovation are frequently urged for (Sundbo, 1997; Gallouj and Djellal, 2010). However, in order to enhance firms' ability to introduce new services successfully, it is crucial to empirically investigate which capabilities are important (e.g. Rubalcaba et al., 2010; Den Hertog et al., 2010). Such evidence can only be gained through inter-firm comparison, rather than by identifying firm-specific capabilities (Baretto, 2010). Similarly, the development of capability-supporting policy instruments and their evaluation demand metrics that can indicate the relative strength of firms' potential to create new services.

To this end, this chapter aims to operationalize a set of dynamic capabilities for service innovation that is general enough to be relevant across different sectoral contexts, yet sufficiently specific to capture the salient evolutionary properties of individual firms' dynamic capabilities. These goals are in line with a so-called synthesis approach to service innovation (Coombs and Miles, 2000; Gallouj, 1994), which is advocated as the step required to advance innovation research as a whole. Once these criteria are met, scholars can investigate similarities and differences across firms in order to equip managers and policy makers with a basis for assessing where to direct investments in capability development.

To meet our objective, we first review existing conceptualizations of dynamic service innovation capabilities (DSICs). After reviewing recent contributions to the dynamic capability view in management theory, we discuss how these have been integrated into the domain of services by studies stemming from the domain of business strategy, marketing and service management. In absence of a central debate in which the various conceptualizations are related to each other, it remains unclear which approach is most suited to assess the relative strength of DSICs. In order to move forward with developing an actual measurement scale, we create a systematic overview and select the conceptualization that fits best with a synthesis approach to service innovation.

Next, we use two subsamples of a multi-industry survey to separately purify and validate a measurement scale. Results from the corresponding exploratory and confirmatory factor analyses show that the selected capabilities can be measured accurately. The most important modification of the original framework concerns the finding that one of the capabilities appears to consist of two sub-capabilities. Apart from assessing convergent and discriminant validity, we use structural equation modeling (SEM) for analyzing the structural paths between the capabilities. Finally, we assess to what extent the distinct DSICs can be associated with turnover from innovation and comparative firm performance. We find positive relations, but the exact value of a particular dynamic capability differs per performance measure.

The validated measurement scale, which is our main contribution, captures to what extent firms possess DSICs that are relevant for different processes concerning novelty creation and application. For researchers, this common measure opens the way for comparative analysis across firms and industries, whereas for managers and policy makers, the scale offers a prescriptive tool to strengthen capabilities for service innovation.

4.2 THEORETICAL BACKGROUND

4.2.1 The dynamic capabilities view

New ways for creating and capturing value often require an enterprise to extend, modify, or completely revamp what it is doing (Katkalo et al., 2010). Dynamic capabilities play a crucial role in this respect: they refer to a firm's ability to adapt its structural organization and resulting output (Teece et al., 1997). Zollo and Winter (2002) describe a dynamic capability as "the learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness".

Despite its theoretical usefulness and broad adoption, the concept of dynamic capabilities proves difficult to operationalize properly. In fact, most contributions in the dynamic capability view (DCV) concern debates on its foundations (Di Stefano et al., 2010). Critics point at the lack of empirical grounding (Zahra et al., 2006) and accurate measurement (Williamson, 1999). Focusing on solely the analytical value of dynamic capabilities, many empirical studies are characterized by the use of distant proxies. In an attempt to make the DCV more hands-on, Teece (2007) specified the *micro-foundations* undergirding *a set of common dynamic capabilities*. His contribution departs from traditional DCV in two respects, which we consider as key properties of the current understanding of the nature of dynamic capabilities.

First, a focus on a few 'fundamental' classes of dynamic capabilities presumes that, despite being executed in firm-specific ways, dynamic capabilities in different organizations and even industries have elements in common on a high level of abstraction. Eisenhardt and Martin (2000) refer to this as 'commonalities in key features, idiosyncrasy in details'. Assuming there are common characteristics within dynamic capabilities that stretch over a range of industries, it is possible to develop frameworks of distinct general dynamic capabilities. Exemplary is the frequently adopted set of 'distinct clusters of activities' as proposed by Teece (2007), covering capabilities for sensing, seizing and transforming. Being positioned in a neo-Schumpeterian tradition, the capabilities fit closely with the *evolutionary mechanism* that describes how organizational learning and novelty creation occur (Zollo and Winter, 2002). Firms use dynamic capabilities for exploring new variations, selecting possible courses of action, and exploiting their newly developed organizational competences (Roper et al., 2008; Nelson and Winter, 1982). The framework suggested by Teece incorporates the firm-level processes of knowledge sourcing, transformation and exploitation by stressing the relevance of each capability for, respectively: acquiring new ideas, converting them into (propositions for) new or altered products, and finally, reconfiguring the organization and its output (Teece, 2007; Barreto, 2010). By building and using the sensing, seizing and reconfiguring capabilities, managers can perform the complementary acts of discovering, creating, defining and exploiting entrepreneurial opportunities (Zahra et al., 2006; Salvato, 2003). The offering (i.e. resource configuration) that results from using these dynamic capabilities will be subjected to forces of market selection, thereby influencing the survival probability of the firm (Metcalfe, 1995; Zott, 2003).

The second key property of the current DCV refers to attempts to separate dynamic capabilities from their constituent micro-foundations (Teece, 2007). This responds directly to the question of what exactly is in the 'black box' of dynamic capabilities (Pavlou and El Sawy, 2011). In the quest for a better empirical grounding of the DCV, it has been urged to break capabilities into component elements; their micro-foundations (Foss, 2011). This notion is used for activities at lower levels of abstraction, including organizational routines like managerial processes, procedures, systems, and structures (Salvato and Rerup, 2011), down to the behavior of individuals within an organization. According to Foss (2011), establishing the link between micro-foundations and capabilities is essential in order to create explanatory leverage for every resource-based theory.

4.2.2 Dynamic service innovation capabilities

Applying the DCV to service innovation

Dynamic capabilities play a major role in innovation literature (Crossan and Apaydin, 2010). Hogan et al. (2011) note that many attempts to conceptualize dynamic capabilities for innovation are focused on large firms in manufacturing and high-technology industries. Likewise, other scholars question whether innovation capabilities encountered in such industries are relevant in a service context (Kindström et al., 2012). These critiques touch upon a widely expressed concern regarding the neglected specifics of R&D and innovation in 'non-manufacturing' firms (Leiponen, 2012). Indeed, literature devoted to service innovation has identified several reasons why existing innovation theories might not hold for services (Gallouj and Djellal, 2010).

Distinctive features of services, as compared to goods, are that they are intangible, heterogeneous, non-stockable (due to simultaneous production and consumption) and coproduced with clients (Parasuraman et al., 1985; Bowen and Ford, 2002). Generally, these characteristics affect the dynamics of processes concerned with service innovation. Compared to strictly technological R&D, the search for new service solutions is hardly organized in a formalized manner, which can for example be concluded from the fact that R&D-budgets are scarce amongst service industries (Miles, 2005). Rather, the development of services often occurs through implicit and possibly non-systematic ways (Thomke, 2003; Miles, 2007). Partially due to the prominent role of customers in service production, activities related to the development and deployment of new services tend to be distributed throughout (or even beyond) an organization (Gallouj and Weinstein, 1997).

The aforementioned service features suggest that, compared to measuring formal R&D activity, looking at dynamic capabilities for service innovation might be a promising alternative for gauging an organization's ability to develop and implement new service concepts (Teirlinck and Spithoven, 2013; Leiponen, 2012). However, service particularities also have implications for the applicability of DCV conceptualizations. So far, scholars have taken very different approaches when trying to apply the DCV to service innovation. The fact that concurrent perspectives could emerge is highly related to the abstract nature of the concept of capability, which allows for variation in the way the DCV is conceptualized to capture service peculiarities. By using the key properties of the DCV, as outlined in section 4.2.1, we systematically evaluate existing attempts to conceptualize dynamic capabilities for service innovation. Remarkable is that cross-references tend to be scarce, leading to an unconnected body of research and hampering knowledge accumulation. After an initial proliferation of concepts, it is essential that the literature consolidates and capitalizes on previous research in a more structured way (Barreto, 2010, p. 277). Our overview can also be regarded as a first step in this direction.

An evaluation of current research on dynamic service innovation capabilities

While there have been several studies defining and/or measuring capabilities for service innovation, only a selected set of those fulfill in our view the requirements advocated by Teece (2007). When searching for conceptualizations in a services context, we exclude those studies that do not pertain to behavioral foundations.[34] As discussed before, an accurate indication of the strength of service innovation capabilities rests indeed on efforts to identify the micro-foundations undergirding a common set of dynamic capabilities (Teece, 2007).

Conceptualizations that do provide a basis for grounded and comparative analysis of firms' abilities to generate and implement new services can be categorized regarding the scope of dynamic capabilities they distinguish. We find that the different attempts so far have followed patterns similar to the application of other innovation theories to the case of services. We recognize three approaches, reflecting how the thinking on service innovation has evolved over the past decades: *assimilation*, *demarcation* and *synthesis* (Gallouj, 1994; Coombs and Miles, 2000). Table 4.1 shows the corresponding attempts to conceptualize dynamic capabilities with relevance for service innovation, and how they deal with the two key properties of the current DCV as defined in our discussion.

First, the assimilation approach (Gallouj, 1994) assumes that service innovation can be analyzed with concepts and tools developed in the context of innovation in mainly manufacturing industries (Tether, 2005). In this vein, Fischer et al. (2010), as well as Kindström et al. (2012), identify micro-foundations that are particularly relevant for manufacturing firms turning towards service development and delivery. By regarding service innovation processes as similar to technological innovation, identification of just service specific innovation routines concerns 'details' rather than the key constructs (Eisenhardt and Martin, 2000). As a result, conceptualizations like the ones above are found to be too general to capture accurately the peculiarities of service innovation processes (Salunke et al., 2011). Conceptualizing service innovation capabilities from a manufacturing or technological R&D perspective thus brings the risk of a myopic view, in this case by restricting the scope of which micro-foundations to include.

34 For instance, the studies by Leiponen (2006), Ordanini and Parasuraman (2011), and Forsman (2011) do not specify on what behavioral activities their dynamic capabilities rely. Also studies focusing on (antecedents of) new service development (NSD) are beyond the scope of our evaluation, since they tend to analyze individual practices rather than capability conceptualizations grounded in the current DCV.

Table 4.1: Overview of conceptualizations of dynamic capabilities for service innovation.

Approach	Key properties of DCV		Example of conceptualization in services		
	Application of commonality	*Focus of micro-foundations*	*Authors*	*Identified capabilities*	*Industry*
Assimilation	Goods-based set of capabilities, associated with evolutionary mechanism*	Service specific translation of goods-based capabilities	Fischer et al. (2010)	Sensing, Seizing, Reconfiguring	servicizing organizations
			Kindström et al. (2012)	Sensing, Seizing, Reconfiguring	servicizing organizations
			Gebauer et al. (2012)	Sensing, Seizing, Reconfiguring	small/medium-sized suppliers
Demarcation	Service specific set of dynamic capabilities, not associated with evolutionary mechanism*	Idiosyncratic (service specific) innovation routines	Agarwal and Selen (2009)	Customer engagement, collaborative agility, entrepreneurial alertness, and collaborative innovative capacity	collaborative services
			Salunke et al. (2011)	Episodic learning , relational learning , client-focused learning ,and combinative capability	(entrepreneurial) project-oriented service firms
			Hogan et al. (2011)	Client-focused, marketing-focused, and technology-focused innovation capability	professional service providers
Synthesis	Extended set of dynamic capabilities, associated with evolutionary mechanism*	Wide range of innovation routines	Den Hertog et al. (2010)	Sensing user needs & technological options, conceptualizing, (un)bundling, coproducing & orchestrating, scaling & stretching, and learning & adapting. capability	(all industries)

*Association with evolutionary mechanism refers to conceptualizations in which the capabilities match distinct but complementary processes through which firms source, convert and exploit knowledge (Nelson and Winter, 1982; Teece, 2007; Baretto, 2010).

Second, the demarcation approach includes studies and theories addressing the specificities of services and service innovation processes. Instead of searching for micro-foundations that can be grouped into an existing framework of dynamic capabilities, studies in this approach introduce service particularities in the capabilities themselves. Thereby, they reveal or pronounce the fundamentally different nature of service innovation (as opposed to innovation in goods). The examples in Table 4.1 concern sets of dynamic capabilities that are specific for a single type of service, e.g. professional services (Hogan et al., 2011) or 'elevated service offerings' (Agarwal and Selen, 2009). Thereby, the conceptualizations are well-suited to capture routines that are idiosyncratic for service innovation processes in these contexts, but limited in their further applicability to other sectoral contexts. Moreover, the theoretical underpinnings diverge from the evolutionary inspired processes prominent in the original DCV.

Finally, the synthesis approach refers to theories and frameworks in which insights from the previous two approaches are integrated into a novel, more integrated view on innovation (Metcalfe, 1998). Although our literature survey does not pretend to be exhaustive, we hardly encountered a conceptualization of dynamic service innovation capabilities that fits within the emerging synthesis approach. An exception is the conceptual framework by Den Hertog et al. (2010), in which six complementary capabilities are proposed as a representation of a firm's capacity to acquire and apply new knowledge in novel services.

Compared to conceptualizations from the assimilation approach, the extended set of capabilities by Den Hertog et al. (2010) is better suited to grasp the idiosyncrasies of innovation in intangibles. At the same time, it avoids putting emphasis on capabilities that would only be relevant for a single type of ('pure') service providers. Additionally, the complementarities between the capabilities offer a basis for studying evolutionary dynamics. As a service-based extension of the original set by Teece (2007), all capabilities can be conceptually associated with the evolutionary mechanism through which entrepreneurial experimentation leads to novelty creation and determines firm evolution (Metcalfe, 1995; Salvato, 2003). 'Sensing user needs and (technological) options', provides ideas for new or altered propositions.[35] 'Conceptualizing' and '(un) bundling' both concerns capabilities essential for selecting an idea and developing it into a detailed proposition. Finally, '(co)producing & orchestrating', as well as 'scaling & stretching', are related to efforts in which a new service is actually delivered to the market. Being a meta-capability, 'learning & adapting' corresponds less with the evolutionary mechanism of consecutively generating ideas, converting them into propositions, and exploiting them on the market (see section 4.3.1).

When introducing their framework, Den Hertog et al. (2010, p. 506), state that it can only be used as a prescriptive tool once empirically tested, which is what we will do in the remainder of this chapter. In particular, we will test on the basis of an extensive survey whether the six dynamic capabilities as distinguished by Den Hertog et al. (2010) can indeed be identified empirically in service firms.

35 To emphasize that the term 'technology' here is consistent with the common meaning of 'technological knowledge', which is broader than only artifact-related knowledge, we place it in brackets.

4.3 DEVELOPING A MEASUREMENT SCALE FOR DYNAMIC CAPABILITIES IN SERVICE INNOVATION

Table 4.2 shows the research methodology and research design we followed in our scale development and testing process (Anderson and Gerbing, 1988; Churchill, 1979). Using the theoretical lens of the current DCV, we started by refining the selected conceptualization. We then performed an exploratory analysis to assess which items could be included in our measurement scale, followed by confirmatory analysis for validity and reliability checks.

Table 4.2: Research design for development of measurement scale.

Phase	Step	Actions
Theoretical grounding	1. Identify constructs	Literature review
	2. (Re)define constructs	Use key properties of DCV to refine the selected framework
Instrument design	3. Generate scale items	Formulate items by identifying micro-foundations (literature review and convergent interviewing)
	4. Test and revise scale items	Deploy pilot survey: interview respondents for ensuring clarity and validity of items
Data analysis	5. Exploratory analysis	Principal component analysis: identification of items that load well on the associated construct (use random half of data)
	6. Confirmatory analysis	Confirmatory factor analysis: assessing reliability as well as convergent and discriminant validity (use other half of data)
	7. Correlation analysis	Estimate structural paths between constructs (using SEM)
	8. External validity	Assess relation with performance measures

4.3.1. Refining the selected conceptualization

The key properties we introduced in section 4.2.1 allowed us to refine and operationalize the selected set of dynamic capabilities for service innovation. Specifically, the theoretical foundations of the modern DCV guided us in the choice of which capabilities of the conceptualization by Den Hertog et al. (2010) to include or exclude, and how to formulate items for their measurement.

First, we applied the perspective of commonality. Essential is that conceptualizations entail a multidimensional set of common but empirically distinct capabilities, although co-occurrence might occur in certain patterns. Learning and adapting, however, is explicitly defined as a meta-capability that helps an organization to reflect upon (and improve) the other capabilities. Thereby, it is not a separate dimension of the same order as the others. Den Hertog et al. (2010) expected that learning is linked to all of the other dimensions, which also implies that it cannot be measured as a distinct capability.

Second, we checked whether each capability can be disaggregated into several constituting micro-foundations. On this basis we also excluded (un)bundling, since it does not reflect a dynamic capability that can be related to observable activities. The capability, as described by Den Hertog et al. (2010), essentially indicates whether an innovation is recombined or not: it is actually a property of innovation and thus a result of the strategic use of dynamic capabilities. Treating information about the outcome of an innovation process as a capability would lead to causal ambiguity, of which the DCV is frequently accused (Williamson, 1999).

4.3.2 Instrument design

Given the abstract nature of dynamic capabilities, their operationalization provides a considerable challenge (Zahra et al., 2006). We developed multi-item 7-point Likert scales, which respondents rated from "strongly disagree" to "strongly agree", for each of the four remaining service innovation capabilities. The scales consisted of statements regarding the presence of particular firm activities, reflecting micro-foundations at the level of concrete processes and structures (Teece, 2007). Since we are interested in a measurement scale that allows for comparative analysis, focusing on such routines is of greater use than exploring the various ways individuals execute them.

With respect to the development of actual items for the multi-item scale of each capability, the theoretical underpinnings of the original framework discussed at length in Den Hertog et al. (2010) and our own additional refinements discussed above guided us in ensuring content validity, i.e. the requirement that the items truly reflect the constructs they are supposed to measure (Churchill, 1979). Additionally, the dynamic capabilities' constructs had a prominent role in nine in-depth case studies of firms that varied in the degree to which they could consistently and continuously develop and implement service innovations. Convergent interviewing based on a semi-structured interview protocol enriched our understanding of organizational processes that may be part of the respective capabilities for service innovation.

After formulating our initial set of items, face-to-face interviews with researchers and pre-tests with respondents from various organization types and sizes delivered useful comments on how to improve the clarity and validity of the scales. Comments concerned unknown words, unclear phrases, and queries about what to do when a question was not relevant to the respondent's situation. The final phrasing of the resulting 18 items, as well as the codes used in the remainder of this analysis, can be found in Table 4.3. In the design of our questionnaire, we followed procedural precautions like guaranteeing respondent anonymity (Podsakoff et al., 2003).

Table 4.3: Survey items.

Construct with underlying items	Item code
Sensing user needs and (technological) options	
• We systematically observe and evaluate the needs of our customers.	SensingA
• We analyze the actual use of our services.	SensingB
• Our organization is strong in distinguishing different groups of users and market segments.	SensingC
• Staying up to date with promising new services and technologies is important for our organization.	SensingD
• In order to identify possibilities for new services, we use different information sources.	SensingE
• We follow which technologies our competitors use.	SensingF
Conceptualizing	
• We are innovative in coming up with ideas for new service concepts.	ConcepA
• We find it hard to translate raw ideas into detailed services.[a]	ConcepB
• Our organization experiments with new service concepts.	ConcepC
• We align new service offerings with our current business and processes.	ConcepD
Coproducing & orchestrating	
• Our organization has problems with initiating and maintaining partnerships.[a]	CoprOrchA
• Collaboration with other organizations helps us in improving or introducing new services.	CoprOrchB
• Our organization is strong in coordinating service innovation activities involving several parties.	CoprOrchC
Scaling & stretching	
• We are able to stretch a successful new service over our entire organization.[a]	ScaleStretchA
• In the development of new services, we take into account our branding strategy.	ScaleStretchB
• Our organization is actively engaged in promoting its new services.	ScaleStretchC
• We introduce new services by following our marketing plan.	ScaleStretchD
• We find it difficult to scale up a successful new service.[a]	ScaleStretchE

[a] Item removed from final version of the scale.

4.3.3 Sampling profile

To test the newly developed scale empirically, we drew a sample from multiple industries, warranted by the broad reach of the service innovation phenomenon (Drejer, 2004; Gallouj and Djellal, 2010). Data were collected through a survey of single-business firms or business units, each with more than 10 full-time employees. Using databases from Bureau van Dijk, we retrieved contact information of Dutch firms located in the Northern Randstad, the broad central region of the Netherlands where most national economic activity and population are concentrated. The questionnaire was sent to 8054 firms and addressed to the CEOs or senior executives to ensure that the respondents were knowledgeable about the key firm processes under investigation in this study (Miller et al., 1998). The questionnaire was administered by mail with the option to be filled in via the web if preferred. We obtained complete responses on our scale from 391 firms. Further details on data collection are described in the general appendix 'Data Sources and Co-authorships' in the back of this thesis.

4.3.4 Data preparation

Since the constructs we aim to measure have only been developed conceptually in earlier works (Den Hertog et al., 2010; Den Hertog, 2010), our operationalization required an exploratory step (Gerbing and Hamilton, 1996). Following Anderson and Gerbing (1988), we used a two-stage process for the exploration and validation of the factorial structure of questionnaire items. In order to do so, we split our dataset into two equal parts of randomly chosen cases. Dataset 1 (n = 196) was used for principal component analysis, whereas dataset 2 (n = 195) was used for the subsequent confirmatory factor analysis.

4.4 DATA ANALYSIS

4.4.1 Item reduction for measurement purification (exploratory analysis)

Our measurement scale was constructed as follows. We entered all 18 items in a principal component analysis (PCA) on dataset 1. A dataset of 196 responses was sufficient to test all the constructs at once, given the fulfilled requirement of a 5 to 1 ratio of sample size to number of estimated parameters (Shook et al., 2004). The Kaiser-Meyer-Olkin (KMO) measure (0.84) for sample adequacy was sufficient and above the critical value of 0.50.

The Varimax-rotated PCA reproduced the anticipated structure of factor loadings reasonably well. However, the items for sensing user needs and (technological) options appeared to load on two distinct factors. The first three items can be associated with the intelligence-function focused at what customers want, whereas the second set of three items mainly relate to sensing possibilities for producing a new offering. The observation that keeping up-to-date with market developments consists of two (sub) capabilities concerning demand and supply matches the 'customer orientation' and 'competitor orientation' by Menguc and Auh (2006).

Furthermore, four items were dropped from the analysis: three reverse coded items (ConcepB, CoprOrchA, ScaleStretchE) loaded on none of the five factors, and one item (ScaleStretchA) loaded on three of the five factors with factor loadings below the critical threshold of 0.60 (Flynn et al., 1994). Table 4.4 shows the component structure for the remaining set of items. The items showed also strong internal consistency with Cronbach's alphas above 0.70 (Nunally, 1978).

Table 4.4: Results from principal component (5 factors) on dataset 1 (n=196), after removing inversely framed items.

Items (code)	Factor Loadings				
	F1	F2	F3	F4	F5
SensingA				0.724	
SensingB				0.761	
SensingC				0.666	
SensingD			0.804		
SensingE			0.759		
SensingF			0.760		
ConcepA		0.729			
ConcepC		0.827			
ConcepD		0.695			
CoprOrchB					0.815
CoprOrchC					0.881
ScaleStretchA	0.436	0.409			0.446
ScaleStretchB	0.716				
ScaleStretchC	0.734				
ScaleStretchD	0.800				
Cumulative % of total variance explained	40.07	50.00	58.109	65.30	71.07
Cronbach's alpha	0.748	0.813	0.776	0.753	0.748

Note: Loadings below 0.4 are suppressed.
Cronbach's alpha is calculated on the basis of items loading above 0.6.

4.4.2 Assessing reliability and validity (confirmatory analysis)

Reliability and validity of the resulting scale were then reassessed by performing confirmatory factor analysis (CFA) on the second dataset (n=195) using AMOS 18.

Table 4.5 lists the measures for estimation of the model fit (see also Chapter 2), indicating that the five-factor measurement model fits our data rather well. The chi-square/degrees of freedom (χ^2/df), the goodness-of-fit index (GFI), the Tucker-Lewis coefficient (TLI), the normed fit index (NFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were all above the respective acceptance levels commonly used in the literature (Hooper et al., 2008).

According to the composite reliability measures in Table 4.6, all above the 0.70 standard, the measurement items sufficiently represented their respective constructs (Bagozzi and Yi, 1988). Moreover, the percentages of average variance extracted exceeded 0.50, indicating that for each construct, a sufficient amount of variance is accounted for by the items rather than by measurement error (Fornell and Larcker, 1981).

Apart from supporting construct reliability, Table 4.6 also provides evidence for convergent validity. The standardized factor loadings of the items were all significant ($p < .05$) and generally above the critical value of 0.60 (Eisenhardt, 1988).

Table 4.5: Model fit values of CFA on five-factor model. Results based on dataset 2 (n=195).

	Acceptable level of reasonable fit*	Acceptable level of excellent fit*	Value
Df			67
χ^2			122.6
χ^2/df	<5	<3	1.83
GFI	>0.90	>0.95	0.921
TLI	>0.90	>0.95	0.934
NFI	>0.90	>0.95	0.901
CFI	>0.90	>0.95	0.952
RMSEA	<0.10	<0.05	0.065

* Source: Hooper et al. (2008).

Table 4.6: Standardized factor loadings, composite reliability (CR), percentage of average variance extracted (AVE), maximum shared squared variance (MSV) and average shared squared variance (ASV). Results based on dataset 2 (n=195).

Construct with underlying items	Factor loading	CR	AVE	MSV	ASV
Sensing user needs		0.791	0.561	0.413	0.313
• SensUserA	0.69				
• SensUserB	0.85				
• SensUserC	0.69				
Sensing (technological) options		0.834	0.629	0.549	0.369
• SensingD	0.86				
• SensingE	0.85				
• SensingF	0.65				
Conceptualizing		0.793	0.564	0.549	0.382
• ConcepA	0.76				
• ConcepC	0.85				
• ConcepD	0.63				
Coproducing & orchestrating		0.794	0.659	0.240	0.161
• CoprOrchB	0.78				
• CoprOrchC	0.84				
Scaling & stretching		0.750	0.505	0.336	0.253
• ScaleStretchB	0.56				
• ScaleStretchC	0.77				
• ScaleStretchD	0.77				

Finally, the discriminant validity of our measurement scale can be assessed with the values in both Table 4.6 and Table 4.7. With the exception of one pair of constructs, the correlations between the capabilities were below the square root of variance extracted for each of them (Table 4.7). This indicates that in general, the items of a dimension are more related to each other than to other dimensions (Fornell and Larcker, 1981). Sensing (technological) options and conceptualizing shared a relatively high amount of variance, but their correlation exceeded the square root of the average variance extracted for each of those respective constructs only minimally (Table 4.6). Moreover, both the maximum shared squared variance (MSV) and average shared squared variance (ASV) values were below the average variance extracted (Hair, et al., 1998). We also compared the CFA measurement model with nested models where the co-variances between pairs of constructs were each constrained to 1. All these models were found to have a lower goodness-of-fit. The test results imply that the discriminant validity of the constructs is supported, indicating that dynamic capabilities cannot just conceptually, but also empirically be discriminated into several distinct capabilities (Teece, 2007). While the need to delete reversed items in the EFA might have been a signal of common method bias, our commonly accepted CFA procedures do not point in this direction.

Table 4.7: Standardized correlations matrix, with square root of variance extracted (on diagonal). Results based on dataset 2 (n=195).

Dimensions	1	2	3	4	5
Sensing user needs (1)	*0.71*				
Sensing (technological) options (2)	0.643	*0.78*			
Conceptualizing (3)	0.633	0.741	*0.74*		
Coproducing & orchestrating (4)	0.375	0.447	0.490	*0.77*	
Scaling & stretching (5)	0.546	0.559	0.580	0.254	*0.72*

4.4.3 Assessing common method variance

The factor loadings in the PCA-results suggest convergent validity (or unidimensionality) for the items within the constructs, and the presence of five distinct factors suggests discriminant validity. Harman's one factor test for the possibility of a common method bias showed that restricting the PCA to one factor returns a factor that only explains 40% of the variance, and thus less than 50% of the total variance extracted (Podsakoff et al., 2003). Following Love et al. (2013), an additional test with a marker variable (Lindell and Whitney, 2001) was performed. When we extended our PCA with items for ambiguity tolerance, a theoretically unrelated concept that was part of our survey as well, the original pattern of capability-related item loadings on different factors remained the same. The finding that our marker variable hardly correlates with the earlier retrieved principal components indicates that common method bias is not likely to be an issue (Love et al., 2013).

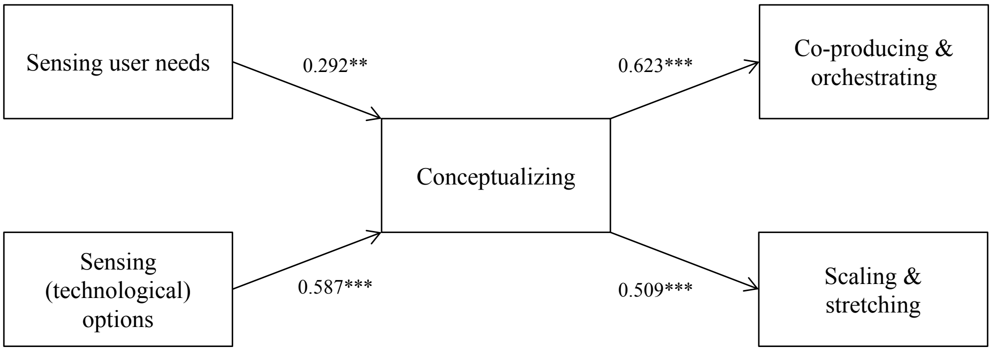
To validate the discriminant validity of the measurement scale further, we inspected to what extent correlations between constructs might be caused by common method bias. A common latent factor was included in the CFA model (Podsakoff et al., 2003). This did improve significantly the model fit ($\Delta\chi^2/df = 0.246$, $p < 0.001$), but the improvement was only incremental ($\Delta rho = 0.017$), and the factor loadings for the constructs all remained significant and above the threshold levels. These findings suggest that although some common method variance may be present, it did not bias the structure of the measurement model and the respondents could generally differentiate among the concepts.

4.4.4 Correlations among the constructs

Our analyses showed that although distinctive, the five dynamic capabilities were also correlated. This begs the question whether a firm can develop a DSIC related to a particular stage of knowledge transformation, without possessing the DSIC that should be enacted in a preceding stage of the innovation process (e.g. searching knowledge). We extended our analysis by building a structural path model among the constructs, using structural equation modeling (SEM) in AMOS 18.

In line with the implicit sequences in the evolutionary processes of novelty creation (Teece, 2007; Zollo and Winter, 2002; Love et al., 2011), our specification followed the order in which capabilities have to be used when acquiring, converting and applying knowledge. Thus, we linked sensing user needs and sensing (technological) options to conceptualizing, which in turn, was linked to co-producing & orchestrating and scaling & stretching. Figure 4.1 presents the regression coefficients of the structural model. The structural equation model had a similar goodness-of-fit with respect to the CFA model, and shows that all of the structural paths are significant.

Analysis of the correlations among the measured constructs confirms that the capabilities should not be seen as completely orthogonal, but that they form a coherent set of complementary constructs. A significant relation between the two sensing capabilities on the one hand, and conceptualizing on the other hand, suggests that translating rough ideas into detailed propositions occurs more in firms that can sense signals in the first place. Similarly, capabilities for the (co)production and up-scaling of such a proposition are particularly present in firms that are able to conceptualize. These findings, derived from measuring capabilities, are consistent with the general belief that exploration and conceptualization need to precede exploitation (Roper et al., 2008). It appears to be uncommon for firms in our sample to invest only in one particular type of DSIC: regardless whether it is intentional or not, they rather develop capabilities with relevance through the whole spectrum of knowledge sourcing, transformation and exploitation. To what extent this strategy is preferable for the successful development of service innovations remains to be tested in further research (see also Chapter 5).



χ^2/df = 1.85; GFI = 0.916; TLI = 0.932; NFI = 0.892; CFI = 0.946; RMSEA = 0.066.
** = $p < 0.005$; *** = $p < 0.001$

Figure 4.1: Correlations amongst the constructs, standardized regression weights. Results based on dataset 2 (n=195).

4.4.5 External validity: the relation with innovativeness and firm performance

Finally, we assessed the external validity of our constructs by examining whether their occurrence is empirically associated with patterns we would also expect on a theoretical basis.[36] The interest in dynamic capabilities stems from the assumption that they are of importance for realizing new solutions, and ultimately enhancing a firm's competitive position (Teece and Pisano, 1997). By using other variables present in our survey, we were able to put this to the test.

According to the correlation statistics in Table 4.8, firms who have stronger DSICs also tend to perform better. First, we see that that presence of several capabilities has a positive correlation with gaining turnover from improved rather than existing products (including both goods and services).[37] This holds for the sensing capabilities as well as the conceptualizing one, but only the latter is also significantly related to the percentage of sales coming from entirely new products.

The findings for comparative firm performance tell a similar story. In general, there is a positive correlation between the total strength of a firm's capabilities and the variables that reflect its competitive position. We also observe, again, that the relation with individual capabilities might point at more nuanced patterns. For instance, coproducing and orchestrating is significantly correlated with having a rapid growth in market share, whereas scaling and stretching is now related to none of the outcome variables.

36 If the emphasis is on verifying whether structural relationships with other variables are consistent with existing studies, this type of external validity is also referred to as 'nomological'. Since we assess the relation with an outcome variable, 'predictive validity' would be appropriate as well.

37 These questions are derived from the Oslo Manual for the CIS (OECD, 2005b).

Table 4.8: Relation between capability strengths and performance measures. Results based on dataset 2 (n=195).

Percentage of revenues coming from ... (100% in total)	**Mean**	**Std. Dev.**	**Sensing User Needs**	**Sensing (Techn.) Options**	**Concept-ualizing**	**Coproducing & orchestrating**	**Scaling & Stretching**	***Sum of capability strengths***
…unchanged goods and/or services	71.46	22.26	-.175*	-.280**	-.299**	-.107	-.182*	*-.280***
… improved goods and/or services	17.89	15.76	.193**	.328**	.275**	.131	.120	*.281***
… new goods and/or services	10.70	12.98	.058	.073	.172*	.021	.162*	*.133*
In comparison to our competitors, … (7-point Likert-scale)	**Mean**	**Std. Dev.**	**Sensing User Needs**	**Sensing (Techn.) Options**	**Concept-ualizing**	**Coproducing & orchestrating**	**Scaling & Stretching**	***Sum of capability strengths***
...our organization generated a higher return on equity in the past year.	4.16	1.69	.220**	.124	.163*	.027	.095	*.169**
...we had more profit growth in the past year.	3.76	1.78	.221**	.123	.201**	.134	.121	*.218***
...we had more turnover growth in the past year.	3.92	1.80	.283**	.176*	.204**	.142	.137	*.256***
...we had a faster growing market share last year.	3.97	1.66	.304**	.202**	.267**	.178*	.127	*.292***

Pearson's correlations, ** = significant at the 0.01 level (2-tailed). * = significant at the 0.05 level (2-tailed).

An additional way to examine external validity, in particular of a predictive kind, is by entering both the capabilities as well as outcome measures in one single structural equation model. In order to investigate better the differences between the capabilities, we merged the structural and predictive analyses into a model in which we assessed relations with the service innovation dimensions constructed in Chapter 2. Inspection of correlations (not shown here) reveals that at the outset, all capabilities are significantly related to all dimensions. Our aim in this last section is to test whether the structure presented in Figure 4.1 really fits best when regressing the capabilities *simultaneously* on one of the indicators for novelty in the service portfolio. The theories discussed in this chapter suggest that having capabilities for engaging in service innovation is positively related to actually bringing about changes (or 'mutations'). This is what we tested for each of the service innovation dimensions.

Figure 4.2 exemplifies how the model looks like when taking the 'New Service Concept' dimension as our dependent variable. All of the other dimensions are tested in separate models. To validate our findings regarding correlations amongst the constructs, we compared an unrestrained model (i.e. including structural paths between the capabilities themselves) against one in which the four intra-capability paths are eliminated. Because of the large number of observations and constructs, we run the models on the total sample again. In total there are 386 cases with full response on the variables used in these final analyses.[38] Due to the multitude of relations being tested here, we use a table instead of graphs to present the output of our analyses. Table 4.9 presents the standardized regression coefficients for the paths between capabilities and the dependent service innovation dimension (i.e. the bold lines in Figure 4.2). The table includes goodness-of-fit values for the model in which the capabilities are linked to each other, as well as the model fit values for analyses in which these intra-capability paths are taken out.

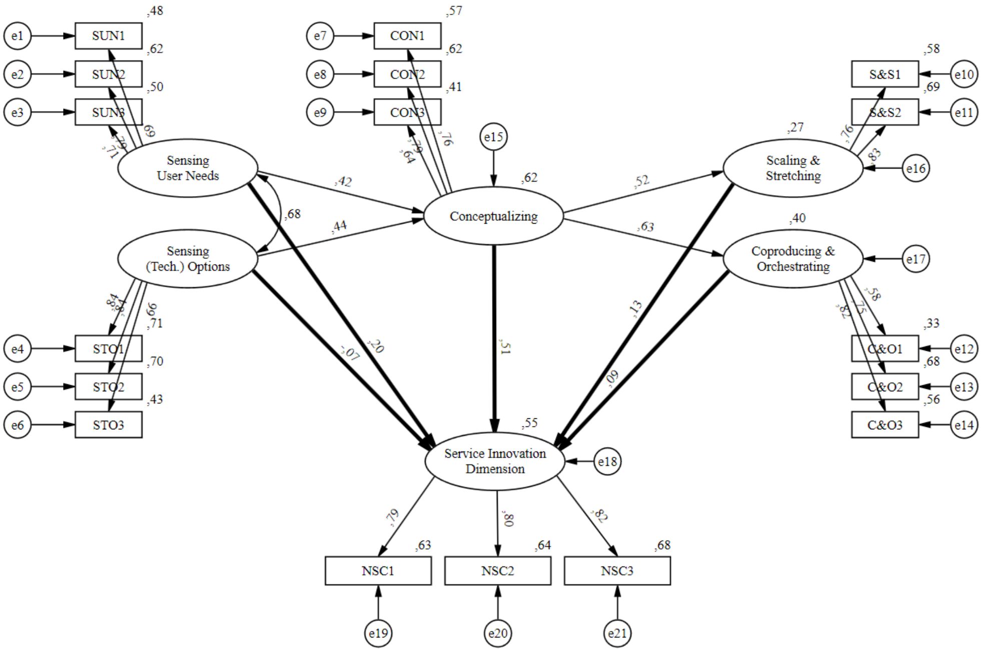


Figure 4.2: Correlations amongst the capabilities, and with service innovation dimension (here: New Service Concept). Standardized regression weights. Results based on dataset 1 and 2 (n=386).

The model variants including structural paths have a reasonable to good goodness-of-fit. A key finding is that simultaneously regressing the capabilities on performance measures confirms their distinctiveness: generally, the capability having most discriminant value for achieving innovation differs per service innovation dimension. Innovations made up by changes in the service concept are for instance found in firms having strong capabilities on the account of sensing user needs, conceptualizing, and

38 Since we are not concerned anymore with developing measurement scales for the service innovation dimensions, there is no preference to focus on only service providers here. In Chapter 2 we chose to start by looking at such respondents only, as limiting our scope to firms mainly providing service products was convenient for interpreting the measurement results. Conceptually, the dimensions are of relevance to renewal in any type of product. See also our discussion in Chapter 9. Imposing the requirement for respondents to be service-intensive leads to better fitting models than the ones reported here.

scaling & stretching. On the contrary, when tested simultaneously, the capabilities for sensing technological options and coproducing & orchestrating are not significantly related to changes on the NSC-dimension. The latter capability does relate significantly and positively to several of the other dimensions (NBP, NRM, NODS), however. Our finding that sensing user needs and sensing technological options really are two distinct capabilities is confirmed by the fact that they have a significant but opposite relation with the NTDS-dimension. Moreover, sensing user needs also has a negative relation with NODS when tested in a model also including the other capabilities (most of them being significantly related to NODS).

When comparing the two versions of the model, we observe that including paths between the capabilities yields the best results for all of the dependent variables. Again, the structural relations from the knowledge sourcing capabilities to conceptualizing are statistically significant in every model, just like the relations from conceptualizing to the capabilities concerning actual application of knowledge. The analyses without these paths are significantly worse, and did not even deliver a fitting model for the NTDS-dimension. This confirms our finding that the operationalized constructs (based on Den Hertog et al., 2010) are not just a random collection of capabilities, but are to be seen in relation to the sequence of knowledge processing activities.

Table 4.9: Standardized regression weights for model with intra-capability paths, and goodness-of-fit values for model with and without intra-capability paths. Results based on dataset 1 and 2 (n=386).

		Service innovation dimensions (Y)					
		NSC	*NCI*	*NBP*	*NRM*	*NODS*	*NTDS*[a]
Service innovation capabilities (X)	*Sensing User Needs*	.196**	.007*	-.143	-.107	-.225**	-.297***
	Sensing (Tech.) Options	-.073	.193	.073	.042	.087	.724***
	Conceptualizing	.507***	.047	.036	.403***	.456***	.186
	Coproducing & Orch.	.127	.074	.648***	.214***	.456***	.015
	Scaling & Stretching	.090**	.346***	.142*	.097	.189**	.073
Goodness-of-fit: Incl. structural paths	*X2/df*	2,527	2,382	2,360	2,337	2,436	2,613
	RMSEA	.063	.060	.059	.059	.061	.065
Goodness-of-fit: No structural paths	*X2/df*	5,703	6,045	6,007	5,981	6,105	-
	RMSEA	.111	.117	.114	.114	1,554	-
Difference in goodness-of-fit	*Significance of change (p)*	.000	.000	.000	.000	.000	-

* = p < .10; ** = p < .05; *** = p < 0.01

[a] = For the model in which Y = NTDS, and in which structural paths are absent, no fitting model could be estimated.

Together, the patterns encountered in this last section emphasize the discriminant validity of the constructs: not every capability is related to each performance measure. Empirical evidence of this kind invites us to explore deeper under what exact circumstances the DSICs do relate to innovativeness or firm performance, and whether this is truly a causal relationship.

4.5 CONCLUSIONS

This chapter provides a basis for gauging the relative strength of dynamic service innovation capabilities. Our review demonstrates the different paths scholars pursued when translating the recent DCV to the domain of services, thereby answering questions like: how do the various conceptualizations differ, and to what extent are they service specific? Consolidating insights from earlier works, the synthesis approach was identified as a suitable direction for conceptualizing and analyzing the relative strength of DSICs within individual organizations.

Firstly, the framework that was found to fit this approach (by Den Hertog et al., 2010) facilitated the development of a measurement scale by providing detailed clues on actual routines (activities and processes). In our exploratory and confirmatory factor analyses, we identified that sensing user needs and sensing (technological) options rely on routines that essentially differ. Besides the finding that discriminative validity is generally sufficient for each of the five remaining capabilities, the fact that convergent validity is high, reflects that our routine-based items are empirically mostly associated with their respective capabilities.

Secondly, and most importantly, the broad scope of the selected set of DSICs makes it relevant for the comparative perspective that is imperative to develop a relative measure for service innovation activities amongst a wide range of firms. Within a synthesis approach, scholars are being urged to focus on service innovation activity, irrespective of the industry in which it is performed (Rubalcaba et al., 2012). We advance such a synthesis approach to service innovation by operationalizing a capability framework that combines service specificity with the theoretical foundations of the current DCV. Moreover, by building on evolutionary theorizing, we contribute to recent efforts to place service innovation in a (neo-) Schumpeterian perspective (Drejer, 2004).

Apart from comparisons across firms (individual or clustered by industry, region or any other system), a primary way to determine which capability deserves more attention is by looking at the balance between the various types of capabilities. Besides explicitly involving the idiosyncrasies of services, consistent with the demarcation approach, the framework proposed by Den Hertog et al. (2010) also builds on evolutionary processes of innovation generation that are implicitly present in the assimilative conceptualizations directly based on work by Teece (2007). Therefore, it enables us to identify which specific aspect of novelty exploration and exploitation is strong, and which is weak. Rather than simply inferring low capability levels from observing a lack of realized innovations, a form of tautology heavily criticized in the DCV (Williamson, 1999), the operationalized conceptualization allows for a more detailed diagnosis of what type of routines are perceived to be truly (under)developed.

Besides the common drawbacks of survey research, a limitation of our study is that we cannot exclude the possibility that relevant micro-foundations are missing from the set we measured. However, by drawing on a broad body of literature and performing pre-testing interviews, we tried to restrict this possibility. Moreover, Teece (2007) already noted that it is impossible to capture all the relevant micro-foundations. The efforts in this chapter should be regarded as a first attempt to use actual routines to assess the relative strengths of dynamic service innovation capabilities.

4.5.1 Research implications

The proposed measurement scale allows for several avenues of future research. First, it provides a comparative measure that can capture the variation in how different organizations or groups of organizations shape their innovative abilities. The proposed scale might be useful for analyzing why differences occur. Apart from firm characteristics such as size, age or geographical location, variation in the perceived strengths of capabilities is likely to depend on the sector where a firm is operating and the strategies it follows (Zahra et al., 2006). Thanks to its high level of commonality, the operationalized framework is able to shed light on the question whether manufacturers that successfully engage in servitization have different strengths than innovative 'pure' service providers (Kindström et al., 2012; Forsman, 2011). In this light, future research can investigate whether a capability differential is somehow related to issues like industry maturity or market velocity (Barreto, 2010). Various typologies for distinct kinds of service innovators (e.g. Castellacci, 2008) might form an interesting starting point as well.

Uncovering the organizational antecedents of service innovation is still one of the main challenges in (service) innovation literature (Ostrom, et al., 2010). Therefore, a logical complement to descriptive explorations is the further investigation (and contextualization) of the relation between well- or underdeveloped capabilities and measures of innovation output or performance (Protogerou et al., 2012). Having a common basis for comparing the presence of innovation activities within firms allows scholars to address questions regarding service competitiveness (Bryson et al., 2012), and the 'innovation gap' in services (Gallouj and Djellal, 2010). So far, studies in the DCV tend to find contradicting results (Zahra et al., 2006; Ray et al., 2004), possibly due to different settings. Looking at the domain of services, the availability of our measurement scale provides opportunities to assess under what conditions firms with strongly developed service innovation capabilities actually do realize innovative output. Thereby, it allows for discrimination between capability failures referring to the absence of routines to transform knowledge on the one hand, and capability failures referring to situations where even firms with strong capabilities do not manage to successfully introduce new service offerings.[39]

The proposed measurement scale gives insight in the extent to which firms possess in-house routines that allow them to generate, transform and apply knowledge. According to some authors, access to the capabilities of partners might be a substitute for developing and maintaining them internally (Van de Vrande et al., 2010). Also in the context of services, the topic of open innovation has been gaining ground in recent years (Chesbrough, 2011; Hsieh and Tidd, 2012). How openness and co-creation should be managed remains unclear (Rubalcaba et al., 2012), but it seems likely that capabilities have distinct roles in the various stages of collaboration (Den Hertog et al., 2010; Love et al., 2011). In this vein, it seems worthwhile to investigate which configuration of service innovation capabilities can be associated with, for example, the success of cooperation patterns (Trigo and Vence, 2012; Tether and Tajar, 2008).

4.5.2 Management implications

The introduction of a measurement scale for service innovation capabilities can serve as a step towards the development of a prescriptive management tool. Managers who are engaged in introducing new or better services within their firm can gauge the presence and strength of their capabilities, helping them to uncover the strengths and weaknesses of their service innovation management strategy. Reasoning from a bottleneck approach, measuring the strength of a firm's DSICs, can provide valuable information on its potential to execute the distinct but complementary processes from which service innovations emerge. Firms might consider investments if the strengths of capabilities are unbalanced, such as when weakly developed sensing capabilities hamper the use or further development of related capabilities (Barreto, 2010).

Thanks to its broad applicability, the operationalized conceptualization provides a basis for diagnostic tools and monitoring or even benchmarking instruments. Operationalizing capabilities with relevance to a wide range of service innovation activities provides ample room for inter-organizational learning - even across industries, firms can exchange ideas on which processes and practices to deploy in order to reinforce their most critical capabilities.

4.5.3 Policy implications

Finally, insight in the relative strength and relevance of service innovation capabilities provides a sound basis for policy development. According to evolutionary economists, the fundamental role of (innovation) policy is enabling organizations to engage in

39 In such cases, the strong 'technological fitness' of the capabilities does not correspond with a high level of evolutionary fitness (Helfat et al., 2007).

experimentation (Metcalfe, 1995; Metcalfe and Miles, 2000). In this respect, one cannot assume this is simply a matter of having the right funding instruments and framework conditions in place; weak innovation capabilities constitute a systemic failure that is detrimental for the processes of novelty creation within markets (Bleda and Del Rio, 2013). Therefore, the observation that many firms lack skills and competences to realize new services (Sundbo, 1997), can be regarded as a strong justification for policy intervention. By averaging the capability strengths of an aggregation of organizations, our measurement scale can provide a well-grounded alternative to common proxies for capability failures (and presence) at the system level (e.g. Castellacci and Natera, 2012).

Acknowledging systemic failure with respect to service innovation capabilities requires adequate institutional arrangements, like the provision of business services and consultancy aimed at enhancing service innovation skills and competences (Rubalcaba et al., 2010). By using the measurement scale we developed in this chapter, governments can monitor the effect of those interventions and evaluate whether the policy measure has any direct impact on the service innovation capabilities of supported firms.

Chapter 5

In the vanguard of openness: Which innovation capabilities should KIBS focus on?

5.1 INTRODUCTION

Already in 1990, Richard Barras noted that business services form the forefront of novel modes of innovation. Whereas the 'interactive innovation process' he discussed concerned alignment between various elements of techno-economic paradigms (Barras, 1990), subsequent studies have also investigated this topic by looking at individual firms' acts of knowledge exchange. A large body of research is devoted to studying how novelty arises from the interactions that are so characteristic for service provision (e.g. Edvardsson et al., 2001). Of particular importance, in this respect, is the role of knowledge intensive business services (KIBS). Because of their tendency to interact intensively with a high variety of parties, KIBS are considered as the bees that cross-pollinate knowledge throughout the innovation system (Den Hertog, 2000; Muller and Zenker, 2001).

Traditionally, scholars have focused mostly on the question how KIBS can contribute to innovation within their clients (Den Hertog, 2000). The fact that daily activities by KIBS firms involve such extensive knowledge brokerage, however, also begs the question how openness affects their own ability to innovate. Contrary to those firms where open strategies are really an alternative to closed innovation modes, KIBS operate practically always in intensive interaction with their customers, as well as with other parties (Leiponen, 2005; Tether and Tajar, 2008). Recent contributions suggest that KIBS engaging in knowledge sourcing and R&D activity are more innovative (Mansury and Love, 2008; Leiponen, 2012), but until now the interaction of these two key factors has hardly been investigated. As a result, there is only a poor understanding of how innovation-oriented partnerships in highly open firms like KIBS are of relevance for their innovation activities and performance. At the same time, given the trend that firms from virtually every industry are increasingly adopting service-based business models and becoming part of multi-actor producing systems, this research gap pertains to a topic that pre-eminently might enrich the broader innovation literature (Chesbrough, 2011).

The interest in open innovation has risen enormously over the past decade (Gassmann et al., 2010; Laursen and Salter, 2013). Looking at the principles of complementarity and substitutability, a research tradition emerged in which authors aim to identify optimal levels of openness (e.g. Laursen and Salter, 2006; Berchicci, 2013). Current efforts in this respect are largely focused on further exploration of the mechanisms that underlie open innovation (Hsieh and Tidd, 2012). A notable and promising example is the study by Love et al. (2011), in which knowledge sourcing activities are related to the distinct phases of the innovation value chain (Hansen and Birkinshaw, 2007; Roper et al., 2008). Assessing the relevance of external parties during the acquisition, transformation, and application of knowledge provides fertile grounds for advancing our understanding of the limitations of openness: on which accounts can external parties contribute best, and which innovation activities should firms still develop themselves (Dahlander and Gann, 2010; Von Zedtwitz and Gassmann, 2002)? Provided that the provision of business services is already inherently open, these strategic considerations are all the more relevant for KIBS.

Studies on innovative search and openness amongst service providers are generally found to be rare (Mina et al., 2014; Battisti et al., 2015). Whereas most of the existing research on complementarities tends to investigate openness in relation to R&D investments or R&D capabilities, these concepts have only limited meaning in the domain of KIBS (Drejer, 2004; Leiponen, 2005). Service providers, be it knowledge intensive or not, are known for formalizing their innovation efforts only occasionally (Miles, 2007). The observation that they (somehow) do develop new services has led to an increasing interest in the innovation activities of service providers (Gallouj and Savona, 2009). One result is the development of an alternative for gauging how able and prone a KIBS firm is when it comes to innovating. Rather than sticking to formalized R&D, scholars are urged to study innovation in services by adopting the broader notion of dynamic capabilities (Teirlinck and Spithoven, 2013; Den Hertog et al., 2010). Depending on how dynamic service innovation capabilities (DSICs) are operationalized, they can be related to the phases of the innovation value chain (see Chapter 4). So far, empirical exploration of the respective influence of DSICs on innovativeness is not available, and also the combination of dynamic capabilities and openness has hardly been touched upon (Van de Vrande et al., 2009; Lichtenthaler and Lichtenthaler, 2009).

This chapter aims to inform KIBS firms who face the decision of which innovation capabilities to develop. Our research interest goes specifically to the question how the relative value of a certain capability is affected by the extent that a KIBS firm is relying on the skills and competences of external parties (be it through on-the-job interaction or deliberate collaboration). The baseline hypotheses we propose are that all DSICs are significantly related to a KIBS's innovativeness, just like its tendency to engage in deliberate partnerships. By building on the resource-based view, we then develop our main hypothesis on the role of capabilities and openness during the different stages of knowledge processing (Love et al., 2011; Lehrer et al., 2012; Roper et al., 2008). Our literature review suggests that external parties can contribute most to the explorative and exploitative aspects of service innovation, but are of less use for the intermediate translation of raw ideas into marketable service propositions. On this basis we expect that the relative importance of conceptualizing increases over the importance of other capabilities as KIBS get more open. The quantitative investigation we present is based again on our survey data. An initial explorative analysis, in which five key DSICs are regressed on innovativeness, first reveals that the capability to sense user needs is not discriminative for KIBS when their innovation output is concerned. This implies that developing a customer-focused sensing capability is hardly complementary to KIBS firms' common tendency to interact with clients. All of the other capabilities - in particular the one for sensing (technological) options - are positively and significantly related to innovative output, and so is the variable for deliberate partnerships. However, only for conceptualizing we encounter a significant interaction effect. This finding confirms that highly open firms, like KIBS engaging in innovation-oriented partnerships, should consider focusing their resources on developing a conceptualization capability. By contributing to literature on open service innovation, we shed light on strategic considerations with respect to balancing capability development and external knowledge sourcing.

5.2 THEORY AND HYPOTHESES

5.2.1 Innovation capabilities in KIBS

According to the capability-based view on economic and technological change, firms need to develop certain capabilities in order to translate knowledge into business value (Barney, 1991; Teece et al., 1997). These capabilities allow firms to sense developments and acquire promising suggestions, transform them into new propositions, and reconfigure their organization so that the new offering can be commercialized (Teece, 2007; Zahra et al., 2006). Therefore, dynamic or innovation capabilities are commonly regarded as important antecedents for the renewal of both firms as well as the products and services they deliver (Crossan and Apaydin, 2010).

Due to their traditional focus on technological innovation, studies on innovativeness tend to be biased towards R&D capabilities. Especially in the understudied field of services, however, performing the processes that generate novel combinations of knowledge entails more than the availability of capabilities bound to R&D (Miles, 2007). Service innovation is argued to depend primarily on individuals' skills and professional knowledge, rather than on the narrow (and relatively rarely encountered) set of activities that fall under formalized R&D (Leiponen, 2012). Because of service particularities like an intangible and interactive nature (Parasuraman et al., 1985; Gallouj and Weinstein, 1997), the continuous and organic innovation process in services occurs relatively close to the client (Edvardsson et al., 2001; Tether, 2005). This is all the more true for KIBS firms, who often develop new concepts by combining the knowledge and experience they acquire in their role as knowledge brokers (Den Hertog, 2000; Tether and Tajar, 2008).

Acknowledging the limitations of the R&D concept, scholars are increasingly adopting the broader notion of innovation capabilities when giving a comprehensive account of a KIBS firms' ability to innovate (Teirlinck and Spithoven, 2013; O'Cass and Sok, 2013; Hogan et al., 2011). Crucial in this respect is the availability of a comprehensive framework of innovation capabilities that allows for comparative analyses across different KIBS firms (Amara et al., 2010). In Chapter 4 we described how the (pre-)

synthesis approach to service innovation (Gallouj, 1994; Coombs and Miles, 2000) provides a basis for selecting and operationalizing a suitable conceptualization.

The resulting framework of dynamic service innovation capabilities (DSICs), based on Den Hertog et al. (2010), combines elements of conceptualizations developed for specific service industries. At the same time, it adopts the modern view on dynamic capabilities in general (Eisenhardt and Martin, 2000; Teece, 2007), stating that one should look at the micro-foundations of common capabilities rather than identifying idiosyncratic capabilities. Instead of explaining innovativeness by looking at heterogeneity in the capabilities firms possess, this view regards the 'capability differential' as a matter of heterogeneity in capability strengths. The five operationalized capabilities are: sensing user needs, sensing (technological) options, conceptualizing, co-producing & orchestrating, and scaling & stretching (Den Hertog et al., 2010; more details in Chapter 4)

In line with the leading work by Teece (2007), the operationalized set of DSICs consists of capabilities that can be associated with the evolutionary properties of knowledge transformation as captured by the innovation value chain (Roper et al., 2008). In the development of a measurement scale, we argued that a firm's ability to 'conceptualize' depends partially on the extent it is able to 'sense user needs' and 'sense (technological) options' in the first place. Similarly, we found that the capabilities required for actual exploitation of a new proposition ('co-producing and orchestrating' and 'scaling and stretching') depend on the presence of the conceptualization capability in turn (see Figure 5.1). Together, these capabilities thus cover the various stages that characterize the iterative processes of knowledge production and application. As each capability has distinct merits, and all value chain stages are essential for bringing about new concepts, our first baseline hypothesis reads:

Hypothesis 1: All dynamic service innovation capabilities are positively related to KIBS' innovativeness

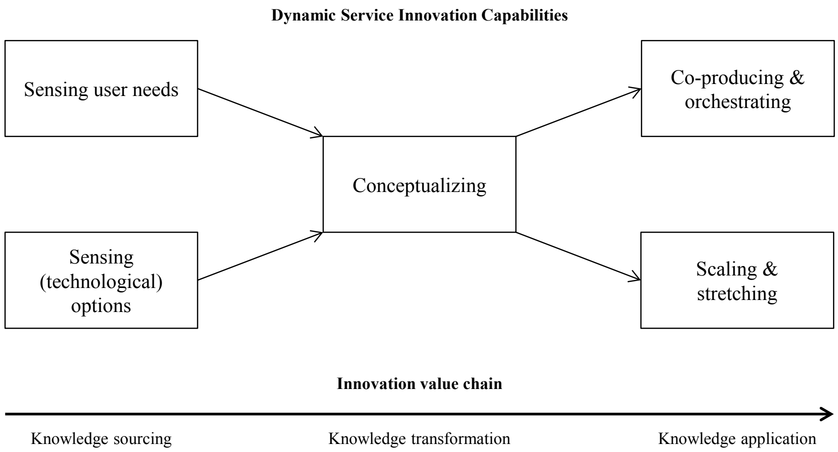


Figure 5.1: Link between dynamic service innovation capabilities (Den Hertog et al., 2010) and the innovation value chain (Hansen and Birkinshaw, 2007; Roper et al., 2008). Based on Figure 4.1 (Chapter 4).

5.2.2 Routine-like and innovation-oriented openness

Apart from investing in dynamic capabilities, firms can also try to access and exploit the knowledge and competences existent beyond the boundaries of the own organization. Innovation scholars have a long history of studying topics like external knowledge search, partnerships, networking, inter-organizational learning and open innovation (Gassmann et al., 2010; Laursen, 2012; Laursen and Salter, 2013). As it is costly to rely entirely on internal abilities to generate, transform and diffuse knowledge, there is strong reason for firms to look for knowledge and skills existing already 'out there'. Whether this knowledge resides in clients, professional experts, or elsewhere, fact is that other parties are sometimes in positions that provide highly valuable insights about market opportunities. All in all, there is a wide consensus that being open to knowledge flows can enhance a firm's innovativeness substantially (Laursen and Salter, 2006; Chesbrough, 2006).

Whereas open strategies can be clearly distinguished from closed R&D in the manufacturing of new goods, this difference is far less obvious in the domain of services (Chesbrough, 2011). Increasingly, service innovation is regarded as emerging from innovation networks that are broader than customers (Bryson et al., 2012). Discussions on multi-agent frameworks (Gallouj and Weinstein, 1997; Windrum and Garcia-Goñi, 2008) have been revitalized with the rising interest in openness (Rubalcaba et al., 2012; Battisti et al., 2015). Today, both service production and service innovation are regarded as inherently distributed phenomena, carried out by a wide range of actors (Tether and Tajar, 2008).

Arguably, the most open form of service provision is found in knowledge-intensive business services. By their very nature, KIBS are deeply involved in extensive knowledge exchange (Den Hertog, 2000; Consoli and Elche-Hortelano, 2010). Their core activity is to transfer information, design, experience or professional knowledge to client firms and assist in applying it (Leiponen, 2005). Besides drawing on interactions that are part of the routines on which the core activities of KIBS rely, KIBS are also found to develop partnerships explicitly aimed at innovation (Leiponen, 2012). The key reason to engage in such purposive inwards and outwards knowledge flows is that the costs of accessing valuable external knowledge might be relatively low (Chesbrough, 2006). Although KIBS are already well-connected to external parties via their routine-like operations, several studies have confirmed that they still engage in (and benefit from) deliberately initiated partnerships (Mansury and Love, 2008; Leiponen, 2012; Mina et al., 2014). Based on this observation, our second baseline hypothesis is as follows:

Hypothesis 2: Engaging in deliberate partnerships contributes to a KIBS' innovativeness

5.2.3 The relative importance of innovation capabilities for highly open firms

Despite the luring advantages that firms might enjoy when opening up their innovation process, there are also reasons to maintain a certain amount of innovation activities inside. Currently, a major question in the field of open innovation concerns the very connection between openness and in-house R&D (Dahlander and Gann, 2010; Cassiman and Veugelers, 2006). On the one hand, scholars argue and occasionally show that having R&D (or innovation) capabilities can leverage the value of external knowledge sourcing (Chesbrough, 2006; Van de Vrande et al., 2009; Caloghirou et al., 2004). This complementarity is in line with the idea of absorptive capacity, stating that that a high degree of knowledge flows is matched with sufficient ability to process it (Cohen and Levinthal, 1990; Dahlander and Gann, 2010; Cassiman and Veugelers, 2006). On the other hand, several authors point at the downside of engaging in both internal and external R&D activities (e.g. Love et al., 2013). Here, the main argument for substitutability is that engaging in both activities is costly (Laursen and Salter, 2006; Leiponen and Helfat, 2010): having internal innovation capabilities reduces the need to rely on external knowledge and competences (Roper et al., 2008; Love and Roper, 2001). One way to resolve this contradiction is by avoiding debates about optimal levels of openness, and instead ask the question which particular activities open firms should be concentrating on (Von Zedtwitz and Gassmann, 2002).

Frameworks of capabilities, grounded in evolutionary theory, provide an excellent but under-utilized basis for analyzing how firms manage internally and externally available knowledge (Lichtenthaler and Lichtenthaler, 2009). Understanding how openness affects innovation processes requires still considerably more insight in the relative role of external parties with respect to acquisition, transformation, and application of knowledge. Especially for KIBS, this is a matter of great strategic importance. Because KIBS are by definition heavily involved in interaction, already their default situation poses the dilemma which capabilities to invest in internally, and which activities to perform together with externals. Furthermore, the emerging literature on open service innovation also stresses the need to investigate to what extent increasing the level of openness has consequences for a KIBS' organization of innovation activities (Mina et al., 2014). The above-mentioned considerations bring us to this chapter's main research question: If innovation-pursuing KIBS do decide to rely heavily on knowledge and competences of partners, which capabilities are most worth investing in?According to the resource-based view, access to the knowledge and competences of others reduces the need to develop in-house strengths (Barney, 1991). Since relying on external knowledge and competences can make internal innovation capabilities partially redundant, and vice versa, spending resources on internal as well as external innovation activities is likely to yield sub-optimal outcomes (Love and Roper, 2001; Leiponen and Helfat, 2010; Love et al., 2013). Compared to investing in activities where external parties also can play a role, those resources can better be devoted to activities that allow a firm to make sense of the knowledge it has to process. From this perspective, balancing the development of innovation capabilities and relying on external partners is essentially a matter of avoiding costly overlap, while maintaining sufficient capabilities to actually use external knowledge (Laursen and Salter, 2006).

Looking again at the innovation value chain, the challenge for innovation managers is to concentrate their efforts especially on activities that can only limitedly be supported by external parties (Roper et al., 2008). Deciding which capability to spend scarce resources on thus demands insight in to what extent openness can contribute to the activities of knowledge sourcing, transformation and application. As for the specific case of KIBS, existing studies offer some valuable insights in the importance of external partners along the innovation value chain.

Knowledge sourcing

In recent years, a wide range of innovation studies has examined the benefits of (predominantly) inbound flows of knowledge (Gassmann, et al., 2010). Chesbrough (2006) stresses that external openness can increase the quality and quantity of ideas entering the innovation funnel on which the innovation value chain is based.

Within the more specialized literature on service innovation and service management, especially the role of customers and co-creation has been receiving extensive attention (Bryson et al., 2012). Almost unanimously, scholars find that involving customers contributes to service innovativeness (e.g. Leiponen, 2005; Tether, 2005). Close interaction with customer offers valuable opportunities to learn about both their explicitly expressed and latent needs (Den Hertog et al., 2010). Edvardsson et al. (2001), for instance, stress that inviting customers in service innovation processes leads to a better understanding of their preferences. When studying external links in UK business services, Love et al. (2011) confirm that customers are of significant importance in primarily the exploratory stage of innovation processes.

Also the involvement of suppliers is generally found to be supportive to gathering ideas for new service propositions. This is shown, for instance, in a study on KIBS by Leiponen (2005), in which knowledge sourcing from competitors is positively related to innovation as well. Although universities turned out not to be an important source for service innovation, this is contradicted by studies on the knowledge-bridging role of KIBS as the center of innovation systems (e.g. Amara et al., 2009; Muller and Zenker, 2001). Access to scientific and technical knowledge is an important complement to keeping up to date with the needs from actual or potential customers (Den Hertog et al., 2010; Mina et al., 2014).

Assuming that a larger variety of knowledge sources corresponds to more diversity in the signals a firm can yield, breadth of knowledge search is often related to innovativeness (Laursen and Salter, 2006). Indeed, by using CIS-data on information flows used by KIBS, Leiponen (2005; 2012) shows that breadth of knowledge sourcing is an important determinant of service innovation as well.

In sum, it is commonly believed that KIBS firms can strengthen their knowledge sourcing by benefiting from the expressed demands and suggestions of external parties. Although this certainly makes the case for interacting intensively with external partners, it does not imply that firms should also invest in capabilities like the ones for sensing user needs and (technological) options (Den Hertog et al., 2010). On the contrary, Roper et al.'s (2008) way of interpreting the resource-based view suggests that firms should ask themselves whether additional investments on these account truly are the most effective way of enhancing overall innovation capability. Exactly because interaction with external partners comes with (relatively) easy access to their ideas, KIBS might consider spending attention to innovation activities on which outsiders are of fewer help.

Co-production and collaboration

On the other end of the innovation value chain, or funnel, we find activities aimed at the actual implementation and commercialization of a new proposition. Manufacturing-based studies on openness in the innovation process tend to associate implementation practices mainly with outbound knowledge flows, such as licensing and selling IP (Dahlander and Gann, 2010). Since the disembodied nature of service innovation hardly allows for such practices, they are less likely to be encountered in KIBS. Consistently, Love et al. (2011) find a reduction in the extent of external linkages KIBS use in later stages of the innovation value chain.

Despite modest possibilities to commercialize outward flows of knowledge, several recent studies suggest that openness can contribute to the actual creation of business value in service firms. Whereas the relevance of searching for unexploited demand and untapped options decreases when proceeding in the innovation value chain, the importance of detailing a new proposition increases. In the knowledge application phase, external linkages with notably customers and suppliers are found to be useful for KIBS. This is emphasized by Den Hertog et al. (2010), who build on several earlier studies when equipping their capability framework with 'coproducing and orchestrating'. Kindström et al. (2009), for instance, argue that the value network of services is based on service systems in which providers, service partners and customers jointly fulfill the tasks required for delivery of a service experience or solution. Interacting closely with clients, in this stage, might yield feedback on how to improve the newly developed service formula (Lehrer et al., 2012). This latter study shows that designers can increase the quality of their services by relying on client collaboration (e.g. for testing solutions), just like many studies on co-creation have done (Carlborg et al., 2014; Rubalcaba et al., 2012). Scholars also point at the value of involving different types of parties (e.g. other service providers) for optimizing and continuously redesigning new concepts (Den Hertog et al., 2010).

Since intangibility makes services an experience-good, relying on tacit rather than codified knowledge, possibilities to stretch new concepts to other markets are limited. Also in this aspect of implementation, however, customers can deliver a valuable contribution to (or even replace) internal capabilities. Similarly, interaction with parties like professional associations might relieve the necessity to possess own skills for rolling out and marketing a new service model (Love et al., 2011).

From the findings described above, we can conclude that deployment of (new) services often occurs in collaboration with external parties who possess skills and knowledge essential for both service production and improvement. Reasoning from a resource-optimizing strategy again (Roper et al., 2008), this ultimately implies a reduced indispensability of KIBS' own innovation capabilities for implementing new propositions. In the operationalized version of the framework by Den Hertog et al. (2010), this relates to importance of capabilities for 'coproducing & orchestrating' and 'scaling & stretching'.

Translating market signals into detailed propositions

In between sourcing knowledge and applying it in market-ready solutions, we find the intermediate stage of converting market signals into actual propositions (Hansen and

Birkenshaw, 2007; Love et al., 2011). Research on openness has only briefly addressed the question how firms can integrate acquired external sources into their own operations and innovations (West and Bogers, 2013). Nevertheless, the capacity to synthesize and transform knowledge is expected to be of great strategic importance for successful innovation (Lichtenthaler and Lichtenthaler, 2009; Roper et al., 2014).

Den Hertog et al. note that the conceptual nature of services implies that this translation stage is peculiar: a service innovation cannot be researched, developed, prototyped and tested in a similar way as physical goods (2010, p. 500). Due to intangibility of the service product, possibilities to communicate codified knowledge are limited. Instead, it involves a high amount of tacit knowledge to assemble raw market signals into an innovative knowledge combination. Only when firms manage to generate full-fledged service concepts, there is a basis to conduct experiments and to assess how delivery of the new proposition can be organized best. Apart from integrating new information (concerning both needs and options) and past experiences, KIBS thus also face the challenge of aligning a novel service proposition with their current business activities. This element of service conceptualization requires a comprehensive understanding of what the new offering entails as well.

The description of the dynamic service innovation capability of conceptualizing provides relatively few suggestions for how to involve external parties (Den Hertog et al., 2010). In fact, the benefits of openness are mainly discussed as an intra-organizational issue: knowledge transformation "is mostly in the hands of a multidisciplinary project team" (Den Hertog et al., 2010, p. 501). Indeed, Love et al. (2011) show that internal openness in the form of team working is important when encoding ideas into viable service offerings. Moreover, relying on three case-studies on customer-interaction by design services, Lehrer et al. (2012) find that the stage of knowledge transformation is performed best in isolation. They claim that separation between service firms and clients at this stage of service innovation can sometimes be beneficial for KIBS, especially when the innovation involves a high degree of creativity.

Synthesis: Openness along a KIBS' innovation value chain

To what extent the encountered possibilities for relying on partners influence the relative need for different innovation capabilities has not been assessed so far; especially not for inherently open firms like KIBS. Already since the seminal work by Laursen and Salter (2006) it is known that there are decreasing returns in external search, but a qualitative appreciation of this drawback is lacking. According to Roper et al.'s (2008) view on open innovation strategy, firms generally are advised to develop capabilities for activities where outsiders are of little help. This view is echoed by for instance Laursen and Salter (2011), as they warn against the risk of overly relying on external parties and thereby failing to perform essential tasks internally. When applied to the case of KIBS, this line of argumentation leads us to form an expectation regarding the capabilities most essential for being innovative.

Synthesizing the observations from the previous sections, we obtain a pattern regarding the possibilities for relying on external partners during the distinct phases of the innovation value chain (for a qualitative illustration, see the box below). First, research on knowledge sourcing by KIBS finds external linkages (be it routine-based interaction or deliberate collaboration) to be important for acquiring signals about market demands and possible ways to meet them. KIBS are therefore expected to have sensing capabilities to their availability already by their very openness. Second, although the role of partners decreases as activities in the innovation value chain get less explorative, studies on commercialization and management of new services have demonstrated that partner importance reappears when the innovation funnel reaches the stage of actually deploying new formulas. KIBS engaging intensively in deliberate partnerships are then expected to show less need to invest in internally developed 'co-producing and orchestrating' and 'scaling and stretching' capabilities, since they can rely on their partners' capabilities as well. Only for activities related to transforming raw ideas in strong propositions, the possible role of external parties is not self-evident. Our review of studies concerned with openness in KIBS seems to suggest that knowledge transformation occurs best in isolation, or at least is less likely to be substituted by the input of external parties. Also scholars not specifically looking at KIBS have stated that firms do need their own encoding capacity in order to actually use the knowledge it has been gathering; "Once acquired, the innovation effect of external knowledge will depend on firms' ability to encode that knowledge into their innovation outputs" (Roper et al., 2014, p. 21).

In sum, the theoretical and empirical findings we discussed above jointly imply that KIBS can complement an open strategy best with a strong conceptualizing capability. While the capabilities for the initial and final stage of the innovation value chain can certainly be of strategic importance, their potential to allow highly open firms to be even more innovative is likely to be inferior to the value of being able to conceptualize. In other words: looking at the *relative relevance* of the various innovation capabilities, we expect the importance of conceptualizing to increase over the importance of other capabilities as KIBS get more open. The third (and core) hypothesis we arrive at is thus as follows:

Hypothesis 3: When KIBS engage in high levels of openness, the capability most important for being innovative is conceptualizing

Illustration of openness along a KIBS' innovation value chain

Existing literature research on innovation by KIBS suggests that the role of partners varies along the innovation value chain. The evidence we retrieved in section 5.2 stems from a variety of studies, each of them typically focusing on solely one phase of the sequential steps through which knowledge is converted into marketable solutions. Relatively, empirical evidence for patterns of partner involvement in a service firms' entire chain of innovation activities is found to be rare. Before engaging in quantitative analyses, we therefore complement the findings from our literature review by reporting the open innovation practices of a single KIBS-firm. The main purpose of this section is to demonstrate in more detail what open innovation can look like in the context of firms that are already open by their very nature. Evidence of such a qualitative nature can provide a valuable contribution to our understanding of open service innovation (Mina et al., 2014).

Our in-depth case study, based on 10 interviews of one hour and additional desk research, concerns the innovation processes in a Dutch organization specialized in advising health-care institutions; the Eye Care Network (ECN) in Rotterdam. This organization, being a spin-off of the Eye Care Hospital Rotterdam, offers services to create better safety and hospitality in (notably eye-care) hospital departments. For example, it provides training aimed at breaking hierarchical barriers for communication and collaboration within medical teams. Other innovative propositions are the adaptation of a 'time-out' in which a one-minute check is performed before starting an operation, and a valet parking service that allows patients to feel welcome and comfortable without stressing about finding parking place. More details on the innovation activities by ECN are provided in De Korne (2011).

Many of the solutions offered by ECN are unprecedented in the domain in which our focal firm is active. As will become clear, the services it offers are largely based on transferring solutions from other industries to the health sector. These solutions, which are practices to improve an organizations' function rather than medical solutions, have mainly been developed by the management of ECN's parent firm. Because the hospital's management could not commercialize her innovations herself, she decided to establish the independent organization we focus on here. The services of ECN are offered via a franchise model in which various innovative procedures are bundled into a single package. After performing an initial screening, ECN develops a multi-annual plan in which she selects standardized practices that fit with the specific needs of the client (i.e. franchise-taker). During the execution of this plan, it remains closely involved for monitoring progress and providing additional guidance. Also beyond the domain of health, KIBS in the Netherlands have rarely a franchise-formula like the one described here.

The continuous development of ECN's innovative propositions depends on the input of a wide range of external parties. Helping hospitals with optimizing the functioning of her organization provides rich feedback. In that way, ECN is able to learn about needs that she would not have identified herself. Apart from looking internally (i.e. at her parent company), it draws on extensive interaction with clients when extending her service portfolio. Rather than developing a pro-active sensing capability, it only ensures that signals from clients are captured and administered.

A more original type of external linkages that led to new ideas is interaction with the airport Schiphol and the airline company KLM. The fields of health and airlines are similar in their search for safety and hospitality. In lack of any competitive threat, the parties were willing to exchange ideas and best practices. Indeed, the time-out and team-training that are unprecedented in the health sector were directly adopted from Schiphol and KLM. Also the implementation of lining on the operation room's floor, in order to ensure that equipment is stored in the appropriate places, is imitated from the lining on the airport. Instead of through a permanent intelligence function, ECN obtained the required knowledge by organizing only a couple of site visits.

As noted, openness in commercialization has been studied less than openness in the phase of idea generation (West & Bogers, 2013). Existing research, typically performed in a manufacturing context, suggest that commercialization requires secrecy rather than openness (Laursen & Salter, 2013). Meeting the demand for examples in a service setting, our case-study demonstrates how KIBS can rely on other parties when implementing and fine-tuning new services.

The services offered by ECN include assistance in implementing new practices for becoming safer. How to achieve this depends on the situation of each individual client. Due to the multitude of eye care specialists in the parent firm, it has not always been easy to implement a new practice there straight away. Instead, ECN 'experimented' with a new practice by deploying it first at a smaller client that might have been embracing the new solution more easily. Applying a new procedure at a client's site provides evidence of the functionality (which increases the chance for successful adoption in the parent firm), but was also found to improve the practice. Contrary to a product that is commercialized by laying it on a shelf, the guidance and consults provided by ECN require the experience of applying it under different circumstances.

Again, also other parties have been influential in shaping the service portfolio of our case-firm. New practices that could be incorporated in the franchise bundle were not just created by observing the airline industry. Instead, a service like mystery-guest visiting in order to have a pre-treatment impression of a client's safety and hospitality is being delivered in close collaboration with professionals (pursers) from KLM. The same holds for the afore-mentioned team training for medical teams, which is delivered by a partnering agency specialized in training pilots. By relying on these external parties, the focal firm herself does not need to have competences and knowledge that are required for delivering her services. Moreover, by adding services from partners to her own portfolio ECN increases her visibility as a one-stop-shop for innovative practices in the health sector.

A major reason for ECN not to avoid outward knowledge flows (in terms of secrecy) is the societal legitimation of her activities. Since the health sector is highly dependent on the politics of public policy, firms in this domain cannot be certain of their future. In order to emphasize its contributions in the domain of health care, ECN and her parent firm appreciate public attention for their qualities. This means that even without obtaining financial rewards, there is a willingness to diffuse some of the successful practices. For instance, the organization occasionally advises other sectors (banking, firefighting) on how to improve safety and hospitality. These forms of revealing are important for ECN's innovations. Deploying practices under other circumstances provides yet more opportunities to learn and to optimize. Secondly, building a wider reputation as a safety and hospitality expert augments the possibility that clients from both the health care sector and beyond are willing to enjoy services on a paid basis. The resulting revenues, in turn, are mainly invested in experiments with new practices.

Like in the case of ECN's' explorative efforts, most exploitative activities rely on knowledge flows from daily business (and some incidental events) rather than on strong internal capabilities.

5.3 METHOD FOR STATISTICAL ANALYSIS

5.3.1 Dataset

The statistical analysis we present is based on a dataset that was constructed by sending out a questionnaire to a wide variety of Dutch firms from the greater Amsterdam and Utrecht area. The sample was composed by randomly drawing addresses from the Bureau van Dijk's REACH database, while ensuring industry and firm size representativeness. The letter containing the questionnaire has been addressed to the CEO's or top managers from 8054 firms with ten or more employees. Providing the possibility to return the survey by mail or to fill it in online, the mailing yielded 458 responses. With respect to industry and firm size, the firms that participated are to a large extent similar to non-respondents. In this study, we analysed a subsample of the firms which were registered as KIBS and have responded on all items used in our models.

Previous studies have classified firms as KIBS when belonging to computer and related activities, research and development, or other business activities (Castaldi, 2009; Leiponen, 2012). In NACE Rev.2, this corresponds with information and communication services (industry group J) and professional, scientific and technical activities (industry group M). The table below shows how our sample of 125 cases is distributed over the respective industries within these KIBS categories.

Table 5.1: Sectoral composition of the dataset.

KIBS group / industry	125
J: Information and communication	42
Publishing activities	*1*
Motion picture, video and television programme production, sound recording and music publishing	*8*
Programming and broadcasting activities	*1*
Telecommunications	*1*
Computer programming, consultancy and related activities	*28*
Information service activities	*3*
M: Professional, scientific and technical activities	83
Legal and accounting activities	*10*
Activities of head offices; management consultancy activities	*28*
Architectural and engineering activities	*22*
Scientific research and development	*3*
Advertising and market research	*17*
Other professional, scientific and technical activities	*3*

5.3.2 Statistical method

We examined the influence of DSICs and openness on innovation by testing a series of hierarchical linear regression models. First, we explored the relative influence of the five innovation capabilities on renewal of the service portfolio (Model 1). Including all capabilities simultaneously in one model served to give an empirical account of the respective importance of each of the capabilities for creating service innovation. So far, this essential step has not been made yet in the literature (Den Hertog et al., 2010; Chapter 4). In section 5.2.1 we hypothesized that all capabilities matter for a KIBS's innovativeness.

Second, we looked at the relation between openness and innovation (Model 2). The purpose of model was to test our second hypothesis, stating that deliberate partnerships have relevance for innovativeness even when looking at firms that are already open by their very nature.

In the third model, we included both the capabilities and openness in one single regression. Model 3 sheds some light on the relative role of openness, but mainly serves as a step towards the final analysis.

In Model 4, we extended the previous model with the interaction effects between innovation capabilities and openness. This model provides a test for our third and final hypothesis. We examined to what extent openness moderates the relations between the distinct innovation capabilities and innovativeness. Although analytically it might be more comprehensive to compare highly open KIBS to moderately open KIBS, we follow the advice by Spiller et al. (2013) not to dichotomize a continuous variable or split our sample; doing so might lead to loss of statistical power and increases the chance of encountering spurious effects. Instead, we adhered to common practice by running a model of the (simplified) type below, with which we eventually test whether and how much an increase in one quantity of openness is related to an increase in the *effect* of a certain capability (Spiller et al., 2013).

$$Y = \beta_0 + \beta_1 {*}\mathit{DSIC} + \beta_2 {*}\mathit{openness} + \beta_3 {*}\mathit{DSIC}{*}\mathit{openness} + \varepsilon$$

5.3.3 Description of variables in the models

The dataset we rely on contains responses to survey questions adopted from the Community Innovation Survey (2010), as well as several items for new measurement scales. For the current study, particularly the items related to dynamic service innovation capabilities (DSICs) and service innovation are of relevance. All of the reported constructs were measured with 7-point Likert-scales. Descriptive statistics and correlations of the subsequently discussed variables are shown in Table 5.2. In order to reduce the effect of multi-collinearity, variables used for interaction terms were mean-centered (Aiken and West, 1991). The last column of Table 5.3, in which our results are presented, confirms that all variables in our final model have a variance inflation factor well below the critical threshold of 10 (Diamantopoulos and Winklhofer, 2001).

Dynamic service innovation capabilities form a key set of independent variables in our models. As mentioned throughout this chapter, they consist of sensing user needs, sensing (technological) options, conceptualizing, co-producing & orchestrating, and scaling & stretching (Den Hertog et al., 2010; Chapter 4). The measurement items for this scale are based on underlying micro-foundations (Teece, 2007), identified in extensive literature and empirical research (Den Hertog et al., 2010). Measures of construct reliability for cases in the current sample are provided in Appendix B.

Openness is the other focal point of this study. To be consistent with the established body of research, we adapted a standard scale from the Oslo Manual for collecting innovation data (OECD, 2005b). Firms were asked to state to what extent they have been engaging in deliberate partnerships with an innovation objective. One minor modification we made was the inclusion of a question regarding the importance of freelancers, since they account for an important part of employment within the Dutch economy. The variable used in our analysis is the average of scores given for all external parties. Note that this indicator concerns deliberately formed partnerships with the aim of innovation; they form an addition to the interaction a firm is naturally engaging in when delivering its products or services. Items and descriptive statistics are included in Appendix C.

Service innovation is the dependent variable. It was constructed by equipping the survey with questions regarding changes and renewal in a firm's services in the preceding three years. Asking respondents to look back is a common method for analysing the lagged effect of capabilities on innovativeness (e.g. Mansury and Love, 2008). Since novelty in services is hard to grasp with traditional distinctions like process and product innovation, we adopted insights on the multidimensional nature of service innovation (Den Hertog, 2000; Chapters 2 and 3). In particular, we made use of the service innovation index introduced and validated in Chapter 2. The index, a second order construct, is calculated by summing the scores on each of the six dimensions (similar to the approach followed by Mina et al., 2014., see also Appendix D).

Control variables, as present in our analyses, include in the first place the logarithm of firm size. In line with similar studies, we also use a proxy for the extent to which a firm is oriented towards engaging in innovation (e.g. Leiponen, 2012). Since R&D budgets are an inappropriate measure in the context of KIBS, we asked them whether they had formalized procedures for innovation in place. Questions were adapted from the service innovation formality scale by Avlonitis et al. (2001), and in particular their items on systematic behavior and documentation. Our formalization measure is constructed as the average score on the 5 items that demonstrated most construct reliability (Appendix E). Finally, our last two control variables concern the environment a firm is operating in. This aspect, which might affect our findings, is captured by the environmental turbulence (Laursen and Salter, 2006), and the degree of competitive intensity (Keupp and Gassmann, 2009). Competitive pressure and market dynamism (Cronbach α = .706 and α = .844 respectively) were measured with scales developed by, respectively, Jaworski and Kohli (1993) and Jansen et al. (2006).

5.4 RESULTS FROM REGRESSION MODELS

Before exploring the role of openness, we examined to what extent the five DSICs can be related to novelty in a firm's service portfolio. Inspection of the descriptive statistics in Table 5.2 reveals that all of the individual capabilities are significantly correlated with service innovation. This is a reassuring finding for managers who are investing in the activities that undergird these dynamic capabilities, but it does not yet reveal where scarce resources can be allocated best. To study the relative influence of the DSICs, and test our first hypothesis, we simultaneously test the statistical relationships of all the capabilities in one single regression model.

Model 1 in Table 5.3 largely confirms our hypothesis that all dynamic capabilities matter for a KIBS' ability to be innovative. The only capability not having significant predictive power (in a model also containing other capabilities and control variables) is the one for 'sensing user needs'. Relatively to the other DSICs, this capability appears not to be discriminative for innovativeness. If we look at the capability that turns out to matter

Table 5.2: Descriptive statistics and correlations. * = p < .05; ** = p < .01.

		Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11
1	Firm size (log)	3.56	1.34											
2	Formalized innovation activity	3.38	1.32	0.01										
3	Market dynamism	5.07	1.27	0.01	0.05									
4	Competitive pressure	4.96	1.16	-0.06	-0.09	.20*								
5	DSIC 1: Sensing user needs	4.74	1.20	0.04	.39**	.19*	0.09							
6	DSIC 2: Sensing (techn.) options	5.29	1.11	0.01	.32**	.34**	0.15	.47**						
7	DSIC 3: Conceptualizing	4.83	1.12	-0.13	.22*	.28**	-0.13	.48**	.54**					
8	DSIC 4: Co-producing & orchestrating	4.64	1.26	0.02	.20*	0.11	0.10	.25**	.30**	.25**				
9	DSIC 5: Scaling & stretching	4.38	1.24	0.10	.26**	0.13	-0.09	.29**	.38**	.26**	0.02			
10	Openness (partnerships)	2.82	0.93	0.09	.19*	.21*	0.16	0.14	.32**	.18*	.37**	0.04		
11	Service innovation	4.46	0.89	0.01	0.13	.31**	0.09	.26**	.52**	.44**	.30**	.33**	.31**	

Table 5.3: Results from regression analyses on service innovation. * = p < .10; ** = p < .05; *** = p < 0.01

	Model 1		**Model 2**		**Model 3**		**Model 4**		**VIF**
	Beta	*Std. error*	Beta	*Std. error*	Beta	*Std. error*	Beta	*Std. error*	
Firm size (log)	0.022	*0.051*	-0.013	*0.056*	0,010	*0,051*	-0,014	*0,052*	1.155
Formalized innovation activity	-0.072	*0.056*	0.068	*0.058*	-0,086	*0,056*	-0,067	*0,058*	1.397
Market dynamism	0.112	*0.057*	0.255***	*0.061*	0,101	*0,057*	0,107	*0,058*	1.279
Competitive pressure	0.055	*0.063*	0.005	*0.067*	0,042	*0,063*	0,052	*0,065*	1.349
DSIC 1: Sensing user needs	-0.089	*0.083*			-0,077	*0,083*	-0,084	*0,088*	1.846
DSIC 2: Sensing (techn.) options	.299***	*0.090*			,276***	*0,091*	,279**	*0,099*	2.333
DSIC 3: Conceptualizing	.228**	*0.089*			,223**	*0,088*	,222**	*0,090*	1.952
DSIC 4: Co-producing & orchestrating	.174**	*0.070*			,141*	*0,073*	0,137	*0,075*	1.348
DSIC 5: Scaling & stretching	.187**	*0.074*			,194**	*0,073*	,211**	*0,075*	1.337
Openness (partnerships)			0.245***	*0.079*	0,119	*0,074*	0,142	*0,079*	1.502
DSIC 1 * Openness							-0,124	*0,091*	1.978
DSIC 2 * Openness							-0,035	*0,101*	2.257
DSIC 3 * Openness							,183*	*0,092*	2.118
DSIC 4 * Openness							-0,020	*0,073*	1.506
DSIC 5 * Openness							-0,116	*0,082*	1.539
R2	0.381		0.164		0.391		0.424		
Adjusted R2	0.332		0.129		0.338		0.345		
F	7.852		4.661		7.334		5.358		

most, especially having the capability of sensing (technological) options is strongly related to creating service innovation.

Looking at Model 2, we observe that the variable for engaging in deliberate partnerships is positively related to service innovativeness, also for firms who already interact intensively with external parties on an operational basis. This finding confirms our second hypothesis. According to the results of the third regression, however, maintaining deliberate partnerships (in addition to routine-based forms of interaction) does not improve the model substantially when these firms also invest in capabilities. In Model 3, the influence of the respective capabilities is similar to the coefficients in Model 1, except for the capability of co-producing and orchestrating. The positive relation of this variable gets slightly less significant when we control for the fact that can be open in their innovation processes, and thus might also have more experience with producing a service jointly with others.

The main question, finally, concerns the interaction between the two factors of interest: which of a KIBS' internal capabilities matter most when its degree of openness increases? This is what the moderating variables in Model 4 reveal. When including the interaction terms of openness and the dynamic capabilities, we find that almost none of them is statistically significantly related to service innovation (which is why the total goodness-of-fit does not improve when moving from model 3 to model 4; the significance of the change in F is only 0.293). The one exception here is conceptualizing. Whereas capabilities for the beginning and final phases of the innovation value chain do not show complementarities with a high level of openness, the interaction term for conceptualizing turns out to be of positive significance. Although the observed effect is only weak, it clearly is stronger than the negative and non-significant effects of the other interaction terms. These findings are in line with the hypothesis that the importance of conceptualizing increases over the importance of other capabilities as KIBS innovate more openly.

In order to confirm our third hypothesis entirely, we calculate the total effects of the innovation capabilities in Model 4. For each capability, the total effect is equal to the standardized β-coefficient of the direct effect, plus the standardized β -coefficient for the interaction effect multiplied with openness. In terms of the simplified model presented earlier, this can be written as: $\beta_1 + \beta_3 * openness$.

As shown in Figure 5.2, the total effects on innovation of four out of five capabilities are basically flat lines, given that the corresponding (negative) interaction term with openness is not significant. For sensing of user needs even the average effect, as captured by the coefficient of the direct effect, is not significant. Only for conceptualizing, we observe that its relation with innovativeness indeed increases significantly as a firm operates more openly. Already for levels of openness that are just above the sample's average (zero because variables are standardized), the total effect of conceptualizing becomes more important than the total effect of sensing technological needs (which is the most influential capability under a KIBS' regular business circumstances). In sum, while additional openness does not lead to a larger marginal innovation-effect of four of the capabilities, there is no clear ceiling to be found for the interaction between openness and the conceptualizing capability. Having a strong conceptualizing capability seems to allow innovation-pursuing KIBS to make more use of the knowledge flows they are engaged in, contrary to the capabilities primarily associated with obtaining or applying (and thus disseminating) knowledge.

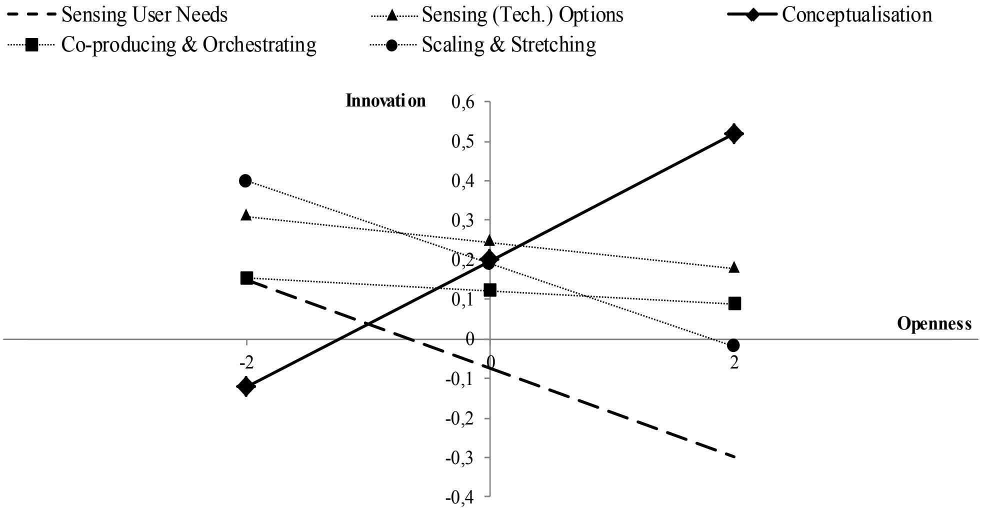


Figure 5.2: Total effect of each innovation capability on innovation is equal to the direct effect and the indirect one.

($\beta_{DSIC} + \beta_{DSIC}$ **openness * openness),* based on results from regression model 4 *(standardized coefficients).*

- Striped line corresponds with effect where intercept and slope are not significantly different from zero.
- Dotted lines are effects where only slope is not significantly different from zero.
- Continuous lines refer to effects where both intercept and slope are significantly different from zero.

5.5 DISCUSSION

5.5.1 Findings and implications

Due to the absence of appropriate metrics, the relation between having dynamic capabilities and realizing service innovation had hardly been assessed so far (Den Hertog et al., 2010).

According to our statistical findings, sensing user needs is the only capability not significantly related to a KIBS' innovation output. This result is at odds with earlier findings from a broader sample of service providers (see Chapter 4). For those firms who might on average interact less intensively with their clients than KIBS do, sensing user needs did have a significant relation with turnover from innovative sales. The counter-intuitive finding from the current study emphasizes the need to focus on complementarity when developing in-house capabilities.

Our results do not object to common findings that customers have a major impact on (service) innovation (e.g. Love et al., 2011); they only suggest that for KIBS this is not the most promising area to target when developing innovation capabilities. Because professional service providers typically engage in 'on-the-job'-learning by engaging in close interaction with their clients (Leiponen, 2005), there appears to be relatively limited value in developing an intelligence function on this account. As Leiponen noted (2012, p. 1258), building an internal sensing function "cannot replace direct contact between clients and employees active in new service development".

On the other hand, sensing (technological) needs turns out to be all the more important for realizing service innovation. The discriminatory property of this capability is in line with the generally acknowledged view that many service innovations are driven by opportunities stemming from, for instance, ICT-technologies (Sirili and Evangelista, 1998). In order to take maximum advantage of the competitive advantage such technologies might offer, KIBS are advised to invest in activities allowing them to stay up to date with developments in this respect. These efforts are typically found in business development or ICT departments within an organization, in which employees are responsible for scanning promising opportunities (Den Hertog et al., 2010).

With respect to the core of the current study, analyses on service innovation in KIBS show that four out of five capabilities are not significant in interaction with openness. Apparently, when KIBS raise their level of openness by maintaining innovation-oriented partnerships (rather than just engaging in operational interactions), conceptualizing becomes the most discriminative capability for achieving innovative output. The regression results thereby provide strong evidence for the expectation that KIBS who maintain extensive external relationships might benefit mainly from having an ability to translate acquired and generated market signals into marketable propositions. In such circumstances, the other capabilities are relatively less attractive to develop internally, as also external parties can take care of (or contribute to) some of the activities at the beginning and end of the innovation value chain.

The empirical evidence we provide holds important implications. For researchers as well as managers, it supports the urge to pay attention to knowledge transformation or assimilation (Roper et al., 2011). Whereas the notion of absorptive capacity is typically associated with the entire range of innovation capabilities (e.g. Boly et al., 2014), or even mainly the explorative and exploitative aspects (Van de Vrande et al., 2009), our results indicate that especially the intermediate capability of conceptualizing allows open firms to benefit from knowledge flows. According to Den Hertog et al. (2010), firms can develop their conceptualizing capability by engaging in practices like prototyping, visualizing, (service) blueprinting, nurturing corporate entrepreneurship and out-of-the-box thinking.

Taking a broader perspective, the encountered findings also invite us to reflect on the role of KIBS within innovation systems. Conceptualizing appears to be the one critical capability that open KIBS better maintain internally. We suggested that there are relatively few opportunities for firms to draw on external knowledge during the encoding stage. This is consistent with the claim that transforming raw ideas into bespoke solutions is a highly complex task, demanding specialized skills (Muller and Zenker, 2001; Lehrer et al., 2012). For knowledge economies, KIBS' ability to transform knowledge might perhaps be just as important as their contribution to disseminating it. After all, translating knowledge into problem-solving strategies and spreading knowledge are both essential for industrial evolution and economic growth to occur (Consoli and Elche-Hortelano, 2010). The ability of KIBS to assemble knowledge into new solutions, in addition to merely transferring knowledge, legitimates special policy attention (Toivonen, 2007). Evidence that conceptualizing resides mostly within KIBS themselves provides support for interventions aimed at improving KIBS' interaction with public and private organizations who are less able to convert knowledge on their own.

5.5.2 Further research and limitations

The analyses in this chapter suggest that the act of conceptualizing is something KIBS might want to invest in especially when they have an above-average level of openness. In order to support innovation managers more adequately, future studies might investigate in more details how to build and exploit a conceptualizing capability. Also, to what extent these results are valid for non-KIBS remains still to be examined. For instance, there might be more possibilities to rely on external parties in contexts where knowledge is often codified. According to Roper et al., the ability of a firm to engage in conceptualizing (or 'encoding') is determined by factors related to organizational culture, structure and resources (2014, p. 21). By demonstrating the use of a capability framework, our chapter opens the way to investigate these expectations empirically.

Future research could also serve to clarify under which circumstances also sensing user needs allows KIBS to become more innovative than their competitors. In a service-oriented study, Salunke et al. (2013, p. 1093) state that "the use of dynamic capabilities in gaining and exploiting customer-based knowledge and its effect on sustaining innovation-based advantage remains a neglected area". One key moderating factor is likely to be the extent to which KIBS deliver customized rather than standardized services. The paradox that sensing user needs does hardly matter to firms who interact so closely with their users can perhaps be explained by downsides of focusing too much on the needs of particular customers, rather than looking for concepts that are valuable to a wider client population. This is what we will explore in the next chapter.

As for the limitations of this study, the authors stress that all empirical results are obtained from self-reported data. Despite our efforts to ensure methodological rigor, we acknowledge that replications and extensions of the presented analyses can benefit from the use of secondary data sources. However, we also stress that the emphasis in all analyses lies on testing which factors (dynamic capabilities and openness) matter most. This focus on relative rather than absolute performance renders problems of common method bias largely irrelevant.

5.6 CONCLUSION

This chapter took up the challenge of diving deeper into the under-researched phenomenon of open service innovation in KIBS (Leiponen, 2012; Mina et al., 2014). Innovation scholars typically have been studying KIBS for their role as knowledge brokers and innovation generators (Den Hertog, 2000; Muller and Zenker, 2001), but research is increasingly focused at how openness affects innovation processes within the KIBS themselves (Love et al., 2011). While some authors did stress the need of assessing the role of openness in services, our study is one of the first to examine the importance of innovation-oriented partnerships in firms whose regular business activities already demand intensive forms of interaction.

Working towards analysis of the moderating role of openness, a first contribution of our study lies in shedding light on the relative importance of having specific innovation capabilities. So far, the framework of dynamic service innovation capabilities has hardly been used to study which kind of innovation activity is most discriminative when it comes to achieving innovation. Acknowledging that resources are limited, we aim to inform managers who have to decide which capabilities to concentrate on especially.

Most importantly, this chapter assesses how the value of innovation capabilities is related to a firm's routine-like and innovation-oriented openness. Whereas research on external knowledge sourcing has focused primarily on identifying optimal levels of openness (e.g. Laursen and Salter, 2006, 2013; Berchicci, 2013), we presented evidence for the argument that there is a functional restriction in the extent to which firms can rely on the skills and knowledge of others. From a resource-based perspective, the most important capability to focus on is the one related to a phase of the innovation value chain where external parties can contribute least (Roper et al., 2008; Love et al., 2011). In line with the exploratory case study by Lehrer et al. (2012), we showed that for KIBS, having an internal conceptualizing capability is most complementary to extensive external knowledge sourcing. Moderately open KIBS benefit most from their capability to sense user needs, but least from a sensing user needs capability. On the basis of our findings, we conclude that KIBS appear to differ in their reliance on external parties. While openness is typically seen as a common characteristic for all of them, there does seem to be room for strategic consideration of which activities to perform or not to perform jointly with others. The mere production of knowledge intensive business services requires extensive forms of interaction, but for the creation of novel services it is up to the firm itself how much (and especially: on what accounts) she wishes to involve external parties. Making the right choices here can be of significant importance for a firm's innovativeness, and therefore competiveness.

Looking beyond the domain of KIBS, our results are also of relevance for the increasing number of firms that takes part in adopting an open innovation strategy and switching to service-inclusive business models (Chesbrough, 2011; Mina et al., 2014). As noted by many authors, servitization involves more than replacing (or complementing) the production of artifacts for the delivery of services. Instead, the provision of services, and the client interaction that comes with it, might have a direct impact on the way how firms organize the development of new propositions. Returning to the observations by Barras (1990), we stress that insights in the innovative behavior of firms in the forefront of openness are of strategic relevance to any firm following the path towards highly interactive modes of production.

Finally, our contributions provide input for emerging debates on knowledge processing. Trying to understand how firms contribute to the creation and dissemination of knowledge, scholars are actively investigating processes like knowledge generation, encoding and application (Love et al., 2011, Roper et al., 2014), or knowledge systematization and reconfiguration (Consoli and Elche-Hortelano, 2010; d'Ippolito et al., 2014). Taking a capability approach, as proclaimed by Criscuolo et al. (2007), the current chapter offers a basis for studying knowledge processing activities in more depth.

APPENDICES B-E: MEASUREMENT ITEMS

APPENDIX B: MEASUREMENT ITEMS FOR DYNAMIC SERVICE INNOVATION CAPABILITIES

Dynamic service innovation capabilities are measured with the scales developed in Chapter 4:

Table B.1: Measurement items for dynamic service innovation capabilities. Source: Chapter 4, based on Den Hertog et al. (2010).

Sensing user needs. Cronbach alpha = 0.737
• We systematically observe and evaluate the needs of our customers. • We analyze the actual use of our services. • Our organization is strong in distinguishing different groups of users and market segments.
Sensing (technological) options. Cronbach alpha = 0.737
• Staying up to date with promising new services and technologies is important for our organization. • In order to identify possibilities for new services, we use different information sources. • We follow which technologies our competitors use.
Conceptualizing. Cronbach alpha = 0.734
• We are innovative in coming up with ideas for new service concepts. • Our organization experiments with new service concepts. • We align new service offerings with our current business and processes.
Coproducing & orchestrating. Cronbach alpha = 0.752
• Collaboration with other organizations helps us in improving or introducing new services. • Our organization is strong in coordinating service innovation activities involving several parties.
Scaling & stretching. Cronbach alpha = 0.650
• In the development of new services, we take into account our branding strategy. • Our organization is actively engaged in promoting its new services. • We introduce new services by following our marketing plan.

APPENDIX C: MEASUREMENT ITEMS FOR INNOVATION-ORIENTED OPENNESS

Questions on the importance of different types of partners are based on the Oslo Manual (OECD, 2005b). In this case the 7-point Likert scale ranges from "very important" to "very unimportant". Since we are particularly interested in external openness, the common list of co-operation partners was slightly modified. 'Other enterprises within the enterprise group' is not taken into account in this analysis, while 'Professional organizations, trade unions' and 'Freelancers' are added to be more complete.

The following partners have been important for our service innovations of the past three years:

- Suppliers of equipment, materials, services, or software
- Companies purchasing your services
- Customers
- Competitors or other businesses in your industry
- Consultants and external advisors
- Commercial labs or private R&D institutes
- Universities or other higher education institutions
- Government or public research institutes
- Professional organizations, trade unions
- Freelancers

Cronbach alpha = 7.52; mean (of mean score) = 2.82; variance = 0.86; standard deviation = 0.93

APPENDIX D: COMPOSITE INDICATOR AND MEASUREMENT ITEMS FOR SERVICE INNOVATION

The variable for ‘Service innovation’ is equal to the service innovation index developed in Chapter 2. This aggregated measure is calculated by summing scores on the six service dimensions defined by Den Hertog et al. (2010). The table below show again which survey items underlie the six constructs. For the 125 respondents used in our current tests, the construct reliability of the composite indicator for service innovation is equal to Cronbach alpha = 0.688.

Table D.1: Measurement items for service innovation. Source: Chapter 4, based on Den Hertog et al. (2010).

New Service Concept (NSC) • Our organization developed new (service) experiences or solutions for customers. • We combined existing services into a new formula. • We developed a new way of creating value for ourselves and our customers.
New Customer Interaction (NCI) • Our organization developed new channels for communicating with its customers. • The way *Business Partners (NBP)* customers is renewed.
New Value System /Business Partners (NBP) • The role of external parties in producing our services is renewed. • We involved new partners in the delivery of our services.
New Revenue Model (NRM) • By introducing new services we changed the way we generate revenues. • The way we get paid (financial construction) is altered.
New Organizational Delivery System (NODS) • We changed our organization in order to produce our new services. • Our production of new services requires new skills from our employees.
New Technological Delivery System (NTDS) • Technology plays an important role in the renewed production of our services. • We renewed our service offerings by new or different use of ICTs.

APPENDIX E: MEASUREMENT ITEMS FOR FORMALIZATION OF SERVICE INNOVATION

Items are adapted from the service innovation formality scale by Avlonitis et al. (2001).

- We evaluate the progress of our development of new services systematically
- The development of new services occurs via specific guidelines and procedures
- The final decision to introduce a new service is the result of a formalized process
- New services are being developed according to a schematic plan
- Progress in the development of new services is documented in writing

Cronbach alpha = 0.916; mean = 3.38; variance = 1.75; standard deviation = 1.32

Chapter 6

The sensing paradox in service innovation: Too much user-producer interaction?

6.1 INTRODUCTION

In many respects, the innovation landscape firms are facing today is changing rapidly. One notable trend, sometimes even referred to as paradigm shift, is the adoption of innovation modes characterized by a high level of openness (Laursen and Salter, 2006; Baldwin and Von Hippel, 2011). Perhaps the most important form of openness concerns learning by engaging in user-producer interaction (Lundvall, 1988; Chatterji and Fabrizio, 2014). Especially in the context of manufacturing industries, traditionally adhering to 'closed' innovation processes, intensification of reliance on customer signals is strongly advocated (Chesbrough, 2006). In order to access and process potentially valuable feedback, firms are encouraged to develop sensing user needs capabilities (Teece, 2007; Den Hertog et al., 2010). Maybe more than ever, strong sensing capabilities are believed to be crucial for a modern firm to stay adaptive (Bharadwaj and Dong, 2013).

A second major development, albeit taking place less disruptively, pertains to the ongoing service revolution (Bell, 1973). During especially the second part of the previous century, advanced economies started to concentrate on the provision of services rather than physical goods (Gallouj and Djellal, 2010). To escape the commodity trap, also 'servitizing' manufacturing firms have started to switch to service-oriented business models (Chesbrough, 2011; Bowen et al., 1991). Following a service-dominant logic, they recognize the opportunities of adding value by delivering services that meet the actual needs of customers better than providing them with material artefacts (Vargo and Lusch, 2004; Suarez et al., 2013). This trend has important implications for how firms give shape to their innovation efforts, including their use of external knowledge (Mina et al., 2014).

A key characteristic of service delivery is found in the intense interaction with customers. Contrary to the traditional production mode, in which manufacturing firms produced artefacts ultimately sold by retailers, the production of service propositions brings firms in permanent contact with their clients (Anderson et al., 1997). This is particularly the case when firms strive to add value by customizing their services to the specific needs of their customers (Bowen and Ford, 2002). Fulfilling these demands provides firms with rich user feedback on unmet market needs, as well as on the quality of the created solution. According to a large body of evidence, user interaction related to service delivery therefore forms a key input for new service development (Edvardsson et al., 2012).

This chapter focuses at the point where the two developments coincide. While the opportunities of using user knowledge might motivate firms to invest in building a strong sensing capability, the very shift to service-oriented business models appears to provide already a natural way for acquiring ideas on what propositions to develop next. The inherent openness of customized service delivery begs the question to what extent having such a capability has sufficient additional value for innovation-pursuing service providers. Particularly concerning is the claim that intensive forms of user-producer interaction might give firms an overly strong focus on the needs of existing clients, thereby leading them to neglect opportunities for developing solutions with a larger market potential (Christensen, 1997; Laursen, 2011). Indeed, in Chapter 5 we observed that sensing user needs is the least discriminative capability for the innovativeness of knowledge intensive business services (KIBS), but the most important one for non-KIBS. A paradoxical finding, if one accepts that fulfilling user needs lies at the heart of what 'to serve' really means.

In order to examine the contested value of actively sourcing user demands, we commence with reviewing existing research on firm and user behaviour related to sensing and signalling user needs. Since innovation literature is largely biased towards manufacturing, the role of user requests is often studied in the context of full-fledged user innovations (Von Hippel, 1976) or user involvement in co-creation experiments (Magnusson et al., 2003). Such a perspective neglects that service-oriented research requires attention for the knowledge flows that occur when firms are practically permanently exposed to user feedback, absent any user participation threshold (Dahlander and Piezunka, 2014).

As the debate on sourcing user knowledge for innovation suffers from a lack of theory (Chatterji and Fabrizio, 2014), also the merits of various modes of user-producer interaction remain largely unknown. To fill this gap, we develop a formal model for the mechanisms determining the value of user knowledge in search processes. Following the logic of NK (Kauffman, 1993), we specify four basic types of interactive search strategies used for exploring new offerings. The model and corresponding simulations lead us to formulate a verifiable hypothesis. We use survey data from 292 respondents to test empirically to what extent sensing and user input are related to sales derived from new services.

Our regression results suggest that, for firms frequently confronted with user requests, there is some value in developing a capability for systematically monitoring and evaluating user needs. However, we also observe that the importance of this capability is limited. Having a strong sensing capability and receiving a high degree of user feedback has a negative interaction effect for firms providing customized services, but a positive interaction effect when firms only deliver non-tailored services. These results thereby contextualize the hypothesis that focusing too much on articulated user needs might prevent firms from introducing successful service solutions.

With our findings, we support innovation managers dealing with the strategic dilemma whether or not to devote resources to sense user needs. While non-customizing service providers appear to benefit from developing strong sensing capabilities, this seems to be less the case for firms who might get trapped in suboptimal solutions as they fulfil the requests of individual customers.

6.2 LITERATURE REVIEW

6.2.1 User feedback as a source of variation

In the burgeoning literature on openness and innovation sources, the role of users is a highly prominent topic (West et al., 2014). Knowledge stemming from the actual use of products is valuable to organizations seeking how to renew or improve their offerings and firm performance. When it comes to understanding and identifying new market needs, as well as optimizing existing products, users themselves are often better positioned than firms (Bogers et al., 2010). By incorporating user-based knowledge (e.g. suggestions on what improvements to make), firms can direct their search efforts towards further elaboration and large-scale commercialization of fruitful user ideas (Chatterji and Fabrizio, 2012; 2014). However, because information is 'sticky', signals on user needs can only be acquired through intensive user-producer interaction (Von Hippel, 1994; Lundvall, 1988)

Acknowledging the importance of users own visions on their demands has led innovation scholars to shift from a producer-focus to a user-focused paradigm (Baldwin and Von Hippel, 2011). Those few innovation studies addressing services largely follow the same line of reasoning. Oliveira and Von Hipppel (2010), for instance, show how many commercial and retail banking services were originally developed by non-bank firms. On this basis, the authors claim that also in services a user-centred perspective on innovation is appropriate: apart from relying on service providers, customers can also 'serve' themselves in novel ways.

The demonstrated approach for extending research on user knowledge (regarding their needs) to services follows an assimilation approach, in which the domains of manufacturing and services are regarded as fundamentally equal (Coombs and Miles, 2000). A different perspective on the role of users in service innovation is offered by studies from predominantly marketing, operations management and innovation studies. Following demarcation and synthesis schools of thought, these literatures typically highlight or integrate service-specific aspects in innovation theory (Drejer, 2004; Miles, 2007). One such aspect concerns the way firms meet the demands of their customers. Whereas manufacturers typically develop physical artefacts with which customers can fulfil their own needs, the provision of tailored services does not (only) go through such intermediary objects: by definition, service providers directly deliver the desired solution or experience itself (Pine and Gilmore, 1999; Den Hertog et al., 2010).

Meeting the requests of individual clients requires knowledge that only can be obtained through intensive customer interaction (Matthing et al., 2004). Service delivery is often understood as an interactive process in which a provider and a consumer jointly aim to fulfil the consumers' needs (Vargo and Lusch, 2004). To what extent they succeed is determined by how well both parties align their resources and competences in this act of co-creation (Vargo and Lusch, 2008). This implies that, apart from being able to express their needs accurately, consumers also need to be involved in subsequent phases of service production. The quality of an expert consult, for instance, highly depends on how the user phrases its question as well as on how the issued advises will be used.

In their dual position of consumer and co-producer, the clients of a service firm are able to provide valuable feedback on the solution or experience they have been purchasing. According to Rubalcaba et al. (2012, p. 702), innovation-pursuing "service firms can benefit from their advantage over manufacturing firms, which stems from their personnel's direct interactions with customers". Similarly, Cusumano et al. (2014, p. 5) state that "because some services are grounded within actual consumer-producer interactions, they reveal information about consumption and usage". Thus, although service providers tend to rely heavily on tacit knowledge, which is more difficult to transfer than codified knowledge like technological characteristics, stickiness of information might be relatively less of an issue in services. Ultimately, the customer-oriented and relational nature of service provision renders the distinction between producer-focused versus consumer-focused innovation paradigms irrelevant.

Service consumers continuously express signals during the simultaneous processes of (co-) production and consumption, which is why service firms have an alternative to setting up resource-consuming co-creation practices (Rubalcaba et al., 2012). When it comes to the content of real-action communication flows, feedback can vary in its level of detail (Gustafsson et al., 2012).

First, users can implicitly or explicitly signal to what extent they are satisfied with the service that is being delivered to them and whether it meets their needs (Matthing et al., 2004). Of particular interest is that service consumers can communicate their appreciation or frustrations during the very acts of coproduction and consumption (Gustaffson et al., 2012), instead of having to do an effort by searching and filling out complaint forms, going back to the shop, etcetera. The interactive nature of service provision allows clients to express evaluative signals immediately to the (front-office employees of) the organization they are dealing with. Apart from being more direct, such interaction also provides opportunities for users to express in detail what particular aspect of a service is satisfying or dissatisfying them. These signals, respectively, can support decisions whether to maintain or alter the properties of the provided service. Especially complaints about a certain feature might provide incentives to search for alternative ways to deliver a solution or experience.

By explicitly formulating a demand for new services, users sometimes go even further in informing a service provider about the needs they would like to see fulfilled. When reviewing research on users as a source of innovation-related knowledge, Bogers et al. (2010) state that information about unmet user needs is likely to go along with suggestions on how to address it. Suggestions from external partners, including customers, are nowadays a popular topic of study (Dahlander and Piezunka, 2014). Also in the context of services, customers coming forward with a specific need often are found to provide cues for a possible way to solve it: "expressed needs may have either expressed or latent solutions" (Gustafsson et al., 2012, p. 313). By tailoring services to the specific needs of a customer, service providers continuously experiment with new *ad hoc* solutions that can possibly scaled up to other users as well (Drejer, 2004; Toivonen and Tuominen, 2009). As a result, service professionals not only obtain inspiring in-depth insights in a customer's use-situation, but being directly confronted with users' perceptions of problems and unmet needs often also yields ideas for which improvements to make (Rubalcaba et al., 2012). It is at this point that the distinction between coproduction and co-innovation starts to blur, thereby making Von Hippel's notion of distributed innovation a common term in service innovation literature (Den Hertog, 2000).

In the light of search for innovative solutions, it should be noted that user demands and suggestions are particularly valuable because of being original, timely and comprehensive (Bogers et al., 2010). However, unless uttered in collaborative development projects and deliberate co-creation experiments (which fall beyond the scope of this study), user input often is fragmentary, less producible and unelaborated (Magnusson et al., 2003). Knowledge stemming from personal use experience tends to be specific for individual needs – latent or articulated –, and therefore only covers a limited part of the body of knowledge required for implementing a total solution (Riggs and Von Hippel, 1994; Sandulli, 2013). The above-mentioned forms of feedback thus pertain mostly to evaluations and suggestions for particular aspects of a service: it remains up to the service provider how to use this knowledge for improving the entire service as such (Vargo and Lusch, 2008).

6.2.2 Organizational capabilities for sensing user needs

Recognition of the importance of user demands begs the question how firms can make strategic use of it. Again, the interest in services corresponds with a (slightly) different focus than the research stemming from a predominantly manufacturing context. The latter, to start with, has typically been examining how producer firms can cross the boundary between their firm and the users of their products. Such efforts are particularly focused at locating, screening and transferring need-related knowledge from the user to the producer (Bogers et al., 2010; Von Hippel, 1994).

In the context of customizing service providers, the distance to users is smaller than for firms that exclusively produce and sell physical and standardized goods. However, given that tailored service delivery essentially pertains to fulfilling user's actual needs rather than providing them an intermediary artefact, it seems all the more important for firms to keep track of present and latent desires. Here, we are mainly interested in the characteristic that service providers are continuously exposed to some sort of feedback, but have to decide how they deal with this. Studies on user involvement suggest that the best way for acquiring user knowledge is by interacting with them 'insitu' rather than by inviting them to participate in experimental settings (Edvardsson et al, 2012).

In order to understand the needs expressed by customers, organizations deploy activities that help them to gather and evaluate the signals they are confronted with. According to Matthing et al. (2004), service firms can respond aptly to user needs by engaging in learning processes. Specifically, the authors refer to the linked processes of market sensing and sense making as proposed by Day (2002). Whereas the first aspect concerns the systemic collection of information, the second type of sensing pertains to interpreting and evaluating the accumulated knowledge (Matthing et al., 2004).

Drawing upon these insights, Den Hertog et al., (2010) introduced sensing user needs as an essential dynamic capability for realizing innovation specifically also in a services context. Being a dynamic capability (Teece et al., 1997), the strength of a firm's ability to sense user needs depends on whether it has structured (but not necessarily formalized) routines in place for staying aware of what its clients want. Although firms can differ in how they fulfil these routines, as indicated by the notion of micro-foundations, there is general agreement that higher-order capabilities can be compared across firms (Eisenhardt and Martin, 2000; Teece, 2007). Such a comparison can point at different capability levels or strengths.

Most service firms have to some extent an intelligence function for keeping track of what existing or potential customers want (Den Hertog et al., 2010). Since accessing user input might to a large extent be performed via a service firm's routine-based interaction with its customers, an important part of the value of sensing user needs lies in carefully administering and systematically evaluating feedback. Creating an overview of which comments are expressed most often and most urgently gives firms an impression of what aspect(s) of their offerings to improve. Deploying such market sensing activities (Day, 2002) thus offers firms an account of where to concentrate efforts: the sensed feedback can provide inspiration when experimenting with new concepts, or allows firms to adjust the novel solutions they had in mind already.

When firms assign particularly high priority to customer demands, they might invest more substantially in developing their sensing user needs capability. Firms deploying a wide range of advanced sensing practices arrive at a point where users play a truly central role in the search for better propositions: user-knowledge is than treated as a key input in the process of sense making (Day, 2002). A strongly developed sensing capability allows firms to determine exactly what their users really want and to focus their resources on fulfilling the most urgent user needs.

6.2.3 The contested value of listening to users

The transfer of user knowledge is essentially a matter of sending and receiving information. While studies on openness in manufacturing typically appear to focus on bridging the distance between firms and users, research on service provision requires a different scope. Especially when solutions are customized to the needs of individual customers, firms are exposed to real-action knowledge flows which might contain valuable information. The question then becomes how to respond to these flows.

By discriminating low and high levels of both sensing and sending activities, we identify four typical modes of user-producer interaction (see Figure 6.1). As for the behaviour of users: feedback originating from direct interaction can tell a service provider in the first place *that* something needs to be changed and on *what* aspect, as indicated by expressions of (dis)satisfaction and signals of unfulfilled needs. If users provide a higher degree of feedback, their demands can also give an indication of *how* this can be done best, i.e. *which* changes are thought to be most suitable. Users who frequently express their requests provide information that is more like concrete suggestions rather than only complaints. Firms, on their turn, can obtain inspiration for innovative solutions by (only) monitoring how their customers are using and experiencing provided services. Or, when investing more substantially in their sensing capability, they can take the user-centric approach in which they follow their users closely in order to be able to adjust and optimize their services precisely to the spotted needs.

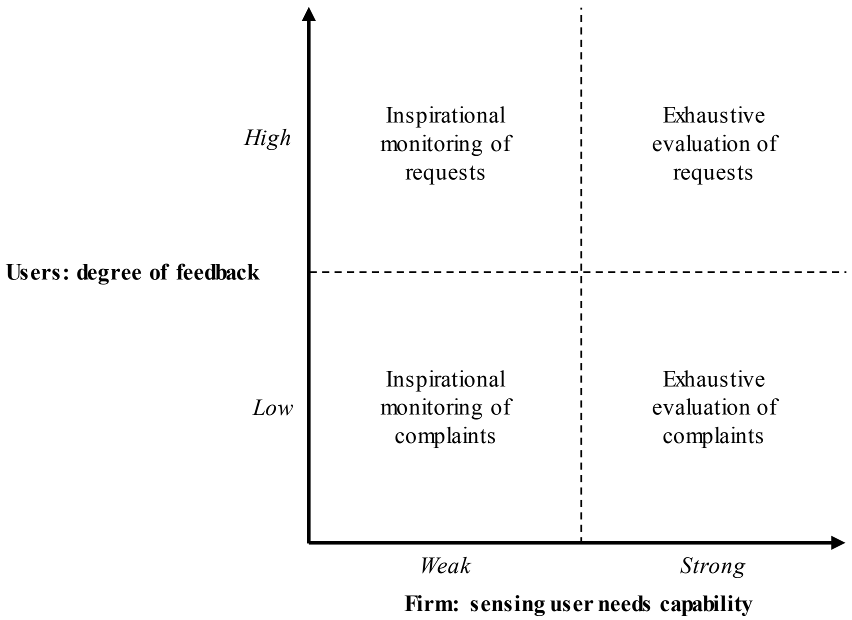


Figure 6.1: Four modes of user-producer interaction.

Deciding whether to invest resources in sensing requires insight in the respective advantages of each interaction mode, including the conditions under which these advantages are most prominent. Despite widespread academic interest in both user innovation and service innovation, however, there is a scarcity of research asking to what extent user's communicativeness and active sensing affect each other's role in innovation processes. In a service-oriented study, Salunke et al. (2013, p. 1093) state that "the use of dynamic capabilities in gaining and exploiting customer-based knowledge and its effect on sustaining innovation-based advantage remains a neglected area". Also Gallouj and Djellal (2010) contend that the role of customers in service innovation is still a conceptual and empirical gap.

On the one hand, we noted that insight in user needs is believed to be crucial for finding new ways to serve them. Studies on the interactive nature of service delivery have shown that the daily and intense confrontation with users indeed forms an important source of inspiration for the development of new service solutions (Bryson et al., 2012; Kristensson, 2004). For instance, survey research based on the Oslo manual (OECD, 2005b) revealed that the more firms are exposed to user interaction, the better they perform in generating innovative solutions (Leiponen, 2005; Tether, 2005). Likewise, Love et al. (2011) show that the importance of user interaction is especially prominent in the exploratory phase of the innovation value chain. These findings suggest that service providers might benefit from strengthening their ability to capture and assimilate external knowledge.

On the other hand, ever-more attention for user needs is perhaps not per se beneficial for innovation success. While current students of openness in innovation increasingly examine the issue of costs and downsides of knowledge sourcing (Dahlander and Piezunka, 2014; Laursen and Salter, 2006), scholars have been warning already for several decades that listening too carefully to users might have an adverse effect. In line with Rosenberg's notion of user needs as a focusing device (1969), Hamel and Prahalad (1991) and Christensen and Bower (1996) conjectured that knowledge about the demands of the existing user base can strongly narrow the options a firm is willing to explore. As existing customers can exert more influence than then potential customers, a firm can be held captive by its current client base and only 'search for new solutions along established paths' (Laursen, 2011). The consequence is that especially incumbent firms might fail to identify propositions that could serve a larger market (Christensen, 1997). Despite the fact that this tension is known to many innovation scholars, only few empirical studies have investigated whether intensive user-producer interaction truly increases the chance that firms yield innovations Lundvall would qualify as 'unsatisfactory' (1988). According to a recent survey study by Laursen (2011), firms relying strongly on input from their users do at some point experience negative returns with respect to their innovative performance. Whether this depends on the types of services (or goods) a firm develops is left to future research, just like questions related to the number and behaviour of clients.

There are reasons to believe that the caveat underlying the innovator's dilemma (Christensen, 1997) is all the more present when firms tailor their services to the needs of customers with whom they engage in co-production. In such circumstances, firms might devote most of their attention and resources to the development of client-specific solutions. These *ad hoc* inventions only become successful innovations when they are also commercialized in other contexts (Drejer, 2004). Because transferring tacit concepts to other clients is observed to be highly difficult (Toivonen and Tuominen, 2009), there is a substantial risk that customizing service providers relying heavily on their sensing user needs capability ultimately fail to introduce solutions that meet widely shared market demands.

In sum, existing research is inconclusive with respect to the question which interaction mode is relatively most effective for realizing successful innovation. It therefore also remains unclear whether service providing firms really should develop a sensing user needs capability. This is what we will assess in the remainder of this chapter. Instead of directly formulating two opposed hypotheses or hypothesizing a curvilinear relationship between user feedback and sensing, we choose to explore deeper the mechanisms determining when exactly adverse effects can occur.

6.3 SIMULATING DIFFERENT MODES OF USER-PRODUCER INTERACTION

6.3.1 Evolutionary search according to NK logic

Assessing the relative benefits of the distinct interaction modes requires a theoretically grounded understanding of innovation dynamics. To this goal, we draw upon evolutionary theorizing on technological and economic change (Nelson and Winter, 1982). This school of thought provides a rich basis of theory and methods for inquiry into the mechanisms behind novelty creation. Here, we are particularly interested in strategies regarding variety generation and selection.

In an evolutionary interpretation, the development of new offerings can be regarded as an experimental search process marked by uncertainty (Fleming, 2001). Firms try to improve the fitness of a product by modifying one or more of the elements it is composed of (Frenken, 2006). For instance, when trying to improve a bicycle, one can think of modifying its frame, gears or brakes. Possible design options for the latter dimension are handbrakes and coaster brakes. The outcome of introducing a modification is often uncertain: even if there are indications that a change will improve the 'technical' quality of a product, it remains difficult to estimate how the market will react to it (i.e. the 'evolutionary fitness' of the overall product). What is more, modification of one product dimension might have impact on the functionality of other elements. An apparent improvement in one aspect of a product might therefore lead to an overall fitness reduction (Beinhocker, 2006).

Borrowing from biological science, the evolutionary school of thinking proposed a form of complexity theory to investigate the above-mentioned characteristics of innovation processes. According to Kauffman's (1993) NK-logic, the act of innovation corresponds with search in multidimensional design spaces. Firms can pursue better solutions by changing the design options ('alleles') of one or more of those dimensions. The number of elements or dimensions a design space is composed of is denoted by the parameter N, while K expresses the number of interdependencies between them. When such interdependencies are entirely absent ($K = 0$), a mutation in one dimension will not affect the fitness of any other part of the design space that is being explored. In the long run, experimentation can be expected to identify which combination of dimensions delivers the highest fitness. The extreme opposite of a smooth fitness landscape is a rugged one (Levinthal, 1997), in which interdependencies between all dimensions exist ($K = N$-1). The 'peaks' in such a landscape are formed by design configurations in which changing one individual element will no longer result in a higher fitness: only by making larger leaps (modifying multiple dimensions simultaneously), firms can try to reach higher local optima or even the global optimum of the fitness landscape in question.

In the subsequent sections, we combine NK-logic with findings from service innovation literature to specify how we can formalize the intersection of key dynamics related to the following question: How important exactly is it to have a sensing user needs capability when the provision of customized services continuously confronts a firm with user input?

6.3.2 Design space of services

As we stressed in our literature review, the conjunction of sensing behaviour (by firms) and sending behaviour (by users) is of particular interest in the context of customized services. First, because service consumers tend to participate in the production of the final experience, they have ample opportunities for expressing their needs and satisfaction with the service that is being delivered. This co-produced nature of a firms' output, and especially the knowledge flows that stem from it, challenges the necessity for innovation processes to rely on the input stemming from internal sensing capabilities. A second and related reason to focus at services is that, compared to manufacturers, service providers invest less in R&D (Miles, 2007). This tendency to rely not or less on internal departments for generating new ideas implies a relatively high dependence on external signals, regardless whether they are obtained actively or passively.

Applying NK-logic in the context of services is a not straightforward exercise: defining the dimensions of a product is challenging when it is essentially intangible (Nelson and Winter, 1982; Frenken, 2006). Earlier contributions in the field of strategic management have studied particular services, like airlines, by regarding them as systems of interrelated activities (Porter and Siggelkow, 2008). More recently, scholars started to use this approach for analysing a greater variety of service solutions (Chae, 2012a, 2012b; Desmarchelier et al., 2013). Particularly promising in this respect are the opportunities offered by conceptualizing services on the basis of multiple distinct dimensions. In 2000, Den Hertog introduced a four-dimensional framework for describing where novelty in services can occur. After becoming widely adopted (Droege et al., 2009; Rubalcaba et al., 2012), the original framework was recently extended with two more dimensions (Den Hertog et al., 2010). Accordingly, novelty in services can concern changes in the following six dimensions: the service concept, the customer relation, the value system (business partners), the revenue model, the organizational delivery system, and the technological delivery system.

The multidimensional approach to describing services provides a fruitful basis for application of NK-logic to any type of solution or experience that is being produced. In this interpretation, firms develop new services by aligning changes in one or more of the dimensions. Various authors, to start with Gallouj and Weinstein (1997), have noted that changes in one dimension might often require modifications in other dimensions as well. This can be explained by the fact that a change in one dimension is relatively unlikely to yield success (either the focal firm or its competitors would have tried this incremental change). Secondly, and more importantly, interdependencies in the design space might offset the success of a single mutation. In order to make a novel service a success, it is likely that some other dimensions need to be adapted as well. Reasoning from this explanation, we assume a rather average degree of mutual interdependence (K = 2 or K = 3) when defining a service design space on the basis of the six-dimensional framework (N = 6) by den Hertog et al. (2010). This assumption, in which K is neither zero nor maximal, is consistent with empirical applications of the NK-logic in a non-service context (Simon, 2002).

6.3.3 Translating interaction modes into search strategies

Although both sending and receiving user requests (individually) are often found to be beneficial for innovation success, few scholars examined the conjunction of the two.

In section 6.2, we identified four typical behavioural modes for users and firms. Each of the quadrants in Figure 6.1 essentially corresponds with a different way of searching through a multidimensional design space. The proposed interaction modes can be used for simulating how the different combinations of user and firm behaviour affect innovativeness and firm performance. Before clarifying how the respective 'search strategies' can be modelled (Figure 6.2), we repeat that users have predominantly insights in their needs and not so much in how to deliver an entire solution. On this basis we assume that if they provide feedback they do this only on specific product aspects rather than that they provide full-fledged plans for the delivery of a new service. For the sake of simplicity of our formal model, we assume that each firm delivers one single service that yields only one type of feedback. We also assume that firms innovate by altering only one dimension per move.

The four search strategies corresponding with the 2*2 interaction modes can be modelled according to Function 1, which expresses the chance (*P*) that a firm will mutate by selecting allele *q* on dimension *n*. This probability is determined by the attractiveness of that particular position in the landscape ($X_{n,q}$). In Appendix F we describe how the attractiveness of a certain allele *n* on dimension *q* is a function of the fitness of that allele ($w_{n,q}$) and of the alleles in the dimensions that are related, if interdependencies are present. Essentially, the chance that a certain position gets selected is a matter of the ratio between the attractiveness of that mutation versus the sum of the attractiveness values of all alternative mutations. Therefore, $\Sigma_q P = 1$. Note that this summation pertains to all possible positions in the landscape, which is the product of the number of dimensions (*N*) and the number of alleles per dimension (*Q*, for all *n*). Finally, argument β in $X_{n,q}$ stands for the type of feedback obtained from users, and exponent α relates to the two ways firms can deal with this feedback.

Function 1: $P_{n,q} = \frac{X_{n,q}(\beta)^{\alpha}}{\sum_q^{N*Q} X_{n,q}(\beta)^{\alpha}}$

The feedback β that user provide, determining the attractiveness of a certain mutation () can take two different forms. In case users do not or hardly take action to express their requests, it is likely firms only can obtain information about (dis)satisfaction (i.e. compliments or complaints on a particular aspect of the service solution). In our formal model we assume that the worst dimension of a service is the most attractive one to be manipulated, while praised dimensions should remain unaffected. This occurs when $X_{n,q}$ equals the distance between the maximum fitness of a certain dimension and the fitness of the currently chosen allele at that dimension ($w_{n,q(now)}$). Indeed, the perceived attractiveness of making a mutation still only depends on undetailed information: firms with this type of user feedback can observe which dimension has the weakest fitness at a given moment, but will have to choose a new allele on that dimension themselves. We assume they do this at random.

When users do express their requests more intensively, they can also convey information about how much they would appreciate a certain modification *q* on dimension *n*. Because customizing service providers will tailor their service to this particular need, they can obtain an indication of the fitness value of a dimension *n* when changing the current allele into the suggested allele. Although this information appears very rich, it still only pertains to the fitness at the level of individual dimensions. As stated before, interdependencies in the design space might imply that increasing the fitness of one dimension affects the fitness of other dimensions in turn. In the formal model, the attractiveness of a certain suggestion is captured by looking at the distance between the fitness of a dimension after adopting the suggested allele and the dimension's fitness corresponding with the allele that is currently chosen ($w_{n,q} - w_{n,q(now)}$).

The two forms of user feedback that determine can be summarized as follows:

- Low level of user feedback: $\beta = 1 - w_{n,q(now)}$
- High level of user feedback: $\beta = w_{n,q} - w_{n,q(now)}$

Also the firms themselves can follow two strategies, expressed by exponent α. When a firm has a moderate sensing capability for monitoring user suggestions, the chance that a mutation gets selected is proportional to the attractiveness of encountered user inputs. Being the main characteristic of function 1, this occurs when α simply equals one ($\alpha = 1$). Firms with a more advanced sensing user needs capability not only monitor user feedback, but also analyse and evaluate this type of input. These firms are focused on identifying the most promising user insight that was yielded when delivering a service of a particular configuration. Here, the chance that a certain mutation will get selected is then no longer proportional to the times it is expressed: firms engaging in thorough user-centric search will be able to determine which feedback is provided most and prefer this option absolutely above other possibilities. This selective behaviour occurs when α takes very large values ($\alpha \rightarrow \infty$).

In summary:

- Inspirational sensing: $\alpha = 1$
- Exhaustive sensing: $\alpha \rightarrow \infty$

In Figure 6.2, below, we present the specification of the search strategies that correspond with the interaction modes. Together, the search strategies cover two main variants of searching through a design space.[40] In strategy 1 and 3, where users express a low degree of feedback, firms follow a strategy known as 'extremal search': they try to improve the weakest aspect of their product. Strategy 2 and 4 are forms of 'greedy search', which occurs when firms have more detailed information for selecting modifications with the highest fitness increase (on the level of a dimension, not the overall fitness). The

40 We omitted random search, which would occur when firms are unable to store any information ($\alpha = 0$).

difference between 1 and 3, and also between 2 and 4, is that firms with exhaustive user-search immediately select the most mentioned suggestion rather than that $P_{n,q}$ is still probabilistic by being proportional to the attractiveness of mutation *n,q*.

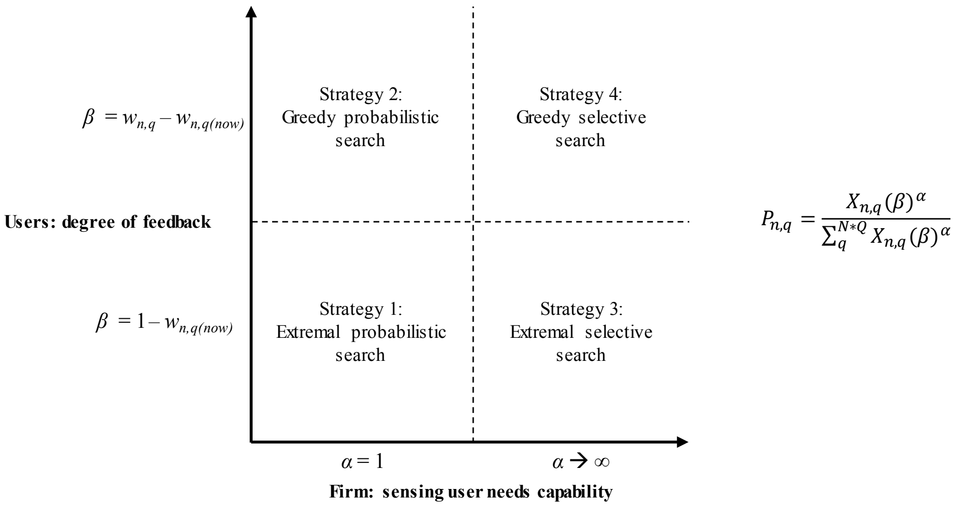


Figure 6.2: Operationalization of search strategies for each interaction mode.

6.3.4 Simulation procedure

In order to run the simulation models, we first define an appropriate design space on the basis of the multidimensional framework by Den Hertog et al. (2010). According to our earlier assumptions and findings from Chapter 3, the level of interdependencies can be calibrated at an intermediate level (when $N = 6$, $K = 2$ or 3). Within this landscape, each dimension n can take states $q = 1 \ldots Q$. Those alleles have their own individual fitness values ($w_{n,q}$). Because of interdependencies, changing one allele might affect the fitness of other alleles. To give an example: in the simplified four-dimensional design space partially presented below in Table 6.1 and 6.2, the fitness values of dimension one (n1) and four (n4) are interrelated.[41] Each string of elements (s) in the final matrices has an average fitness W.

41 A 4-dimensional landscape with 3 alleles/dimension, contains 81 (3^4) design configurations. Only the first 5 are shown.

Table 6.1: Example of possible design configurations in a four-dimensional design space with 3 alleles per dimension (states of alleles expressed by A, B and C).

	n1	n2	n3	n4
s_1	A	A	A	A
s_2	B	A	A	A
s_3	C	A	A	A
s_4	A	B	A	A
s_5	A	C	A	A
s_q				
s_{81}	C	C	C	C

Table 6.2: Fitness-values ($w_{n,q}$) corresponding with the design space presented above (n1 and n4 being interdependent).

n1	n2	n3	n4	*W*
0.1	0.2	0.6	0.1	*0.250*
0.5	0.2	0.6	0.2	*0.375*
0.4	0.2	0.6	0.6	*0.450*
0.1	0.5	0.6	0.1	*0.325*
0.1	0.9	0.6	0.1	*0.425*
0.2	0.7	0.3	0.5	*0.425*

Having defined the key parameters of our design space, we create a fitness landscape by assigning random fitness values between 0 and 1. For the example of $K = 2$, implying that three dimensions are mutually interrelated, the fitness value for each position q at dimension n varies for different alleles in the other related dimensions (written as $w_{n,q,q2,q3}$, in which q2 and q3 are the alleles in the other two dimensions). For the unrelated dimensions, on the other hand, the fitness values for a certain position are stable with respect to the conditions in any other dimension. In order to allow for search journeys to unfold in our six-dimensional design space, we set the number of alleles per dimension (q) at 15. Results are robust for variation in this parameter (e.g. $q = 10$, $q = 20$).

Once a design space is created, we run a simulation for all four search strategies. The specification of α and β determines the chance that a firm chooses a certain mutation. Using the chances $P_{n,q}$ for making a draw from a uniform distribution then leads to the actual selection of a mutation (see Appendix F). Each simulation consists of R number of steps. Finally, being a Monte Carlo experiment, we repeat the entire procedure MC=50 times.

6.3.5 Simulation results and hypothesis formulation

Inspection of the simulation results shows that most important patterns become clear within R=25. As shown in the graphs in Figure 6.3, these patterns are generally robust to variation in parameter K. Only if the degree of interdependencies is zero (upper left graph), strategy 4 is obviously superior. In the more realistic situation where at least a couple of dimensions are interrelated, a different order emerges.

A notable finding is that agents following strategy 1 have the lowest take-off in their fitness increase, followed by strategy 3. Both of these strategies involve a minor amount of user feedback; the difference is that agents with strategy 3 have a sensing capability for identifying what dimension should definitely be modified. The observation that agents with a modest sensing user needs capability catch up with (and eventually even take over) agents with a stronger sensing capability is even stronger if we look at the difference between firms who are frequently facing user requests (i.e. strategy 2 versus 4). Agents facing feedback on what mutations to make are generally very well able to improve the fitness of their products, but the value of sensing is now of even shorter duration. Despite initially having a high fitness-quotient (i.e. fitness increase per step), all graphs with $K>0$ show that the maximum achieved fitness level for strategy 4 stabilizes after a few mutations.

Apparently, when agents are exposed to detailed feedback (including information on unmet needs and the perceived quality of a firm's solution) and also have a strong ability to analyse user needs thoroughly, they have a risk of ending up in a local optimum. This finding is largely due to the fact that such agents respond to urgent user needs with respect to certain dimensions. Although this initially leads to rapid fitness increases, agents quickly arrive at a point where the identified position in the landscape can no longer be improved by selectively reacting to needs regarding specific dimensions. Agents who do not rely heavily on sensing, like those following strategy 2, turn out to have a higher probability of experimenting with mutations that leave more room for tweaking and tuning. The same holds for agents who do develop (and use) a strong sensing capability, but are exposed to users who do not articulate their requests explicitly.

For the case of firms providing customized services, our simulations would suggest that user feedback generally has a positive effect on innovation success: agents with a high degree of user feedback initially outperform those with a lower level. To a lesser extent, the capability of sensing user needs is likely to be beneficial for innovation efforts as well. By having a substantially strong sensing capability, firms can make use of the demands they encounter when providing their services, and thereby outperform the ones who do not invest in such ability. The comparative advantage that can be derived from this capability is thought to be more limited, compared to the benefits of facing a high degree of user feedback, because firms are tempted to focus excessively on the needs their current users are experiencing. Fulfilling those needs improves the existing product for the existing market, but might often not be the optimal choice for introducing solutions that can deliver even more value than those based on 'fixing' complaints. While agents with strategy 3 keep achieving higher fitness levels over time, this does not hold for agents who follow strategy 4.[42] Agents in the latter situation tend to reach a local optimum that is at maximum equal to the fitness levels other agents arrive at, or even lower if we look at more realistic values of K. Therefore, we would expect that the combination of having a strong sensing user capability and also facing extensive user feedback has an adverse effect on the innovation performance of customizing service providers.

On the basis of these simulation results, we arrive at the following hypothesis:

Hypothesis: Customizing service providers' sensing user needs capability and (especially) the user requests they encounter are individually positively related to innovation success, but the interaction term has a negative direction.

42 Another reason to believe that sensing user needs might still be valuable for firms delivering customized services is that all simulated strategies are better than a random strategy in which firms have no ability to evaluate user feedback at all ($\alpha = 0$).

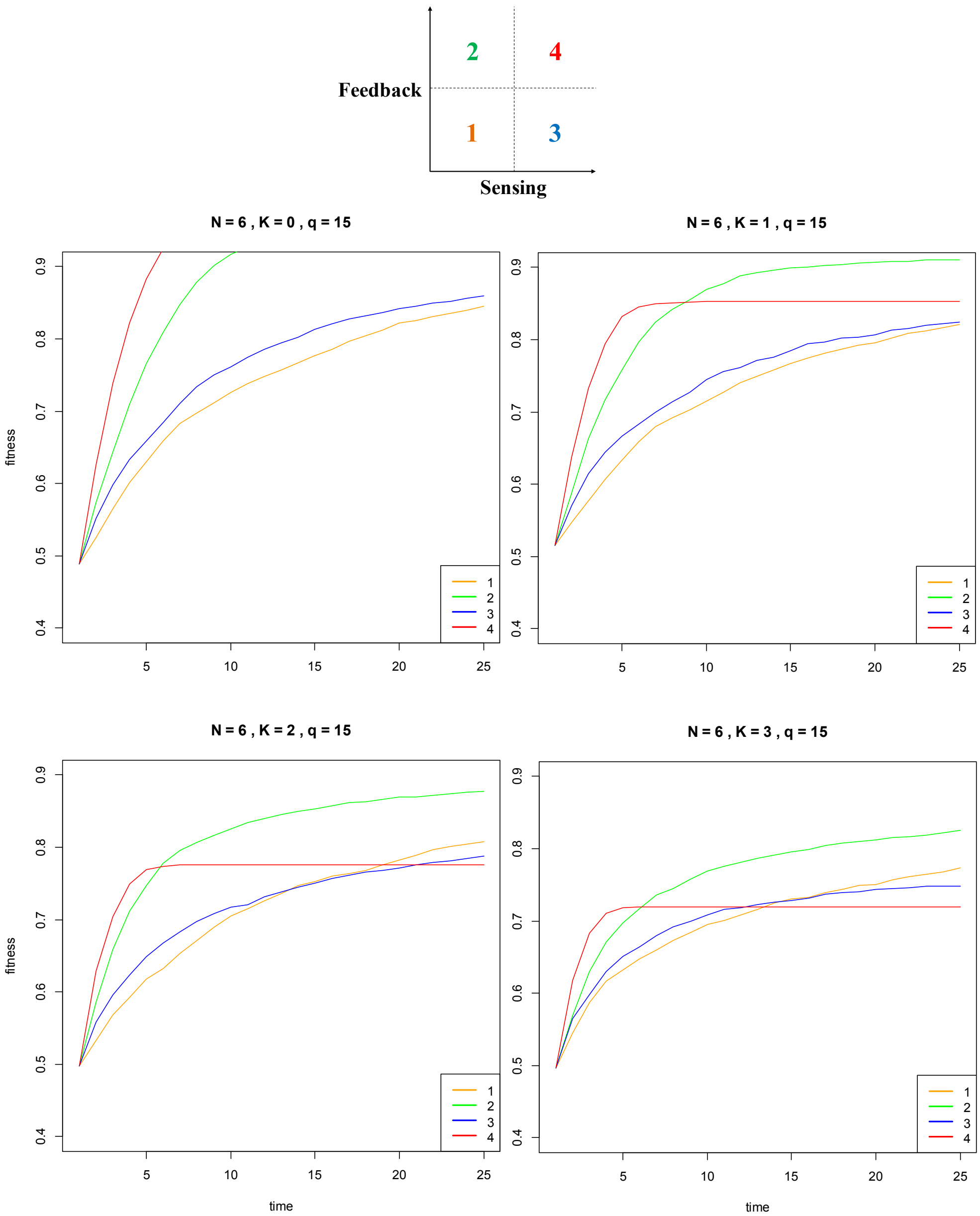


Figure 6.3: Maximum achieved fitness levels for K=0, 1, 2 and 3. MC = 50.

6.4 EMPIRICAL EXAMINATION

6.4.1 Methodology

Sample

We examine the hypothesis with a dataset based on a survey deployed in 2011. Details on this survey are described in the Appendix on 'Data sources and co-authorships' as well as Chapters 2, 4 and 5. In general, most items make use of a 7-point Likert scale ranging from "strongly disagree" to "strongly agree". Our sample includes Dutch firms with at least 10 employees. Given the scope of our study, we only look at firms who are somehow involved in service provision. An indication for this is given by asking respondents whether they have substantial turnover stemming from services; those who did not have any revenues like that (scoring below the middle of the Likert-scale) are omitted from the current analysis (18%). The final subsample contains 292 complete cases, most of them stating to serve a relatively high number of customers via labour intensive processes in pre-dominantly a business-to-customer setting.

As noted throughout this chapter, our expectations concern in particularly innovation efforts by firms who adapt their services to the needs of individual clients. It is pre-eminently in this type of service providers where interaction is high, and where firms can experiment with the user feedback they receive. Figure 6.4 shows the distribution of responses to the question whether firms in our sample tailor their services. Most of our respondents appear to be heavily engaged in customization, which is hardly surprising if one realizes that meeting individual requests of clients is often seen as an inherent part of service provision: "Services are intangible activities customized to the individual request of known clients" (Pine and Gilmore, 1999, p.8). Nevertheless, some firms indicate to tailor their services only to a limited extent. Since we wish to focus on customizing service providers, we perform our analysis primarily on firms who responded with a 6 or 7 on the Likert-scale. The remaining 218 cases account for 75% of our final sample.

Variables and statistical models

Our main question is which interaction mode is most conducive to successful innovation. Accordingly, the dependent variable is constructed with survey-items asking how much of a firm's turnover stems from improved or newly introduced products. Following the CIS-guidelines (OECD, 2005b), these products can be services, goods, or combinations thereof. What matters in this study is that a firm is at least engaged is some extent of service provision, and thus direct customer interaction: the exact form of the innovation that is ultimately being realized is considered to be irrelevant. Given the truncated distribution of turnover figures (see Figure 6.5), ranging between 0% and

100%, relations between our variables are assessed with multivariate Tobit regression models (Laursen, 2011).

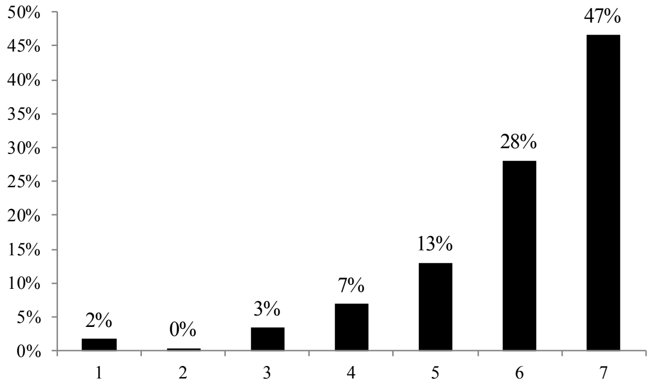


Figure 6.4: Distribution of answers on the statement: "Our services are customized", on a 7-point Likert scale.

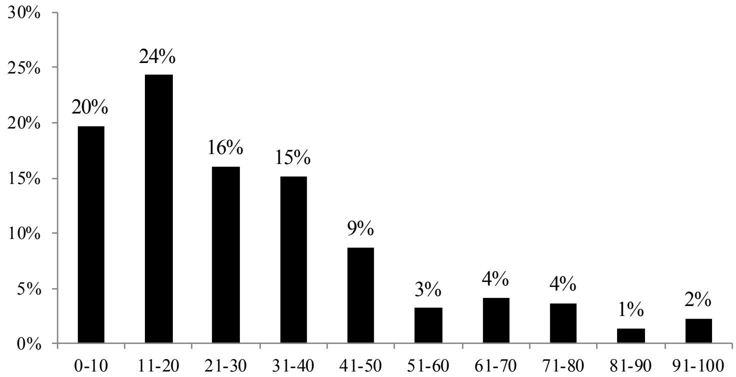


Figure 6.5: Distribution of dependent variable for sample of customized service providers (n=218).

As for the independent variables: the multi-item measurement scale for sensing user needs capability (based on Den Hertog et al., 2010) has been constructed and applied in Chapters 4 and 5 already. Again, we take the average of the underlying three items as a measure for the strength of this capability. The item for User Requests ("Our clients regularly ask for new goods and services") stems from work by Jansen et al. (2006). Both independent variables resemble a normal distribution. When firms are exposed to a low level of user requests, they only can base their entrepreneurial experimentation on the complaints they receive during regular service delivery. In case users often ask explicitly for new solutions, they provide more detailed information on what aspects of a service to modify (search strategy 2 and 4). Using hierarchical modelling, we first include both independent variables in our regression model before extending it with an interaction term. Such an analysis sheds light on the combined effect of sensing user needs and user requests along all values that both variables can take. In this analysis, however, we are especially interested in the question whether sensing user needs can have an adverse effect when firms are exposed to high degrees of user requests. Following Spiller et al. (2013), we therefore also conduct a so-called floodlight analysis to examine at which particular values for user requests a possible interaction effect occurs.

Finally, to control for the fact that user requests and innovation might be more common in turbulent markets, a variable for market dynamism is included in the model (retrieved from Jansen et al., 2006). The logarithm of firm-size is used as a control variable as well, just like a construct that indicates to what extent a firm has formalized R&D efforts (see Chapter 5).[43]

Table 6.3, below, shows the descriptive statistics of the variables in our models. These models generally have the following form (see Table 6.3 for variable codes):

$$Y = \beta 0 + \beta_1 {*}C1 + \beta_2 {*}C2 + \beta_3 {*}C3 + \beta_4 {*}X1 + \beta_5 {*}X2 + (\beta_6 {*}X1{*}X2) + \varepsilon$$

Table 6.3: Descriptive statistics and correlations (in italics) for sample of customized service providers (n=218).

Customized services (n=218)	Mean	Std. Dev.	*C1*	*C2*	*C3*	*X1*	*X2*	*Y*
C1. Firm size (log fte)	3.42	1.156						
C2. Formalization	3.47	1.331	*.037*					
C3. Market dynamism	5.45	1.391	*-.011*	*.140**				
X1. Sensing User Needs (S.U.N.)	4.70	1.173	*.097*	*.363***	*.221***			
X2. User Requests (U.R.)	4.44	1.626	*-.046*	*.325***	*.572***	*.312***		
Y. Turnover from new or improved offerings (%)	32.90	22.515	*-.086*	*.020*	*.137**	*.164**	*.290***	

6.4.2 Regression results

Table 6.4 presents the regression results. Although market dynamism is strongly related to user requests, the control variable is not significantly related to turnover from innovation. The contrary holds for formalization of innovation efforts. Its negative direction is consistent with the general finding that service firms can (and often do) innovate without engaging in formal R&D (Miles, 2007). In fact, our overall regression results emphasize that looking at structured but not necessarily formalized activities,

43 Looking at the number of observations, the risk of saturation requires us to minimize the amount of control variables. If we do include variables for 'labour intensity', 'number of customers' or' market type' (B2C/B2B), all reported results remain similar.

like dynamic capabilities, is a suitable option for analysing how service providers achieve innovation success.

The findings from our empirical analysis turn out to be largely in line with the hypothesis derived from simulating the different user-producer interaction modes. For firms that provide customized services, sensing user needs has a weak but positive effect on the appropriated turnover from innovation. In accordance with the simulation results, user requests appear to be relatively more important, as indicated by a bigger beta coefficient and significance value (Model 1). The interaction term of both factors, shown in Model 2, is weakly significant and has a negative direction.

The encountered interaction effect is obtained when both continuous independent variables are multiplied. Since the mechanism we hypothesized concerns the diminishing effect of sensing user needs (S.U.N.) at in particular high values of user requests (U.R.), we continue by decomposing the interaction (Spiller et al., 2013). To do so, we dichotomize the user requests variable at all possible thresholds. Creating these dummies allows us to run a series of 'spotlight regressions' in which we test the interaction of S.U.N. and U.R. at the full range of U.R.'s cut-off values.[44] Jointly, the spotlight regressions make up a floodlight analysis revealing the Johnson-Neyman point: the value where the interaction term starts to be significant (Spiller et al., 2013). In our sample, the switching point appears when U.R. exceeds a value of 5. This value, marking the median of the response to this question, is just above the middle of the Likert-Scale. Models based on cut-off values below U.R. = 5 do not yield a significant interaction (only the direct effects of S.U.N. and U.R. are significant and positive), while the two models above this point confirm that sensing user needs combined with ample user requests has a significant and negative relation with innovation-based turnover (see Model 3 for U.R. threshold = 5; the model with threshold at 6 has an interaction term with significance at the level of $p < .001$). The results of Model 3 are also visualized in Figure 6.6, clearly showing that firms facing only a low amount of user requests do benefit from having a strong sensing capability. The contrary holds for firms more often exposed to user requests: generally their innovation-based turnover is relatively high, but this decreases as firms start to rely more on their sensing capability.

44 Because user requests are measured on a 7-point Likert scale, we can make six separate dummies (Dummy 1: U.R. = 1 versus U.R. = 2-7; Dummy 2 = U.R. = 1-2 versus U.R. = 3-7; etc.).

Table 6.4: Regression results for sample of customized service providers (n=218)* = p <.10, ** = p < .05, *** = p < .01.

Y = % turnover from improved / new offerings	Model 1 Beta	Model 1 *(Std. error)*	Model 2 Beta	Model 2 *(Std. error)*	Model 3 Beta	Model 3 *(Std. error)*
Intercept	19.153**	*(8.516)*	-8.825	*(17.267)*	22.608**	*(9.371)*
Firm size (log fte)	-1.567	*(1.255)*	-1.827	*(1.253)*	-2.252*	*(1.234)*
Formalization	-2.023*	*(1.199)*	-2.018*	*(1.190)*	-1.975*	*(1.166)*
Market dynamism	-0.938	*(1.267)*	-0.757	*(1.261)*	-0.423	*(1.163)*
Sensing User Needs (cont.)	2.580*	*(1.360)*	8.539**	*(3.530)*	4.958***	*(1.538)*
User Requests (cont.)	4.410***	*(1.146)*	10.903***	*(3.676)*		
S.U.N.*U.R.			-1.373*	*(0.739)*		
User Requests (binary)[a]					52.563***	*(14.516)*
S.U.N.*U.R. (binary)[a]					-7.507***	*(2.807)*
Wald-statistic	*27.03*		*30.91*		*36.34*	
df	*5*		*6*		*6*	
p	*0.000****		*0.000**		*0.000**	

[a] = Dummy for user request, threshold is ≤5 (U.R. = 0) versus >5 (U.R. = 1). See description of floodlight analysis.

6.4.3 Extension: non-customizing service providers

In order to strengthen our evidence, and to reduce the possibility of explaining our results with alternative mechanisms, we extend our investigation by looking at the earlier excluded group of non-customizing service provides. The delivery of non-tailored or standardized services typically requires less co-production and thus user-producer interaction, which is why providers of such services form an excellent comparison group within the domain of services (Tether et al., 2001). On this basis, we repeat the regression analyses for the sample of non-customizing service providers (n=74). As for the descriptive statistics of this comparison case; none of the differences with the focal group (with respect to variable means) is statistically significant. Thus, at the outset, both groups are on average equally innovative, encounter a similar degree of user feedback, and have similar capability strengths.

Models 4 and 5, shown in Table 6.5, cover the comparison situation in which service providers do not customize their solutions. For them, sensing user needs appears to be of significant value, as opposed to user requests. Note, however, that the overall model is only weakly significant. If we include the interaction term for sensing user needs and receiving user requests (continuous variables), the overall model fit improves to $p <$ .05, and we notice that both independent variables significantly reinforce each other. A floodlight analysis reveals that this positive interaction already starts to be significant at the cut-off of U.R. = 4 ($p < .05$), but for comparison reasons we show again the results for the variable based on a threshold of 5 (see Model 6). The positive direction of the interaction term is contrary to the observations retrieved in the group of firms providing customized services, which implies that for innovation in more standardized services the myopia risk might be less likely to occur.

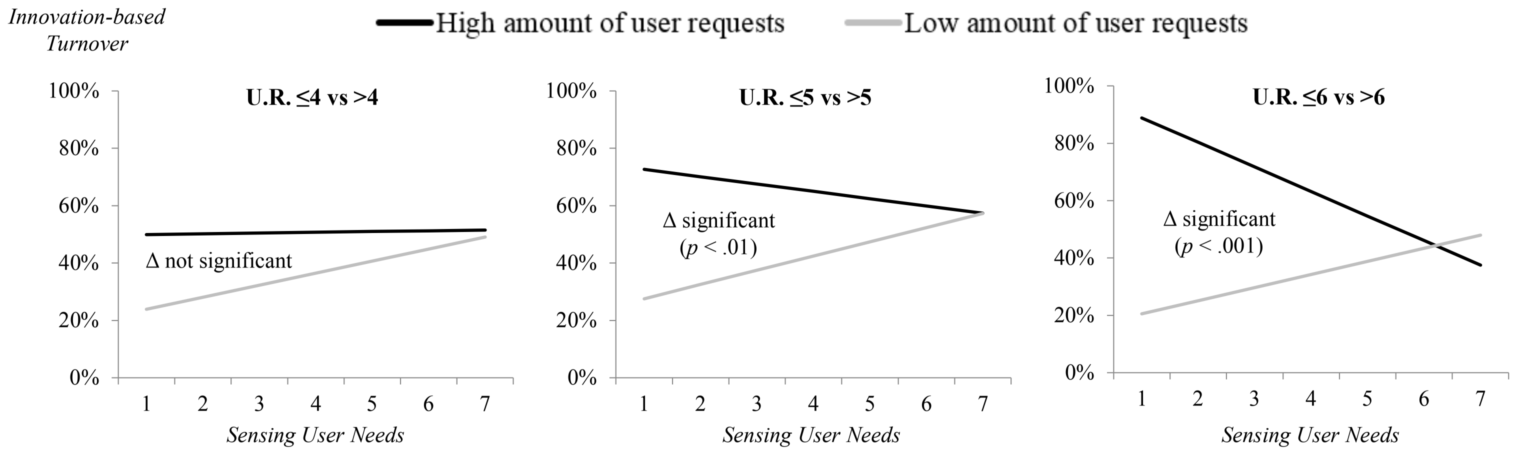


Figure 6.6: Visualization of regression parameters for models based on different thresholds for user requests (U.R.). The moderating effect of U.R. (i.e. difference between the slopes) only is significant when the threshold lies at U.R. ≥ 5.

Table 6.5: Regression results for comparison case of non-customized service providers (n=74).

Y = % turnover from improved / new offerings	Model 4 Beta	Model 4 *(Std. error)*	Model 5 Beta	Model 5 *(Std. error)*	Model 6 Beta	Model 6 *(Std. error)*
Intercept	3.886	*(14.679)*	64.282	*(32.401)*	27.882*	*(16.545)*
Firm size (log fte)	0.768	*(1.657)*	0.662	*(1.611)*	0.724	*(1.569)*
Formalization	-4.403**	*(2.220)*	-4.439	*(2.158)*	-3.421	*(2.147)*
Market dynamism	0.822	*(2.010)*	-0.511	*(1.960)*	0.416	*(1.754)*
Sensing User Needs (cont.)	5.650**	*(2.454)*	-7.880	*(6.939)*	1.339	*(2.940)*
User Requests (cont.)	2.009	*(1.910)*	-9.856	*(6.009)*		
S.U.N.*U.R.			2.726**	*(1.313)*		
User Requests (binary)[a]					-29.894	*(19.715)*
S.U.N.*U.R. (binary)[a]					8.592**	*(4.028)*
Wald-statistic	*10.13*		*15.03*		*18.13*	
df	*5*		*6*		*6*	
p	*0.072**		*0.020***		*0.006****	

* = p <.10, ** = p < .05, *** = p < .01.

[a] = Dummy for user request, threshold is ≤5 (U.R. = 0) versus >5 (U.R. = 1). See description of floodlight analysis.

6.5 DISCUSSION

Aimed at contributing to scholarly debates on user-producer interaction in innovation processes (Rosenberg, 1969; Lundvall, 1988; Chatterji and Fabrizio, 2012), the current chapter provides a theoretical argument for why investing heavily in a sensing capability might have adverse effects for customizing firms exposed to a high amount of user requests. So far, little profound effort has been made to understand how exactly the use of user knowledge affects the success of search processes (Chatterji and Fabrizio, 2014; Laursen, 2011). Our answer to this gap has the form of simulations based on a formal representation of various forms of user-producer interaction. By describing the respective merits and pitfalls of four concrete search strategies, the theoretically grounded NK-model and the empirical examination thereof add to a discourse that is being dominated by intuitions and contradicting results.

The mechanisms described by our simulations are consistent with the pitfall warned for by Christensen in his influential work on the innovators dilemma (1997). His ideas on the caveat of being misled by market demand have originally been developed in the context of established firms tempted to focus on their existing customers, thereby overlooking possibilities to serve a potentially more profitable user base. Here, rather than focusing on how incumbents and entrants explore new markets, we have shown how the myopia principle also applies to customizing service providers who are heavily exposed to user requests. The proposed NK-model describes how they face a challenge which is rather similar to the innovators' dilemma, except that it concerns the tension between focusing on individual needs versus exploring solutions to broader needs (yet possibly still in the same client base).

The simulation results demonstrated that listening carefully to demanding customers is particularly useful for identifying the most efficient and immediate improvements, but when relying heavily on sensing abundant user feedback, agents in our model run the risk of getting stuck in a suboptimal configuration. Accordingly, also our empirical examination suggests that firms who tailor their services to demanding users might be tempted to focus strongly on encountered needs, and therefore go down an unfruitful path of 'local optimization'. Such excessive attention to their clients can prevent them from seeing possibilities for introducing genuinely new improvements or commercializing solutions in other contexts. Thus, in order to keep improving, it appears wise to also engage in experiments that are not exclusively based on the user's own (more or less detailed) ideas of what would be a viable adaptation of the current offering. Pointing at the importance of overcoming local search (Rosenkopf and Almeida, 2003), this mechanism explains findings like the ones presented by, for instance, Laursen (2011) who observes that innovation performance is negatively affected when firms do not complement intensive user-producer interaction with sourcing other knowledge channels. Similarly, it is consistent with earlier findings that service providers benefit more from investing in other aspects of knowledge generation and application than concentrating their efforts on intensifying user-producer interaction (Mina et al., 2014; Chapter 5).

By building on recent attempts to conceptualize service innovation as the search in multidimensional design space, this study also forms a contribution to the currently unfolding debate regarding NK-modelling in the context of services (Chae, 2012a, 2012b; Desmarchelier et al., 2013; Chapter 2). Moreover, from a methodological perspective, we aim to advance innovation studies by showing how a simulation study can be complemented with an empirical validation. To our knowledge, such a combined approach is of considerable originality to the audience we address. Possibly it can inspire more research on understanding and afterwards validating mechanisms of which the interaction is unknown at the outset.

6.6 CONCLUSIONS

With this study we have sought to explain the paradox that those firms who are most engaged in fulfilling actual user needs might be the ones who benefit less from developing a capability for sensing user needs. Strategic considerations regarding the use of user knowledge differ across various lines of literature. On the one hand, studies focused on manufacturing industries tend to argue that innovation processes often benefit substantially from investing in activities for sensing user needs. Service-oriented research, on the other hand, commonly stresses that the relational nature of efforts to meet individual customer needs provides opportunities for firms to acquire user feedback already during regular business activities. Only few existing studies asked whether a strong capability for sensing user needs is essential for service firms to develop new ways for meeting customer demand. We examined to what extent the benefits of openness to user insights depend on the behaviour of a service firm's clients, and in particular whether explicit requests for new solutions or experiences can make a sensing capability a weakness rather than a strength. For firms who tailor their services to the user requests they are receiving, a myopic focus on introducing quick-win incremental changes might be a serious caveat.

Since customer interaction is an inherent characteristic of service provision, this study is predominantly focused on firms that co-produce intangible solutions together with their clients. However, we have no reasons to believe that our results are exclusive for service providers only: this study might also inform specialized suppliers who resemble the manufacturing equivalent of customizing service firms (Cusumano et al., 2014). Likewise, we already noted that also manufacturing firms are increasingly adopting or even switching entirely to service-based business models. The finding that sensing is of limited relevance under certain circumstances might therefore also be of relevance to industries where 'opening up' is still actively proclaimed (Chesbrough, 2011). By looking at service-characteristics that are becoming prevalent for an increasing number of firms, we contribute to on-going efforts of exploring how peculiarities of service innovation hold implications for our general understanding of novelty creation in modern economies (Drejer, 2004; Miles, 2007). This study can be regarded as another advance in the line of research that aims to make innovation theories, in particular with respect to openness, more sensitive to the peculiarities of service provision (Mina et al., 2014).

APPENDIX F: CLARIFICATION ON SIMULATION PROCEDURE

This appendix clarifies according to which mechanisms agents in our simulation choose a particular mutation. In the partially depicted landscape from Tables 6.1 and 6.2, an agent can start at position (*n*1,*q*1; *n*2,q1; *n*3,q2; *n*4,q1), which is string s_1 in the upper row.

If the user feedback has type β = 1, an agent will observe the following 'attractiveness-values' (Table F.1 is based on $X_{n,q} = 1 - w_n(now)$; values for $w_{n(now)}$ are underlined). Search strategy type 1 implies that an agent only uses feedback for determining which dimension to change, which is why parameter q can actually be removed here. Which specific allele is chosen on that dimension results from random selection.

Table F.1. Information available to agents with β = 1. (X_n = attractiveness of changing dimension n).

	n1	n2	n3	n4
X_n	1 - <u>0.1</u> = 0.9	1 - <u>0.2</u> = 0.8	1 - <u>0.6</u> = 0.4	1 - <u>0.1</u> = 0.9

If we ignore α (i.e. α = 1, like in strategies 3 and 4), the possibilities for selecting a certain mutation are linearly proportional to the relative attractiveness of mutations. Note that we only look at the chance that a dimension gets changed: which allele is chosen for the mutation is just a random choice. We can state that all alleles *q* for a certain dimension have equal chance of being selected, so again, index *q* in formula below can be left out.

$P_{n1,q} = 0.9 / (0.9+0.8+0.4+0.9) = 0.30$

$P_{n2,q} = 0.8 / (0.9+0.8+0.4+0.9) = 0.27$

$P_{n3,q} = 0.4 / (0.9+0.8+0.4+0.9) = 0.13$

$P_{n4,q} = 0.9 / (0.9+0.8+0.4+0.9) = 0.30$

$\sum P_{0\text{-}n,q} = 1$

If the user feedback has type β = 2, the selection procedure is more advanced. The attractiveness now depends on the fitness increase that occurs at a certain dimension when adopting a particular suggested allele. We take a piece of the earlier shown fitness landscape to illustrate the effect of interdependencies in the design space (for original fitness values, below underlined, see Table 6.2). The first three strings relate to changing n1 while keeping n2 constant, whereas string 4 and 5 relate to changing n2 while not changing alleles of dimension n1. In the four possible mutations below, *s*5 would denote the biggest fitness increase (+0.7 at dimension n2). However, as we can see in Table 6.2, *s*3 would yield better overall results (total fitness *W*) due to the interdependency with n4.

Table F.2: Information available to agents with β = 2. ($X_{n,q}$ = attractiveness of changing to allele *q* on dimension *n*).

String	notation of configuration	$X_{n,q}$
s_1	A,A	(current)
s_2	B,A	0.5 - 0.1 = 0.4
s_3	C,A	0.4 - 0.1 = 0.3
s_4	A,B	0.5 - 0.2 = 0.3
s_5	A,C	0.9 - 0.2 = 0.7

Again, we can now calculate the probability that a certain mutation gets selected. Let's pretend that the five strings above are all available options, so there are four alternatives to current position s_1 (A,A).

$P_{n1,B} = P_{s2} = 0.4 / (0.4+0.3+0.3+0.7) = 0.24$

$P_{n1,C} = P_{s3} = 0.3 / (0.4+0.3+0.3+0.7) = 0.18$

$P_{n2,B} = P_{s4} = 0.3 / (0.4+0.3+0.3+0.7) = 0.18$

$P_{n2,C} = P_{s5} = 0.7 / (0.4+0.3+0.3+0.7) = 0.41$

$\sum P_{0\text{-n},q} = 1$

PART C:

Policy options concerning services and innovation

Chapter 7

Developing service-inclusive systemic policy: Four approaches

7.1 INTRODUCTION

For several reasons, attention for service innovation is on the rise. It is becoming widely acknowledged that service providers do innovate, rather than just being adopters (Djellal and Gallouj, 2001; Gallouj and Djellal, 2010). Service businesses, especially knowledge-intensive ones (KIBS), are also seen as important drivers of innovation by other actors in the innovation system (Den Hertog, 2000; Muller and Zenker, 2001). Some of these actors have in fact started to switch to service-oriented business models themselves: for manufacturing industries facing the commodity trap, service-dominant logic is a key to innovative and high value-added solutions (Vargo and Lusch, 2004).

Having observed how a better service-orientation can improve the competiveness of firms, and innovation systems as a whole, policy makers increasingly try to overcome the manufacturing-bias that characterizes many R&D policies (Miles, 2007). In pursuit of economic progress, innovation policy is being turned from 'service-friendly' and 'service-inclusive', to service-focused (Gallouj et al., 2014). Especially the past decade has witnessed a surge of reports and policies on service innovation, popping up at regional, national and supranational levels (Den Hertog et al., 2010). For instance, the European Commission has launched several initiatives for helping regions to modernize their economic structures by 'unlocking the transformative power of services' (e.g. EPISIS, 2011; European Commission, 2012; ESIC, 2013), and also the OECD has actively been tracing and spurring policy developments on this topic (OECD, 2005a; Janssen et al., 2012).

Policies addressing the issue of service innovation still tend to be of an experimental nature. Despite widespread interest from academics and policy makers alike, it remains unclear how service-sensitive innovation policy can best be developed in accordance with socio-political goals like economic growth in general or solutions to specific societal challenges. This struggle is partially due to the fact that the topic 'service innovation' stretches over a broad range of essentially different phenomena (Sakata et al., 2013). Whereas some policy interventions are positioned as service innovation policy when supporting particular service industries (e.g. tourism, financial services), other measures carry this label when, for example, promoting the knowledge-brokering activities of KIBS, the development of new software applications, or the creation of new solutions in domains like health and sustainability (Den Hertog et al., 2010). Most likely, the fuzzy nature of service innovation (Gallouj and Savona, 2009) also explains why some policy makers are reluctant to overcome manufacturing-bias and stick to supporting novelty creation in the form of goods (Rubalcaba et al., 2012). Finally, as a consequence of the various ways one can look at the position of service innovation within the economy, also the place of services in ongoing discussions regarding specific and generic innovation policy is rather unclear (Rubalcaba, 2006; Rubalcaba et al., 2010). As innovation policy is often rooted in industrial policy, policy makers tend to associate services only with specific service industries or to contrast it with manufacturing (e.g. as in Kim, 2011). Clearly, such narrow or even dualistic perspectives are not consistent with the observation that services are of great importance for economic transformation in other industries as well.

The current chapter takes up the challenge of clarifying how different types of service innovation policy measures fit in the specific context and path-dependent policy mix of a region or state. Existing scholarly attention for service innovation policy has mainly focused on economic rationales for policy intervention: this debate identified market and system failures, urging for a specific form of service innovation support (Rubalcaba, 2006; Rubalcaba et al., 2010). However, insight into why intervention is needed does not immediately inform policy makers about how this can be done.

To meet our research objective, we introduce a framework for classifying the service-inclusiveness of innovation policy. This framework refers in the first place to the variety of roles services can play within innovation systems. Not only can services themselves be a (often neglected) form of novelty; service providers are also of major importance when it comes to diffusing knowledge and yielding innovation in other system actors. In order to distinguish these roles, we build on the widely adopted set of service innovation approaches we discussed and extended in Chapter 1 (Coombs and Miles, 2000; Gallouj, 1994). Each viewpoint relates to a different potential for economic transformation in and through services. Therefore, only by recognizing the different ways to think of service innovation, do policy makers have a basis for determining how services can contribute to achieving policy priorities.

The second theoretical pillar of our framework is the perspective of innovation systems. The view on innovation policy we take here is one that accounts for how a multitude of actors and policy interventions within such a system interact with each other. In recent literature on innovation systems and the choice of policy instruments, policy makers are advised to avoid focusing on individual measures only (Flanagan et al., 2011; Edquist, 2014). For policy instruments to be systemic, they need to be "combined into mixes that address the complex and often multi-dimensioned nature of innovation" (Borrás and Edquist, 2013, p. 1522). According to the functional perspective on innovation systems, public and private parties should perform activities aimed at functions like developing, diffusing and applying knowledge (Edquist, 2005). Whenever an innovation system fails to fulfil all functions, policy intervention is needed (Hekkert et al., 2007; Borrás and Edquist, 2013). Identifying and solving weaknesses in the innovation system thus lie at the heart of developing balanced policy mixes (Bleda and Del Río, 2013). Surprisingly, this view has hardly been used for formulating service innovation policy (Rubalcaba et al., 2010). Our main contribution here is to analyze the service-inclusiveness of systemic policy mixes in the light of the different perspectives on service innovation.

In the following sections, we discuss the various meanings that go under the label of service innovation (so-called 'service innovation approaches'), present a framework for assessing the service-inclusiveness of individual policy measures, and show what type of policy mix corresponds with each of the approaches to service innovation. Rather than just urging for more service innovation policy, we plea for a better understanding of the various ways in which (explicit or implicit) attention to services can help to achieve policy priorities and how this translates into systemic instruments (see Van Mierlo et al., 2010) that complement existing policies.

7.2 TOWARDS SERVICE-INCLUSIVE SYSTEMIC POLICY MIXES

7.2.1 Viewpoints on the nature of service innovation

In order to engage in theoretically grounded service-inclusive policy formulation, it is essential for policy makers to be aware of the various positions one can take regarding the nature of service innovation. With positions, approaches, schools of thought, or points of view, we refer to how scholars look at the unicity of service innovation features. Whether or not service innovation is believed to be a phenomenon that differs fundamentally from other forms of innovation has far-reaching implications for considerations on how to support it (Rubalcaba, 2006).

Our literature review in Chapter 1 led us to extend the existing lines of thought by separating the synthesis approach in a post- and pre-synthesis phase (see also Figure G.1 in Appendix G). As the differences between the approaches have been discussed extensively already, we will not repeat them here. Important is that each of the approaches offers its own perspective on the nature and distinctive features of service innovation. A point of view which focuses on the similarities between various occurrences of service innovation activity, like the pre-synthesis approach, has not been introduced so far. As we will see now, this additional conception of service innovation has implications for policy formulation.

7.2.2 The service-inclusiveness of individual policy measures

Recognizing the distinct ways to think of service innovation might help policy makers to understand the various opportunities for benefitting from it (Rubalcaba, 2006). Thereby, the approaches form a starting point for developing a structured approach regarding the formulation of systemic innovation policy in which the potential of services is carefully considered and embedded in the structure of other policy instruments, institutions and actors that characterize an innovation system.

So far, local policy experimentation has yielded a wide variety of instruments with relevance for service innovation (Den Hertog et al., 2010). This relevance can be present in an explicit way, like in funding schemes devoted to service innovation, but also implicitly. If a measure supports R&D in a domain such as ICT, some of the innovation it generates will have a high service-component (e.g. software solutions or high-tech services like imaging and data storage, security and analysis). However, innovation support stretches further than R&D policy, and especially in these other forms we can expect to encounter the participation of service firms and the creation of service solutions (Den Hertog et al., 2010). Thus, even if policy mixes do not contain measures dedicated to service innovation, it does not imply that service innovation is unsupported.

A comprehensive overview of options for service innovation support demands examining the variety of possibly relevant policy measures. In order to express how important a certain policy measure is for service innovation, we map its 'service-inclusiveness' along two main dimensions.

The horizontal axis in Figure 7.1 indicates to what extent a particular measure is aimed at either goods or services, which is the distinction we are examining. As noted above, apart from being supported by measures explicitly devoted to service or even manufacturing industries, support for services can also be embedded in schemes with a wider scope. Such policy interventions are to be located at the middle of the goods-services continuum, but can still vary in their degree of specificity. To be precise, the vertical axis of the framework conveys a distinction between measures that are not aimed at any concrete policy theme at all ('Generic'), or measures based on a single thematic program ('Specific'). In this latter category, encompassing goods-based as well as service-based activities (and industries), we find policies that focus on, for instance, a certain problem, technology, or societal issue. Note that the resulting framework is not a two-by-two matrix, but rather a constellation of two independent axes. As both axes relate to merely gradual distinctions, policy instruments can be plotted anywhere on this conceptual 'map'.

The advantage of this simple map is that it allows for objective comparisons of the service-inclusiveness of policy measures. It thereby facilitates the kind of policy learning that is required for drawing lessons from ongoing experiments with different forms of service innovation policy (Miles, 2007; Rubalcaba et al., 2010). The framework will also allow us to clarify how services fit in the discussion on generic and specific innovation instruments (Rubalcaba, 2006; Rubalcaba et al., 2010).

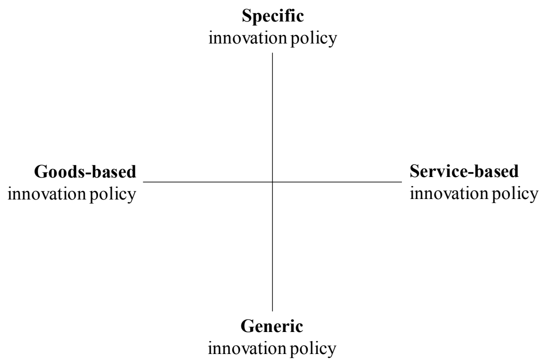


Figure 7.1: Framework for plotting the sectoral orientation of innovation policy measures.

7.2.3 Four approaches for developing systemic policy

Understanding the different approaches to service innovation does not yet answer the question of how they can guide the development of systemic policy mixes. In literature on innovation systems, policy mixes are regarded as systemic when they ensure the fulfillment of various basic functions (Edquist, 2005; Borrás and Edquist, 2013). Several authors have proposed classifications describing a select number of those basic functions. For instance, Hekkert et al. (2007), Hekkert and Negro (2009), and Bergek et al. (2008) study niche creation and transitions in technological innovation systems by focusing on seven functions: entrepreneurial activities, knowledge development, knowledge diffusion, guidance of the search, market formation, mobilization of resources, and creation of legitimacy. Looking at innovation efforts in general, scholars have stressed the importance of collaboration and networking, as well as innovation-oriented competence building, incubation activities and knowledge-spreading consultancy (Edquist, 2005). The innovation system's functions and constituting activities (two terms often used interchangeably) can be executed by private as well as public parties. In cases where a function is weakly developed, policy makers might consider implementing additional support (Bleda and Del Río, 2013; Ács et al., 2014).

According to current holistic innovation policy thinking, policy instruments do not have to be 'systemic' themselves (see Smits and Kuhlmann, 2004): they can be complementary when strengthening distinct system functions (Hekkert et al., 2007; Borrás and Edquist, 2013). By combining this interpretation of the functional perspective with our reflection on service innovation approaches, we propose four ways to develop a systemic innovation policy mix. Earlier work has equaled systemic policy to the synthesis view (e.g. Rubalcaba, 2006; Den Hertog et al., 2010). We provide an alternative view by taking the functional perspective on innovation systems as a starting point. Specifically, we argue that each of the service innovation approaches can form a basis for shaping policy mixes in which all the functions of the innovation system receive appropriate support.

In Figure 7.2, below, we use the framework from section 7.3.1 to present how the viewpoints on service innovation can all form a basis for strengthening the functions within an innovation system. For understanding the difference between the approaches, it is irrelevant which specific set of system functions or activities is observed; the only thing that matters is that every approach has its own unique way of addressing system functions. We will now discuss the resulting four policy approaches by providing examples of concrete policy measures corresponding to each of them.

Systemic policy according to an assimilation approach

If assimilation at the level of individual policies refers to *broadened* measures, then the assimilation approach for developing systemic policy is to use sector-neutral measures for supporting all system functions. Almost by definition, this implies the use of generic innovation policy.

Our view on what these measures could look like is consistent with earlier work on assimilative policy (Den Hertog et al., 2010). The core of this approach is to create instruments that are neutral with respect to supporting either goods or services. One way to create such measures is by adapting the criteria of formerly goods-focused innovation policies. Illustrative are funding policies aimed at mobilization of resources (Hekkert et al., 2007), and in particular, access to finance. Whereas such measures used to focus on technological R&D, they are increasingly made eligible to intangible innovations (Miles, 2007). Likewise, tax schemes allowing firms to deduct innovation expenditures have long since been broadened up to service renewal (OECD, 2000; Van Ark et al., 2003). Following the broadening strategy, collaboration and networking within an innovation system can be improved by extending labor mobility schemes to the domain of services (Expert Group on Innovation in Services, 2007).

A second type of generic measures that fits with the assimilation approach is the type of policy that is inherently generic. Here, one can think of measures that strengthen the system function of knowledge development by supporting PROs and universities' research activities. Apart from policy for science and education, also measures that facilitate entrepreneurship are rarely specific for the domains of either goods or services. An exception is perhaps the kind of instrument that aims to address knowledge application by providing training on firm-level innovation capabilities and innovation culture; it has been argued that these can often be improved by taking services better into account (Van Ark et al., 2003; Abreu et al., 2010). Also in the context of education, scholars pointed at the need to better embed knowledge on services in curricula

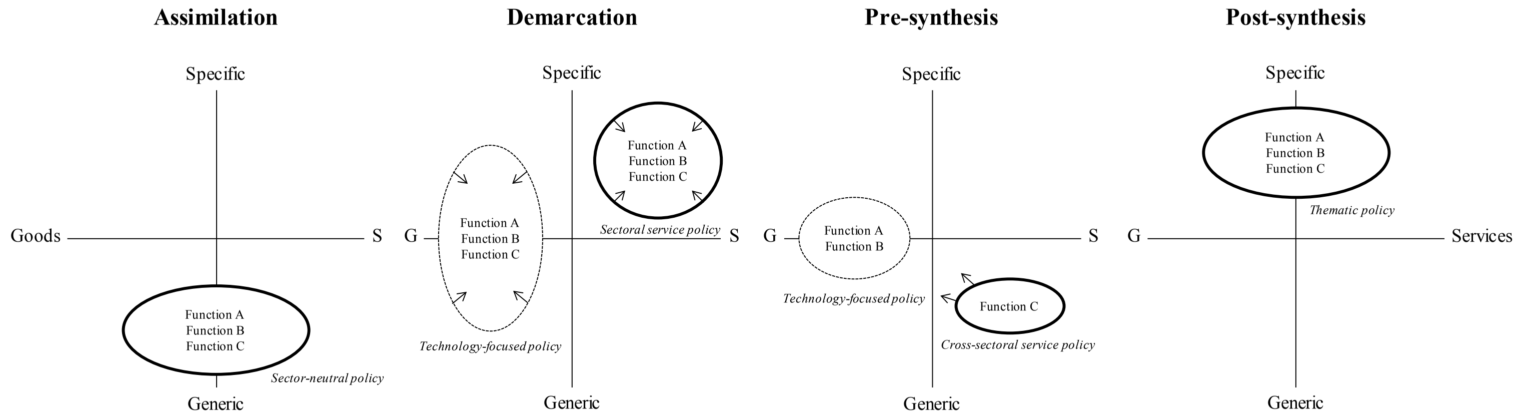


Figure 7.2: Translation of service innovation viewpoints to four systemic approaches. Each approach corresponds to a different configuration of functions (and constituting activities) that determine novelty creation within an innovation system (Edquist, 2005; Borrás and Edquist, 2013; Hekkert et al., 2007). See also Appendix G.

(Rubalcaba et al., 2010), for instance in business administration, marketing, or software studies.

Systemic policy according to a demarcation approach

Following the demarcation or differentiation approach, a systemic innovation policy mix can be achieved by implementing various measures that meet the needs of specific manufacturing and services industries. Therefore, in the debate on generic versus specific policy measures (Rubalcaba, 2006), the demarcation approach often favors the latter style.

Again, existing literature provides useful examples of how to address the peculiarities of service industries. Some are in reports like 'Enhancing the performance of the services sector' (OECD, 2005a), where the focus lies on reforming service sector policies. The proposed interventions typically focus on improving the financial market for services and adapting the public-science outcomes to services' commercial needs (Rubalcaba et al., 2010). Respectively, these suggestions are relevant for system functions like financing innovation and growth, and knowledge development and transfer. Green et al. (2001) stress how informal networks can be reoriented towards the requirements of service industries. Their suggestion to support internationalization and remove trade barriers for services is particularly relevant for an innovation system's activities related to entrepreneurship. When it comes to generating innovation, many reports highlight the importance of having appropriate and accessible ICT-infrastructure in place (OECD, 2005a; Evangelista and Savona, 2003).

Characteristic for policy mixes fitting this approach is that there is a certain amount of *duplication* in instruments addressing a particular system function. Sometimes this is limited to one instrument for the technology domain, and one for the services domain. However, as many acknowledge that the service sector is highly heterogeneous (Pilat, 2001), most demarcation instruments only meet the needs of a particular service industry. For instance, parallel with funding measures for technological R&D, systemic policy mixes following this approach include vertical measures aimed at providing financial support to either logistics, or trade, or tourism, etc. (Den Hertog et al., 2010). Similarly, with respect to functions like knowledge development and application, duplication results from respecting arguments for developing service-specific IPR instruments in addition to legislation typically focused on technology. Such service-specific IPR is particularly encouraged in service industries dealing with franchises, software, or consultancy methods (OECD, 2005a). Other examples of instruments for particular service industries can easily be found.

Systemic policy according to a pre-synthesis approach

Rather than addressing each single system function by implementing distinct measures for the goods and services domains, the pre-synthesis approach suggests benefiting from each domain's contributions to the overall functioning of the innovation system. Corresponding measures see service innovation in relation to other industries. By regarding 'service innovation' as a non-sector-specific concept, the cross-sector orientation of this policy approach is mostly on the side of generic measures. However, because service innovation policy is still more specific than fully neutral innovation policy, it is not as generic as the assimilation approach.

In the existing classification of service innovation approaches, measures focused on service innovation as such appear in both the sector-focused demarcation approach as well as in the fully integrative synthesis approach (Den Hertog et al., 2010). Indeed, service innovation role-models and courses might be thought of as restricted when focused exclusively on service industries. However, when designed to inform also other industries about how to engage in service innovation, this measure fits better with our idea of pre-synthesis. Yet, measures aimed at increasing the role of KIBS and creative industries in innovation systems are not as integrative as the programs where the opportunities for goods and services are unified. In our perspective, the 'outward-looking' measures for role-models, KIBS and creative industries are neither demarcation nor complete synthesis, but fit in a pre-synthesis approach focusing on how particular service firms can contribute to the functioning of other actors in the innovation system. These other actors can be manufacturing, service, or hybrid organizations; what matters is that they can benefit from support in developing new (service-based) business models (Wood, 2005).

From a systemic perspective, policies corresponding with this approach focus on system functions where services can contribute the most: of key importance are the ideas of *complementarities* between goods and services (Rubalcaba et al., 2010) and innovation *through* services (Den Hertog, 2000). Particularly promising opportunities occur in the context of knowledge development and transfer. With respect to knowledge development, Probert et al. (2013) argue that R&D services can be seen as the engine of the high-tech economy. Such a perspective departs radically from considering R&D only within the domain of services (European Commission, 2006). Second, KIBS might be supported on the basis of their potential to spread knowledge throughout the innovation system (Den Hertog, 2000; Toivonen, 2007). It is widely acclaimed that such specialist services like KIBS contribute significantly to the economic and innovative performance of other industries (Simmie and Strambach, 2006; Shearmur and Doloreux, 2013). Mas-Verdú et al. (2010), when discussing the role of services in regional development and innovation, stress that policy makers can benefit from the distributive function of services either by supporting private KIBS or by developing public forms of transfer and connection services. By acting as cross-fertilizers, service businesses also play an important role in generating new business models in other industries. Notably creative industries like design firms and marketing agencies are known for their ability to provide input that might help client firms to turn inventions into successfully commercialized innovations (Lehrer et al., 2012; Mangematin et al., 2014). The various roles services can play in the growth and evolution of industries (Cusumano et al., 2014) suggest that there is a clear case for policy interventions aimed at spreading service-based business models throughout industries predominantly geared to manufacturing.

Systemic policy according to a post-synthesis approach

Systemic policy mixes based on the post-synthesis approach contain interventions where support for goods- and service-based innovation is entirely *integrated* in individual instruments or programs. Measures corresponding to this approach acknowledge that both domains have their own dynamics, but also that the two types of innovation often need to build upon each other. Just like individual firms might benefit from delivering hybrid product-service systems, also large scale economic change often requires the interplay of novelty in the spheres of physical products and services (Gallouj et al., 2014; Consoli, 2007). This is convincingly demonstrated in Windrum and Garcio-Goñi (2008) for innovation in health systems. Taking into account the distinct but intermingled nature of goods- and service innovation, the post-synthesis approach is particularly applied in policy strategies with a focus on *specific societal or technological themes*. This topical scope distinguishes it from the assimilation approach, which is all-encompassing only because it does not have a sectoral focus.

Policy interventions that see goods- and services innovation in relation to a specific topic can be found for practically every function in an innovation system. Cluster policy is a strong example of such policies. According to Porter (1998), clusters are geographic concentrations of companies, specialized suppliers, public or private service providers, and associated institutions (including academia) connected to each other through their highly similar fields. Due to agglomeration and network effects along the value chain, these fields are typically broader than a single manufacturing or service industry: more common is that the cluster concentrates on a specific technology (e.g. biotechnology) or a domain like health, sustainability, or energy. By supporting interactions between the various co-located actors, cluster policy can affect system functions like knowledge development (in universities) or collaboration and networking. Often, clusters or campus management organizations provide facilities for start-ups, such as advisory services and incubation funds. These policies concern system functions like entrepreneurial activities as well as mobilizing resources for innovation (Hekkert et al., 2007).

Another example of integrated policy aimed at specific themes is public procurement of innovation (PPI). Addressing system functions like competence building and financing innovation (Edquist, 2005), policy makers can invite and support market parties in the (phased) development of solutions for specific issues. Thereby, PPI also forms a powerful tool for addressing societal challenges (Borrás and Edquist, 2013). Like most demand-side policy instruments, participation in PPI schemes is often open to firms from any sector. In fact, one of the main features is that creative input can be brought forward by firms other than the 'usual suspects' in manufacturing.

7.3 A COMPARATIVE CASE STUDY

In the previous section we outlined four different approaches for achieving systemic policy mixes, based on a comprehensive account of the potential of service innovation. The purpose of this empirical section is to demonstrate how classifying policy instruments according to these approaches can assess the service-inclusiveness of policy mixes. We also show how our analytical structure provides opportunities for identifying where extra support might be needed. Comparing the policy mixes of different regions can offer fruitful inspiration for solving functional weaknesses.

This section builds on two of the case studies conducted by the European Service Innovation Centre (ESIC), an initiative of the European Commission's DG Enterprise. ESIC's objective was to shed light on the transformative power of service innovation. One part of the research project consisted of case studies in regions coping with the challenge of revitalizing their economy.

Despite having a similar economic structure, the regions Upper Austria (Austria) and Limburg (the Netherlands) differ in their strategy for including services in their innovation policy mix. As both case studies have been conducted by the European Service Innovation Centre, they rely on exactly the same methodology. The practices for information sourcing follow most of the suggestions by Borrás and Edquist (2013). First, information on the region's economic performance and policy mix was retrieved through extensive desk research. Part of this phase was a benchmark exercise using indicators from the European Service Innovation Scoreboard to compare the two regions to similar and best-performing regions. During site visits in 2013, one-hour interviews were conducted with about 10 key stakeholders per region. Interview summaries were returned for verification purposes. Some of the stakeholders agreed to fill out a self-assessment about the current state and service-inclusiveness of their policy mix. After an assessment report was shared with the regional stakeholders, policy workshops were organized early 2014 to verify the findings and to explore opportunities for further policy development. Apart from local stakeholders and peers from other regions, also independent experts participated in these sessions. The final assessment of the innovation strategies in both regions, including detailed descriptions of the present policy measures, can be found in the publicly available reports (ESIC, 2014a/2014b).[45]

We analyze the policy mixes of both regions on the basis of our four approaches: first we discuss the generic policy instruments (assimilation), then we describe how goods-focused policy is complemented by the sectoral and cross-sectoral variants of specific innovation policy (demarcation and pre-synthesis), and we conclude with the thematic policies (matching the full synthesis approach). For each service innovation approach, we describe which innovation system function or activity is addressed by a particular policy measure. The ESIC review of regional policy mixes considers a total of five functions. Although also inspired by frameworks from the TIS-literature (e.g. Hekkert et al., 2007), the chosen set mostly resembles a selection of the activities proposed by Edquist (2005; see also Borrás and Edquist, 2013). Building upon the ESIC analyses, we illustrate our approach by observing the following activities: creation of new knowledge, innovation generation (covering both competence building and provision of consultancy services relevant for innovation processes), creating and changing organizations for developing new fields of innovation (entrepreneurial activities), networking knowledge dissemination), and financing (covering both incubation activities as well as funding for innovation processes).[46] For the sake of clarity, our analysis here does not take into account the innovation policies present at the (supra-)national level.

7.3.1 The case of Upper Austria

Regional background and policy goals

Upper Austria is the nation's most competitive and export-oriented region. Particularly strong is its performance in manufacturing industries like automotive, mechanical engineering, metal processing, chemicals, plastics, paper, wood, and automation.

Policy makers at Upper Austria's innovation agency concentrate on two policy goals. The first is to sustain the region's economic performance. A major problem here is the region's weakness in exploring new business models: Upper Austrian firms are highly inclined to stick to their traditional (and so far successful) focus on selling medium-tech goods. Although some regional stakeholders recognize the commodity trap, the willingness to explore new business models appears to be modest. A related problem concerns the labor market. Because many students leave the region, there is an increasing shortage of skilled personnel that can continue or transform businesses.

45 Subsequent activities in the ESIC project, involving interaction aimed at fine-tuning policy advice, are outside the scope of this chapter. Also, they came after the preliminary assessment of existing policy mixes on which the cases studies are based.

46 All of these activities are typically affected by supply-oriented innovation policy measures. We fully acknowledge that demand-side activities and framework conditions (e.g. patent and tax laws, safety and environmental regulations) are essential for innovation as well (Edquist, 2005). For illustrative purposes, however, we limit ourselves to the set chosen in the ESIC analyses.

Upper Austria's second objective is to shape its new 'strategic program for economy and research' according to the grand challenges set by the European Commission. This has resulted in five action fields that form the core of 'Upper Austria 2014-2020': industrial processes, health / ageing society, energy, food / nutrition, mobility / logistics. With the exception of the first action field, none of these themes has a strong orientation towards either goods or services innovation.

Regional policy mix

The number and diversity of policies at the regional level is rather high in Upper Austria. Each of the interventions is categorized in Table 7.1, below, but also plotted on the map we developed in section 7.2 (see Appendix H). A first observation is that its policy mix contains many measures fitting the assimilation approach. By jointly addressing all the innovation system's activities, we see this part of the policy mix is rather systemic. For instance, knowledge creation is supported by the Upper Austrian research funding programme (providing additional finance to research funded by the national Research Promotion Agency); competence building and networking are the goals of the Innovation Assistant Programme (university graduates helping SMEs with their innovation processes), entrepreneurial organizations find support in no fewer than three policy measures, and capital for innovation is provided through (amongst others) loan guarantees. All in all, half of the assimilation measures are inherently neutral, mostly those focused on entrepreneurship. The other half is R&D measures that have been opened up to services and service innovation.

Nevertheless, many of the originally goods-focused policies remain unaffected. As the composition of the policy mix reveals, technology support still lies at the heart of Upper Austrian innovation policy. Like in the case of assimilation policies, every system function is addressed by at least one goods-oriented intervention. The few demarcation measures all concern very specific industries. Two initiatives involve funding for a service industry, in addition to the funding measures that only support (energy) technology. The logistics network, originally an initiative for transport businesses, has currently become an instrument with a broader perspective on logistics.

At the moment of writing, Upper Austria's goal to make use of the transformative power of services has not yet resulted in a policy measure for service innovation as such (following the pre-synthesis approach). In fact, its reason for being interested in the ESIC analyses is exactly the wish to understand better how measures of this kind can be implemented.

Finally, post-synthesis refers to one measure of major importance for the region. Upper Austria's renowned Clusterland initiative traditionally focused on different manufacturing industries (e.g. automotive, mechatronics). In recent years, however, the program has been extended with Clusterland Networks devoted to topics like human resources and resource and energy efficiency. As the focal domains indicate, these networks stretch beyond any distinction between goods and services. Only the logistics network might be associated with a particular service industry, but the ambitions and members of this network indicate that its activities pertain to the development of integrated solutions.

Table 7.1: Policy mix in Upper Austria: detailed description of each instrument found in ESIC (2014a), pp 13-16.

Service innovation approach	Examples of policy instruments	Innovation system function / activity*				
		K	C	O	F	N
1. Assimilation	Innovation assistants (university-industry link)		x			x
Neutral measures that cover technological and	Upper Austrian research funding	x			x	
service innovation on an equal basis	Loan guarantees				x	
	Investment capital				x	
	Innovation award		x			
	Education account for young entrepreneurs			x		
	Economic stimulus program			x		
	Founder Funds			x	x	
Goods-focused	Research and technology council	x				
	Innovation Network					x
	High Tech Incubator		x	x	x	
	Energy Technology Program				x	
	Green Energy & Environ. Technology				x	
	Technology Centres		x			
	Clusterland (clusters)	x	x	x		x
2. Demarcation	Tourism initiative				x	
Sectoral (vertical) programmes for services	Business start-up (tourism & transport)			x		
	Local supply program				x	
	Logistics network		x			x
3. Pre-synthesis						
Cross-sectoral measures focused on service						
innovation and the link with manufacturing						
4. Post-Synthesis	Clusterland (networks)	x	x	x		x
Thematic programs integrating opportunities						
from goods and services						

* Creating knowledge (K), innovation–oriented competence building and consulting (C), creating organizations (O), finance for innovation (F), and networking (N). Based on Edquist (2005) and Borrás and Edquist (2013).

7.3.2 The case of Limburg

Regional background and policy goals

Just like Upper Austria, Limburg's economy was traditionally based on manufacturing. Especially after closing its mines in the 1970s, industry has gained importance in the economic structure. Also with respect to its policy goals, Limburg is similar to Upper Austria (and probably many other European regions). The main objective is to sustain the success of the region by shaping a knowledge-based economy. Where possible, the region also aims to meet societal challenges.

Regional policy mix

As can be seen in Table 7.2, Limburg has only a small number of policies fitting the assimilation approach. In our categorization of system functions, the only one not affected is innovation and business model generation. Also the goods-focused interventions do not strengthen this function.

In Limburg's policy mix, one service-oriented initiative applies the demarcation approach. The Smart Services Hub was established by universities and public and private organizations engaged in financial, administrative and information-based services. By initiating joint projects, the hub aims to use knowledge transfer and collaboration for spurring innovative entrepreneurship. Its long-term aim is to become an expertise center that contributes to the renewal of businesses models in other industries, thus changing this to a pre-synthesis approach. An alternative trajectory is that it is developing into a hub specifically for creating and commercializing smart services, using combinations of modern technology (e.g. data servers, cloud computing) and clever applications of the functionality enabled by such technologies.

Currently, several instruments are already following a pre-synthesis way of designing systemic innovation policy. Whereas the goods-focused elements of Limburg's policy mix mostly concern financing and collaboration, the pre-synthesis interventions address a complementary set of functions. Almost all of them aim to generate new business models. Initiatives like the Service Science Factory and the Business Services School aim to bring service thinking to non-service industries as well as to service firms, not knowing what innovation might mean to them: their power lies in the experience of introducing service innovation in a wide variety of firms and having strong links with universities. While the Business Services School focuses on offering courses related to service innovation, the Service Science Factory positions itself as an institute where researchers, students and firms jointly work on actual business problems related to customer-centric thinking and service design.

Finally, Limburg's policy mix contains several interventions or policy initiatives that fulfil the post-synthesis approach. The chemicals/materials campus is classified as goods-focused due to the dominant role of manufacturing, but three similar initiatives take a more integrated perspective. The Document Services Valley, for instance, supports innovative entrepreneurship with respect to high tech services in the domains of printing, imaging and document management.[47] A thematic focus is also clearly present on the agro-food and the health campus. Neither focuses exclusively on products or services: the goal is to come up with integral solutions where technology and services reinforce each other.

47 The Document Services Valley is about to drop the word 'Document' from its name. By positioning itself more prominently as an initiative for all sorts of (high-tech) services, just like its Business Services School, it might actually be on its way to moving from synthesis to pre-synthesis.

Table 7.2: Policy mix in Limburg: detailed descriptions of each instrument found in ESIC (2014b), pp 17-21.

Service innovation approach	Examples of policy instruments	Innovation system function / activity*				
		K	C	O	F	N
1. Assimilation	Innovation vouchers	x				
Neutral measures that cover technological and	Starters funds			x	x	
service innovation on an equal basis	Participation funds			x	x	
	SILVER (Industrial Symbiosis Program)					x
Goods-focused	HighStarters TechStart			x	x	
	Top Technology Clusters					x
	Limburg Ventures				x	
	Chemicals / Materials Campus			x		x
2. Demarcation:	Smart Services Hub	x	x	x		x
Sectoral (vertical) programmes for services						
3. Pre-synthesis	LimburgMakers (part: servitizing entrepreneurs)		x	x		
Cross-sectoral measures focused on service	Service Science Factory	x	x			
innovation and the link with manufacturing	Service Business Acceleration Program		x	x		
	Business Services School	x	x			
4. Post-Synthesis	Document Services Valley		x	x	x	x
Thematic programs integrating opportunities	Health Campus	x		x		x
from goods and services	Agro-Food Campus					x

* Creating knowledge (K), innovation –oriented competence building and consulting (C), creating organizations (O), finance for innovation (F), and networking (N). Based on Edquist (2005) and Borrás and Edquist (2013).

7.3.3 Comparison and opportunities for mutual policy learning

Despite similar economic positions and ambitions, the policy mixes in the examined regions are highly different. Limburg is clearly further on its way towards a service-inclusive policy mix. A more detailed comparison indicates several learning opportunities for both regions.

A remarkable feature of Upper Austria's policy mix is the number of measures. Apart from the confusion this may cause amongst local firms, it also seems to require more governance than the leaner policy mix in Limburg. A holistic perspective on policy mixes demands that policy interventions complement each other (Borrás and Edquist, 2013; Edquist, 2014). Not only does this imply that no underperforming system function should be ignored, it also implies that redundant support for the same function is avoided if there is no evidence of additional benefits from the overlap. Our overview demonstrates how especially goods-based innovation is heavily supported: taking into account both goods-focused and generic (assimilation) policies, each system function is addressed at least twice. At the same time, Upper Austria's extensive policy mix also suggests how to make the assimilation (and goods-focused) policies in Limburg more systemic. For instance, instruments like innovation assistants and innovation awards could potentially strengthen innovation-oriented competence building in Limburg. The policy workshop did in fact reveal great interest in such instruments for encouraging firms to explore new ways of commercializing their knowledge.

The two regions can also learn from each other with respect to making demarcation measures more (pre-) synthesis-like. Both Upper Austria and Limburg aim to increase the importance of certain types of services (logistics and smart services, respectively) by strengthening the link with other industries. Their experiences of how to create this link is something the regions can fruitfully share.

Whereas pre-synthesis is missing in Upper Austria, this approach is strongly adhered to in Limburg's strategy to develop service-innovation policy. Its various initiatives provide highly useful examples of means to persuade manufacturing firms to explore services more. Such an instrument for 'infusing' other industries with service-thinking directly addresses Upper Austria's goal of modernizing its economy. A local variant of a service innovation laboratory has the potential to support manufacturing firms shifting to service-based business models. By embedding it in the university, like several initiatives in Limburg have done, opportunities arise to develop courses that meet the increasing demand for young engineers who can achieve business success in novel ways.

In addition to historically developed clusters, Limburg is also actively supporting the creation of new clusters and campuses. So far, these are less systemic in their scope than Upper Austria's Cluster Network. Moreover, the different clusters in Upper Austria are occasionally brought together by the central agency coordinating them. For Limburg, creating synergetic linkages between the local clusters remains a main challenge. Apart from opportunities for Limburg to learn from Upper Austrian experiences, we also observe the potential for policy learning in the other direction. Developing solutions in the domain of health (and ageing) is one of the ways Upper Austria is attempting to tackle societal challenges. This aim is currently being translated into policy formulation, whereas Limburg's health campus has been running for a number of years already.

7.4 DISCUSSION

7.4.1 From analytical structure to policy implications

In the previous sections we developed an analytical structure not only for understanding how service innovation can be made part of systemic innovation policy, but also for assessing the service-inclusiveness of policy mixes. Apart from serving analytical purposes, the four approaches can help to formulate policy.

First, policy makers should carefully consider what goals they are ultimately trying to achieve (Borrás and Edquist, 2013). Whether these concern economic progress or innovation in a particular domain – as determined in complex political processes – it is essential that the policy mix supports the creation, diffusion and application of relevant knowledge (Edquist, 2014). According to the current views, this requires the government to develop policy that strengthens a set of functions or activities that should be performed in an innovation system. Instead of trying to develop a single policy measures that is systemic all by itself (Smits and Kuhlmann, 2004), policy makers can also consider distinct measures that address a complementary set of system functions (Hekkert et al., 2007).

Second, policy makers need to have a thorough understanding of the various opportunities in which their innovation system can benefit from service innovation (Rubalcaba, 2006). Recognizing the different points of view is a prerequisite for determining which type of policy approach is appropriate within a certain context. Each way of looking at the nature of service innovation has its own focus. The specific innovation dynamics that a certain point of view brings to the fore, in turn, correspond with a distinct set of policy implications. We extend the traditional classification of service innovation approaches by distinguishing 'pre-synthesis' from full or 'post-synthesis'. Due to its focus on similarities between instances of service innovation, the pre-synthesis approach is what we regard as an important step in the aim to move from studying specific service industries to developing completely integrated innovation theory. Applying the extended range of approaches to policy formulation illustrates how the existing and newly introduced lines of thought differ.

The last step is to assess which interventions would be appropriate additions to existing policy. This can be done by categorizing how existing policies deal with services (using the framework we introduced in section 3.1), and which functions they address. Such an analysis reveals opportunities for making policy mixes more systemic by showing which functions are overlooked in each of the approaches to policy innovation. While one approach might require policy makers to duplicate policy measures for each system function (one goods-focused instrument, and one for services), other approaches correspond to measures that address complementarities and interdependencies between the two domains.

It is important to note that we do not advocate adopting all approaches. Rather, we show how systemic policy can be shaped to each concept of the nature and potential of service innovation. In this respect our chapter departs from earlier work stating that systemic policy can only be achieved by introducing service-goods integration at the level of individual measures (Rubalcaba, 2006; Den Hertog et al., 2010). Our alternatives show that an assimilation approach can be systemic, as long as its relation to other instruments is well-balanced with respect to system functions.

The proposed variety in possible courses of action supports the fact that policy makers are restricted in their possibilities for transforming policy measures: what type of systemic policy can be realized depends on existing policy as well as the policy goals ultimately pursued (Borrás and Edquist, 2013). The four alternative approaches cannot be viewed in isolation, as specific innovation policy is often implemented to complement generic measures. Our aim is to support policy makers in ensuring that also these specific accents address all system functions. By creating an overview of the functions addressed by existing policy measures, policy makers can reach an informed decision on how essential it is to facilitate support for a system function in the context of a specific goods- or services domain (in addition to the generic measures already present).

Drawing on a comparative case study, we illustrate how policy makers can analyze the service-inclusiveness of their policy mix and compare it with other policy mixes. The approaches we propose provide a framework for mutual policy learning: both the examined regions have introduced policy measures that, from a functional perspective, would complement the other region's policy mix. Extending the number of policy mixes against which a region is benchmarked, we reckon, would highlight even more opportunities for structured debates aimed at exchanging policy experiences.

7.4.2 Possibilities for further research

Further research could be devoted to identifying additional service-sensitive policy instruments and categorizing them according to the systemic approach they belong to. In line with the increasing scholarly attention for an all-encompassing account of innovation, integrative thematic policy instruments are of particular interest.

One notable example of how policy makers can benefit from more insight in service-inclusive specific innovation policy, concerns cluster policy (e.g. in the form of campus management). This kind of innovation policy is explicitly being promoted in the European Commission's new framework program, but the potential of well-considered service-orientation often remains unaddressed. A possible response is to explore the potential of supporting demarcation-like service clusters (Hsieh et al., 2012). A (pre- or post)synthesis view, however, would emphasize the interaction between distinct parties, including both manufacturing and service businesses, within the value chain around which a cluster is centered. In our empirical examination, we encountered substantial variance and doubt regarding ways to 'infuse' cluster policy with the topic of service innovation. Some clusters traditionally focused on manufacturing, like the chemicals/materials cluster in Limburg and Clusterland in Upper Austria. In both cases, the initiatives enable cluster members to jointly explore what service innovation can mean to them (a pre-synthesis line of thinking). Alternatively, the post-synthesis-like health campus in Limburg and Clusterland Networks in Upper Austria consider services as an intrinsic part of the economic activity they support: service-sensitivity is embedded in their thematic and interdisciplinary focus. How policy makers and campus managers can strategically exploit service innovation requires information on the orientation, design, implementation, governance and success of policy experimentation in different circumstances. Investigation of the complementary role of more generic policy instruments is also a crucial factor in this respect.

An alternative way to extend research on the integrative approaches to innovation policy is to explore another theme that is gaining popularity among (European) policy makers: smart specialization (Foray et al., 2009). This term is applied to policy agendas that take an integrative and knowledge-based perspective on transforming economic structures. Some key features of research and innovation strategies for smart specialization (RIS3), accordingly, are: the focus of national or regional priorities and challenges, the exploitation and further development of local strengths, and the support for diverse forms of innovation (Camagni and Capello, 2013). To a large extent, these correspond with the principles of a full synthesis approach to policy formulation: the relevant policy instruments identified in our cases concern goods- and service-inclusive programs focused on particular strongholds. How to use service innovation policy for reinforcing existing domains of (regional) specialization seems to be a promising avenue for extending the current study. In particular, we consider it worthwhile to explore not only the role of services within those specializations, but also between them. Recent studies of regional development and technological relatedness (e.g. Frenken et al., 2007) show that knowledge flows between unrelated specializations are rare, but at the same time have the potential to cause disruptive breakthrough innovations (Castaldi et al., 2014). Since knowledge about service innovation is relevant throughout different specializations, policy makers could consider using this theme for linking previously unrelated industries. Essentially, some of the encountered pre-synthesis instruments already aim to position service innovation as the glue between regional strongholds. In the next chapter this will be explored in more depth.

7.5 CONCLUSION

As a nuance to our propositions and suggestions for further research, we conclude by stressing that this chapter takes an analytic and thus neutral standpoint with respect to which approach to service innovation is preferable. Instead of being unconditionally in favor of some particular form of service innovation policy, we merely emphasize the benefits of having alternative ways in which services can be made part of systemic innovation policy. While the sectoral approach (demarcation) and cross-sectoral approach (pre-synthesis) correspond with policy focused on service industries or service innovation as such, the other two approaches relate to a predominantly embedded role for services. Our main message is that, in principle, any of the approaches lends itself for a systemic policy mix. Both an implicit and an explicit focus can be appropriate: what matters is that a thorough analysis of the most suitable way to include services in policy mixes is deliberately considered rather than entirely neglected. The approaches we introduce are designed to support this type of thinking.

APPENDIX G: FOUR WAYS TO APPROACH AND GOVERN SERVICE INNOVATION

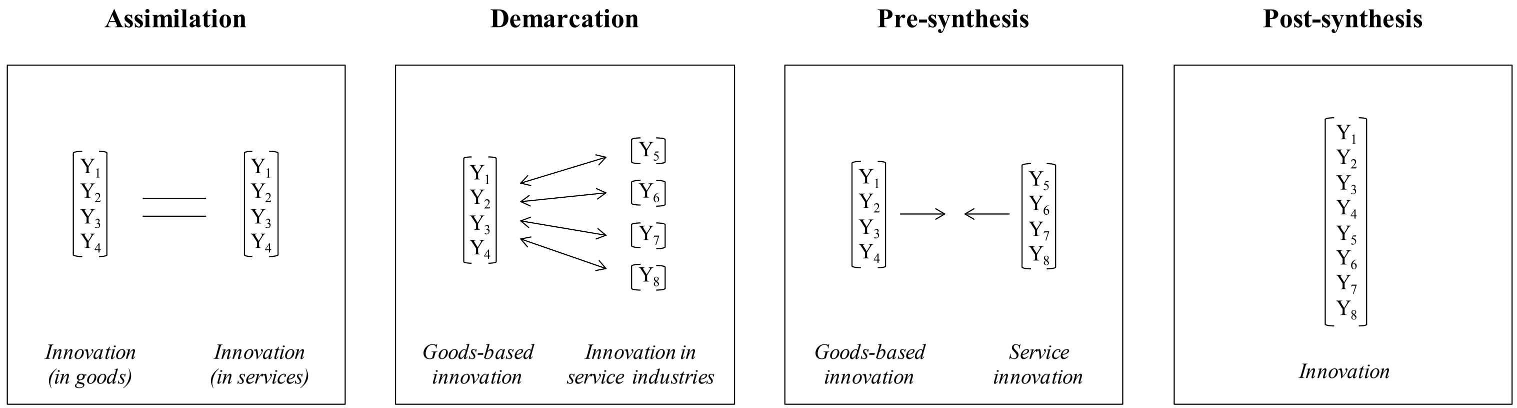


Figure G.1: An extended classification of views on the nature of goods-based and service-based innovation. Inspired by characteristics-based approach (Gallouj and Weinstein, 1997).

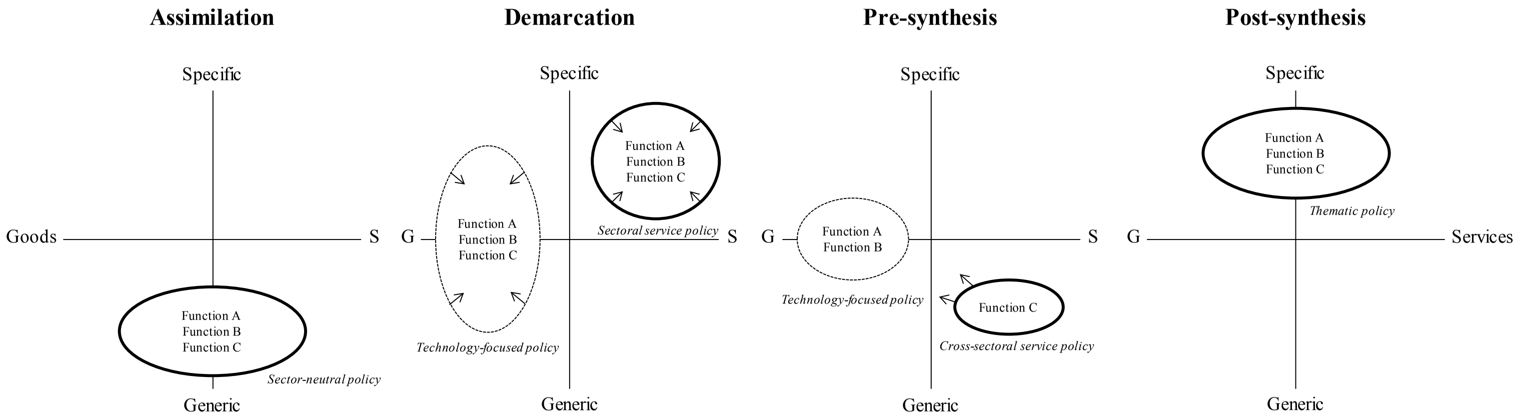


Figure G.2 (7.1): Translation of service innovation viewpoints to four systemic approaches. Each approach corresponds with a different configuration of functions (and constituting activities) that determine novelty creation within an innovation system (Edquist, 2005; Borrás and Edquist, 2013; Hekkert et al., 2007).

APPENDIX H: MAPPING THE SERVICE-INCLUSIVENESS OF POLICY MIXES

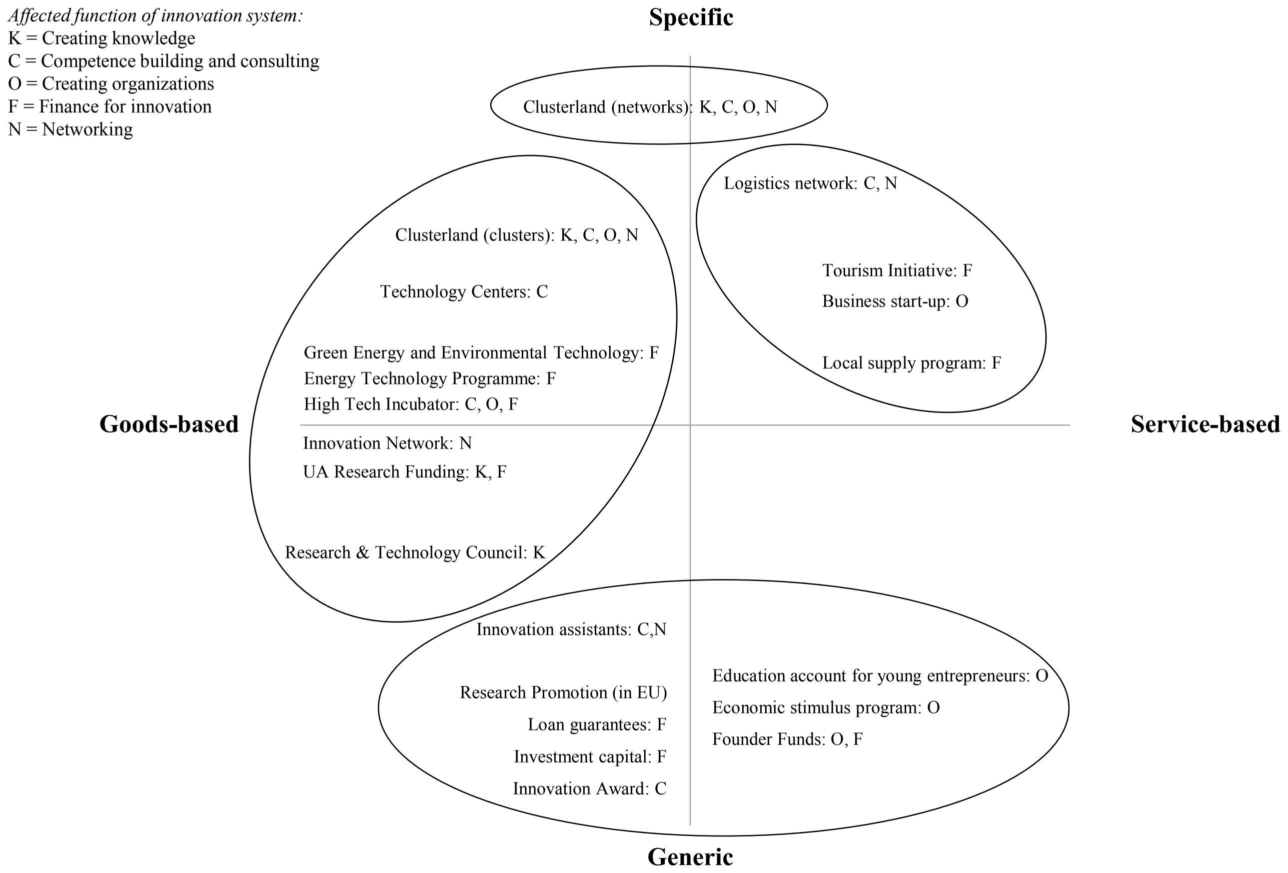


Figure H.1: Policy mix in Upper Austria: detailed description of each instrument found in ESIC (2014a), pp 13-16.

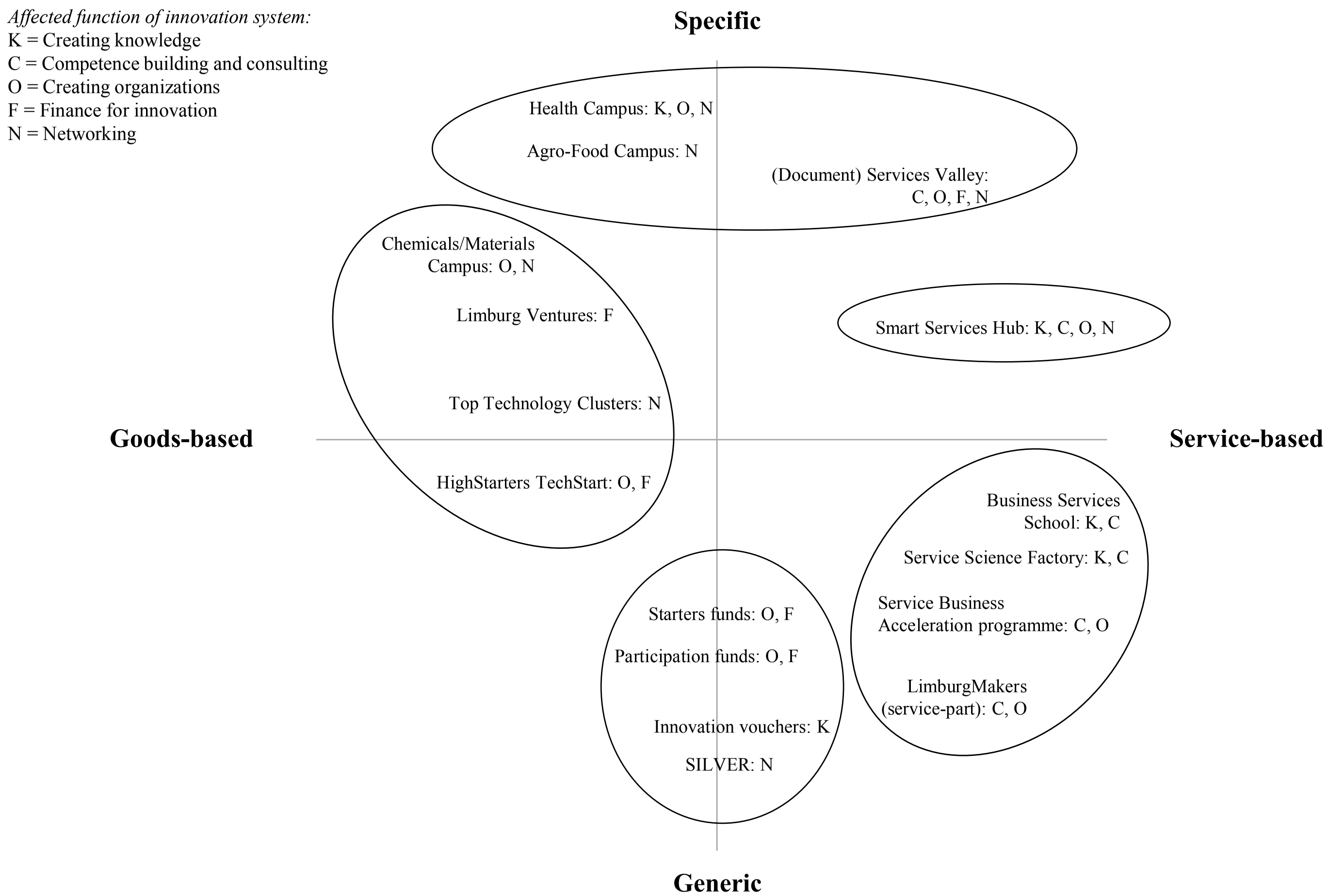


Figure H.2: Policy mix in Limburg: detailed descriptions of each instrument found in ESIC (2014b), pp 17-21.

Chapter 8

Cross-specialization:
(Using service innovation for)
Making unrelated strengths related

8.1 INTRODUCTION

Policy makers and economists have since long debated over the question whether or not to support innovation in specific industries. One main argument in favour of 'vertical' innovation policy approach builds on the opportunities offered by local presence of unique resources (Lazzarini, 2015), like specialized knowledge bases and institutions. By referring to modern societies as 'knowledge economies', scholars like Porter (1986) stress that competiveness is derived from the presence of deep and specialist knowledge that is hard to be imitated by others. Assets with such properties particularly occur in scientific and technological domains that have developed into strengths during a long period of knowledge and experience accumulation (Asheim et al., 2011). Government support for the exploitation of this excellent knowledge, so the classical argument goes, is justified by the expectation of additional growth within the specialized industry. Moreover, through local knowledge spill-overs, support for stronghold industries can also spur growth in other industries. The belief that these benefits can exceed the relatively high governance costs of specific policy (as compared to the costs of 'horizontal' innovation policy) motivates policy makers not to stick only to generic interventions.

Frequently used policy options for supporting specific industries, whether they have traditionally been important or recently became excellent, include the development of industry-based innovation programs and cluster policy (Warwick and Nolan, 2014). In practice, implementations of such types of specific policy suffer from various potential weaknesses. The domains in which a country or region decides to specialize are often so numerous, and broadly formulated, that support measures become available to a part of the economy that is arguably larger than the notion of 'specialization' would suggest (Jacobs, 2000). Relatedly, it also has been noted that there is considerable overlap in the domains that regions select (Asheim et al., 2011). Given that the uniqueness of a knowledge base is supposed to provide the competitive advantage, choosing common domains is unlikely to be a successful strategy.

Over the course of the past decade, the debate on policy styles was reinvigorated with insights from evolutionary theorizing. Especially in the context of regional economies, authors have reconsidered the respective advantages of 'backing and picking winners' by fostering established stronghold industries (Lambooy and Boschma, 2001). Although such industries might be competitive in existing business conditions, the question to ask is how success can be sustained over time. The pace with which markets are currently changing demands economies to be adaptive. Therefore, in order to continue capitalizing on the competiveness of historically developed assets, even industries with a stronghold position might have to transform to some extent (Asheim et al., 2011).

The mechanisms behind economic transformation and industrial evolution can be interpreted as processes of knowledge recombination: whether a competitive industry can develop further is largely determined by the availability of knowledge that can enrich the industry's current knowledge base. Since knowledge is most likely to spill over between similar industries, opportunities to exploit and expand idiosyncratic strongholds typically arise from industries with a high degree of technological relatedness (Frenken et al., 2007). This implies that policy makers should shift their support from the stronghold itself, which is already performing rather well, to adjacent domains that might either strengthen the stronghold or become a stronghold itself.

Even when policy support is aimed at related variety, a pitfall remains. Indeed such a strategy reduces the chance that wrong industries are selected, but recent studies show that true breakthroughs are most likely to stem from recombining notably unrelated types of knowledge (Castaldi et al., 2014). The probability that actors within an economy find original trajectories for sustaining the advantageous position of an industry increase when knowledge from disparate fields is being combined. However, it is also widely acknowledged that knowledge exchange is difficult when parties are cognitively remote (Nooteboom, 2000).

Altogether, there currently is no conclusive answer on the question how to use local strongholds as a basis for diversifying into a competitive economic structure. The current chapter contributes to this discussion by introducing a policy approach that aims to address the above-mentioned considerations. In particular, we argue that policy makers should concentrate on the links between strongholds rather than on the strongholds (and related activities) themselves. Although firms from unrelated specializations are unlikely to collaborate, we will stress that policy makers do have means to facilitate this. Essentially, our argument is built on the idea that cognitive distance (and thus technological relatedness) is a malleable rather than a static condition. We pay specific attention to the role of services, which can be seen as the glue for connecting unrelated strongholds together. By clarifying the potential role of service innovation in industrial evolution, we give direction to future investigations of the "mechanisms underlying the evolving nature of technological relatedness" (Castaldi et al., 2014).

The remainder of this chapter is structured as follows. First, we argue that the fact that a region can be specialized in multiple unrelated domains provides a basis for forms of knowledge recombination that are unlikely to occur through natural branching processes. Of crucial importance is the claim that certain technological and non-technological developments can bring the knowledge bases of disparate industries closer to each other. Such convergence factors, like the ubiquitous need for knowledge on service-based business models and service delivery, open opportunities for policy makers to bridge strong but seemingly unrelated knowledge domains. This idea of 'cross-specialization' is further elaborated on by discussing three manifestation forms. We discuss how policy makers can use attention for services to govern the interface between unrelated strongholds, thereby enabling knowledge recombination that might eventually spawn promising niches.

8.2 ECONOMIC TRANSFORMATION THROUGH KNOWLEDGE RECOMBINATION

8.2.1 Related and unrelated knowledge

Transformation of industrial structures is largely driven by processes of knowledge creation and application. Because knowledge is cumulative and only limitedly transferrable, different regions tend to specialize in different industries.[48] Such excellent industries, which we will call strongholds hereafter, are regarded as a solid basis for regional competitiveness (Warwick and Nolan, 2014). In fact, attention for local strongholds has been rising with the increased interest for cluster policy and smart specialization (European Commission, 2014).

Apart from the earlier mentioned fallacies of specialization policy, there are also other reasons not to concentrate resources too narrowly on local strongholds. Knowledge within a traditionally popular science or technology domain might be highly valuable, but when R&D and economic activity occur in only a very select number of domains there is a risk that a region's knowledge base becomes uniform. Recent studies stress that a more diversified industry composition provides important agglomeration externalities (in addition to the types that are more geographically-bound). These so-called Jacobs's externalities pertain to innovation and growth stemming from knowledge spill-overs between firms or industries with a different knowledge base.

Knowledge spill-overs occur mostly when industries are related to each other. Therefore, scholars stress that innovation demands a substantial degree of technological relatedness. Cognitive distance should not be large (Nooteboom, 2000). Neither, however, should it be too small: when the knowledge bases of two interacting entities overlap almost entirely, there is not much they can learn from each other and resulting knowledge combinations will be hardly novel. Recent research shows that high degrees of related variety within regions can be associated with economic growth (Boschma and Iammarino, 2009), growth in employment (Frenken et al., 2007), and innovation (Boschma et al., 2014). In addition to related variety, one can also distinguish its conceptual counterpart. Unrelated variety is found in conditions in which there are hardly any economic or technological linkages between an economic system's main sectors (Boschma and Frenken, 2011). Instead of looking at similarity amongst firms in subsectors (industries), the degree of

48 According to the Darwinism stream within evolutionary theory, this specialization results from the continuous processes in which firms adopt and modify the body of knowledge and routines that remain locally present ("survives") after market forces posed the greatest rewards on the use of this particular knowledge (while leading other varieties to disappear).

unrelated variety is determined by measuring how business activity is distributed over the higher order sectors within an economy (see Appendix I).

8.2.2 Recombinant search for breakthrough innovation

In the current chapter, we are interested in the question whether and how the presence of unrelated but specialized knowledge bases can be used as a starting point for strengthening a region's competiveness. Valuable insights on this matter originate in particular from studies on recombinant search. Most of the available studies have been developed in the context of individual firms (Tödtling and Grillitsch, 2014), technologies (Arts and Veugelers, 2014) or even inventors (Kaplan and Vakili, 2014). To a lesser extent, the underlying theories have also been applied for studying an entire industry's 'search' for new product lines or even trajectories (Frenken et al., 2007; Broekel and Brachert, 2014). Given that the key principles of knowledge recombination hold at both the firm-level and at the industry-level, we consider findings on both accounts when developing our arguments.

The pursuit of creating new solutions, like products that could open up new markets, is often interpreted as a search journey. An inherent element of search, as many have noted, is uncertainty. This uncertainty pertains to technological factors ("does it work?") as well as to economic factors ("is there market demand?"). When searching for new opportunities, firms can face various degrees of uncertainty. If the knowledge they are dealing with has already been applied extensively, the familiarity with these 'components' might make it easier to assess how they can be made part of new products: "Recombination usually occurs […] between components that are salient, proximal and available for the inventor" (Fleming, 2001, p. 119). For individual firms, such knowledge is likely to be encountered within the knowledge base of the particular industry it is active in. Reversely, when actors are not familiar with certain knowledge or components, the risk of failure is substantially higher (Fleming, 2001). Experiments with knowledge that has rarely been applied in a certain contexts thus reduce the chance that a firm will introduce a successful new product.

On the one hand, scholars have argued that opportunities for developing breakthrough innovation reside in particular in new combinations of well-used components (Nelson and Winter, 1982; Fleming, 2001). Organizations having a very comprehensive understanding of the state-of-the-art knowledge in a certain domain are believed to be in the best position to encounter and solve weaknesses (Weisberg, 1999). Rather than searching for combinations based on unrelated knowledge, they are advised to capitalize on the 'deep' knowledge base of an industry by exploiting the fact that they are so familiar with this knowledge. The view that organizations at the knowledge frontier have the highest chance of identifying anomalies, in addition to the claim that building on used components is a relatively secure option, makes a case for investing in an economy's strongest industries.

On the other hand, there are also indications that especially the combination of unrelated knowledge holds a breakthrough potential (Weisberg, 1999). The downside of being immerged in one specific knowledge domain is that it goes at the cost of creativity, ultimately resulting in myopia. Therefore, one could expect the most original and radical innovation to stem from combinations of highly diverse knowledge. Next to firm-level studies on bridging unrelated knowledge bases and creating commercially successful ideas, evidence is available for the working of this mechanism at the industry level. As Castaldi et al. (2014) show, the presence of unrelated variety in a region increases the probability that innovative breakthroughs will be produced. Their results imply a trade-off of advantages: more common ground for exchanging knowledge, based on the presence of related variety, seems to be directly at odds with chances of finding truly original knowledge combinations.

The proposed views might seem inconsistent with each other, since they consider relying on either related or unrelated knowledge recombination to be the most promising way for identifying radically novel propositions. Kaplan and Vakili (2014), using patent data, provide evidence for the claim that the presumed trade-off may in fact be a matter of a 'double-edged sword' (Sternberg and O'Hara, 1999). The merit of combining input from the same deep knowledge base is a higher level of novelty, but combining unrelated knowledge is associated with more economic value. Recently also Arts and Veugelers (2014) have shown that combining formerly uncombined but familiar technology components forms a solid basis for breakthrough innovation. The finding that recombining deep knowledge and recombining unrelated knowledge each have their own respective benefits holds important implications for innovation policy, as it calls into question whether there are perhaps any synergies to exploit also at the level of industries (rather than technologies).

8.2.3 The potential of cross-industry linkages

So far, the debate on related and unrelated knowledge has focused mainly on identifying optimal levels of (un)relatedness, thereby neglecting any other properties of the knowledge that is involved. A particularly relevant issue, in our view, is the question what kind of unrelated knowledge is being combined when searching for breakthroughs. For an individual firm, having its own unique experiences and thus facing an idiosyncratic search space, all knowledge that is unfamiliar might be considered as unused. This does not hold at the level of the entire economic system. Here, the question whether a component is used depends on how much it has been applied in general, by any of the actors that is part of the system. It is very well possible that economic systems contain multiple specializations, each of them relying on a couple of highly related and extensively used knowledge bases that are not necessarily also linked to the strong knowledge bases of other specializations. This situation is also sketched in Appendix I.

Based on arguments for the respective benefits of the two types of knowledge recombination, we would expect that particularly promising opportunities arise when deep knowledge from one specialization is combined with deep knowledge from another specialization (Fleming, 2001). Arguably, the sophisticated knowledge within excellent industries has been used extensively, and is therefore more promising than knowledge from a random industry. However, because a firm from one stronghold will consider the knowledge from another (unrelated) stronghold as unfamiliar, it is unlikely that the firm will indeed make combinations of components that would be classified as 'used' at the system level. Essentially, this sub-optimal situation pertains to a structural hole within the industry space. In the last appendix of this chapter we use the case of the Dutch Topsectors to illustrate how industries with a structural hole position can be identified.

The rich potential of recombinant search we envisage requires knowledge to flow between very dissimilar industries. Previous studies have shown that this is relatively uncommon. Due to for instance a large degree of cognitive distance, knowledge flows remain absent even if actors are close with respect to other forms of proximity (Nooteboom, 2000).

One possible and probably overly deterministic conclusion would be that efforts to combine disparate knowledge bases are likely to be in vain. Another view at it this issue, however, is that policy intervention is particularly relevant in situations in which knowledge flows can be fruitful but will not naturally emerge. The policy challenge when facing such kind of system failure, falling under the header of information asymmetry, is to enable these 'unnatural' knowledge flows.

We will now argue that even when technological and sectoral (trade) linkages appear to be scarce, there are possibilities for knowledge exchange to occur.

8.3 THE EVOLUTION OF RELATEDNESS

8.3.1 Branching and convergence

According to Boschma and Frenken (2011, p. 64), "the sectoral composition of a regional economy at one moment in time provides and constrains (though does not determine) diversification opportunities of regions in the future". Existing discussions on regional specialization and diversification have particularly looked at branching mechanisms: the evolutionary processes through which economic activity shifts to technologies and industries that are related to the existing ones. As a result of innovation, path dependent knowledge accumulation and creative destruction, old industries diverge into industries that draw upon a more specialized knowledge base. On this basis one might expect that new branches are more different from each other than those closer to the 'stem' of knowledge accumulation.[49] Yet, in modern economies, we also observe various trends that might increase the extent to which different industries share similar knowledge.

Attention for cross-industry similarities typically concerns technological factors, as also expressed by Neffke et al.'s call for more research on role of generic technologies (2011). Perhaps the most pervasive development of modern times is the on-going adoption of a general purpose technology (GPT) like ICT (Bresnahan and Trajtenberg, 1995). The rise of telephony, computers and internet has led to drastic changes in the production modes and business models of firms in virtually every industry. Although those developments resulted in the rise of many new sorts of business activities, actors within both old and new industries now share a body of ICT-related knowledge and skills. This effect of convergence is inherently connected to the nature of any GPT.

Apart from ICT, the European Commission believes the following generic technologies (also referred to as key-enabling technologies; KETs) to be crucial for the competiveness of industries in the knowledge economy: nanotechnology, micro- and nano-electronics including semiconductors, advanced material, (industrial) biotechnology, photonics, and advanced manufacturing technologies. Coining the notion of smart specialization, Foray et al. (2009) urged policy makers to enrich local strongholds by adopting such new multi-purpose technologies. By following the smart specialization approach, regions that will not lead in the development of new technologies can at least take the lead in specific applications of these technologies. Of course, this does presume that the regions have a sufficient level of absorptive capacity for actually staying up to date with respect to relevant technological developments.

8.3.2 Convergence through service innovation

The factors described above concern developments in the narrow sense of the word 'technology'. At same time, there are also less tangible developments that increase the similarity between industries. In the first place, these can consist of the peripheral activities that most firms perform (and thus have in common), like HRM, marketing, sales, etcetera. Since such activities hardly affect the core business of a firm, these kinds of similarities have only limited relevance when searching for opportunities for generative knowledge exchange between distinct strongholds. Some developments, however, do hold implications for the knowledge base lying at the heart of how a given firm creates and captures value.

A very notable trend, not just in Western economies, is the widespread adoption of service-based business models. Increasingly, manufacturing firms are realizing that they

49 This does not necessarily imply that regions only diversify: due to relatedness, the new branches are still relatively similar to the industries from which they originate. Neffke et al. (2011) demonstrate that relatedness in a region can remain stable when entry of dissimilar industries and exit of dissimilar industries equal each other out.

can only beat the commodity trap by switching to the delivery of customer-specific solutions and experiences (Chesbrough, 2011). Even when organizations heavily rely on manufacturing activities, they can add more value by engaging in service activities aimed at fulfilling all a customer's needs. Rather than only producing and selling an artefact, firms can distinguish themselves when they provide the actual service a client is looking for. Also, by engaging in direct interaction with clients, firms obtain detailed information of what their customers really demand. This information is valuable for improving or even renewing a firm's offering. Not surprisingly, the service component of many firms has become more profitable than the traditional core activity of manufacturing (Norman, 1983; Chesbrough, 2011; Visnjic and Van Looy, 2013).

Although value of service-based business models is becoming widely recognized, many firms still struggle with the required transformation (Sundbo, 1997). Numerous studies have shown that servitization, the partial or entire shift towards service provision, poses many organizational challenges (Olivia and Kallenberg, 2003). As a result, both managers and policy makers are highly interested in the question how firms should organize the development of new services and what they could look like.

Even despite the fact that not all firms succeed in switching to services, or choose to do so, we can observe that many of them have made the transition. The fact that employment and growth in the tertiary sector have been rising over the last century led scholars to describe current times as the service economy (Illeris, 1996). Perhaps this label puts too much emphasis on services, since they are often delivered by hybrid organizations or form part of wider product-service systems. And also should it be noted that the number of services firms inevitably increases when value chains become more fragmented and transformation of physical goods is concentrated in only a few locations within this chain. Nevertheless, it is undisputed that services currently do account for a major part of economic activity.

What is particularly important about the increasing pervasiveness of services, is that it underlines that degrees of related and unrelated variety are not given conditions: the fact that a wide range of firms is relying on service-knowledge implies that they (now) do share some similarities. Convergence factors like services thus make technological relatedness more dynamic than usually assumed. So far, only few authors explored how developments in relatedness occurs (Castaldi et al., 2014). Neither, to our knowledge, did anyone ask how convergence can be guided. As argued earlier on, the relevance of this question pertains to the rich potential of creating linkages between unrelated industries.

8.4 SERVICE-BASED CROSS-SPECIALIZATION

8.4.1 Cross-specialization

In the previous sections, we provided theoretical reasons for why combining used but unrelated components might result in the identification of fruitful trajectories. A promising but so far largely overlooked way to avert the treat of other regions specializing in the same domain is by searching synergies between multiple deep and region-specific knowledge bases. Since actors from distinct specializations possess knowledge bases with little overlap, finding complementarities and establishing partnerships might be difficult and thus rare. Our solution for solving this is to find ways to create cross-overs between present specializations. This is the core idea of cross-specialization. Rather than advising policy makers to concentrate their resources (only) on individual strongholds, and economic activities most related to those, we suggest they should search for ways to enable knowledge transfer crossing those strongholds.

With our discussion of convergence factors, we aimed to argue that relatedness indeed is malleable (Asheim et al., 2011). Ultimately, relatedness is a matter of perception.[50] If firms realize that they are in fact (to a certain extent) similar to firms in other industries, they might be willing to learn from each other or with each other (Nooteboom, 2000). It is these kinds of interactions that then form the basis for more intensive knowledge exchange, possibly resulting in original and even breakthrough knowledge recombination (Castaldi et al., 2014).

When convergence factors do not simply happen, but can actually be actively influenced, policy makers in the end do seem to have possibilities for using local strongholds as a basis for developing a competitive industrial structure. Essential is the identification of a body of knowledge that is potentially relevant for, but not actually shared yet by unrelated industries. Whereas GPTs and KETs are already being recognized for their ability to connect industries, this is less the case for services. Services, we believe, have a large and probably overlooked potential of homogenizing (to a certain extent) the knowledge base of heterogeneous industries. This is what we will turn to now.

8.4.2 Forms of cross-specialization, and the role of services

The working of cross-specialization, be it service-based or not, is best to be explained by considering three possible mechanisms through which exchanging unrelated but valuable knowledge can result in economic diversification (the dark grey parts of Figure 8.1). In short, recombining knowledge from stronghold industries can lead to innovations that are an extension of what is already being offered within an industry (A), that are entirely novel within an economic structure (B), or that contribute to (and

50 Since perceived relatedness is hard to gauge, most of the available empirical measures actually concern revealed indications of relatedness (Neffke & Henning, 2008).

benefit from) developments in system-level topics and technologies with a horizontal nature (C).

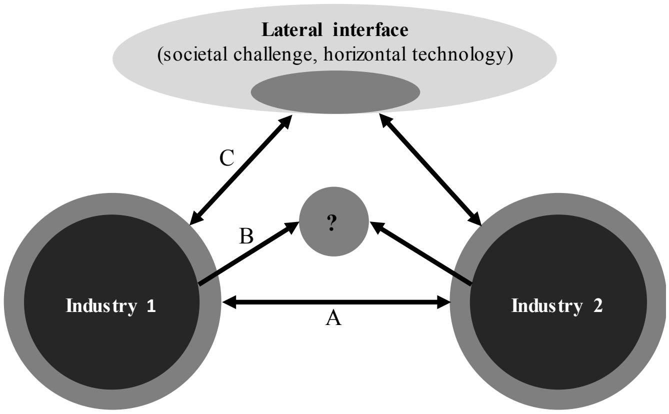


Figure 8.1: Three forms of cross-specialization.

Apart from providing a detailed description of the three cross-specialization modes, the following sections contain a discussion of how services can be of relevance in the respective mechanisms. In particular, we believe that each mode of knowledge recombination can be supported with increasing firms' familiarity with certain service-based business models ("what"?) and ways to organize service delivery or development ("how?"). We do not contend that the relevant body of 'service knowledge' is equal for the three cross-specialization modes. Instead, our claim is that the different possibilities for combining unrelated knowledge correspond with different sorts of service (innovation) insights. The presented efforts to position services as a policy-sensitive convergence factor rely heavily on a recent study by Cusumano et al. (2014), in which they link a service taxonomy to different phases of the industrial life cycle. For additional insights and examples of how services can be used for creating linkages between unrelated industries, we draw upon the literature on service innovation that has been developed over notably the past decade.

In a nutshell, the link between service knowledge and recombining unrelated deep knowledge strengths is as follows. For the first two types of cross-specialization, opportunities for exchanging knowledge are based on the fact that services are both relevant for and yet unexploited by many industries. We believe that the act and result of 'homogenizing' knowledge bases (through acquiring service-knowledge, individually or jointly with other firms) provide a basis for also deeper knowledge to flow. For type C, services-knowledge is regarded as a medium for letting firms from very distinct industries participate in finding solutions to societal challenges and using generic technologies. The table in Appendix J contains a summary of our propositions. In order to contribute best to ongoing discussions on the role of services in industrial evolution, we will exemplify the cross-specialization forms by assuming traditional strongholds to be manufacturing industries (as they often are). Examples to take in mind are the 34 'sector-based initiatives for a French industrial renaissance' (French Ministry for Industrial Renewal, 2013), the 70+ French Competitiveness Clusters (French government, 2014), or the 9 Dutch Topsectors (see Appendix K).

A. Direct knowledge exchange leading to related products

One possible result of combining unrelated knowledge is that firms develop products or services that are similar to the kind that at least one of them was already providing. This situation would occur when knowledge of one industry is introduced in the context of another industry, and used for diversification into products that are related to the existing portfolio of at least of these industries. By drawing on a body of knowledge that was accumulated with time and experience, conform the idea of recombining used components for which deep knowledge is available (Fleming, 2001; Kaplan and Vakili, 2014), these new branches might be more promising than branches originating from other input.

Examples of this scenario include situations in which (specific) technologies or knowledge developed for a certain market were adopted and applied by an entirely different. For instance, specializations in the fields of robotics, chemicals or materials have a large potential for being applied in other possible stronghold domains, like agriculture or health. Firms that only search for new solutions by starting from what they do themselves might fail to identify complementarities with industries that are at first sight unrelated. Actors outside an industry boundary, like public authorities, sometimes have more overview and are better positioned for observing promising cross-overs.

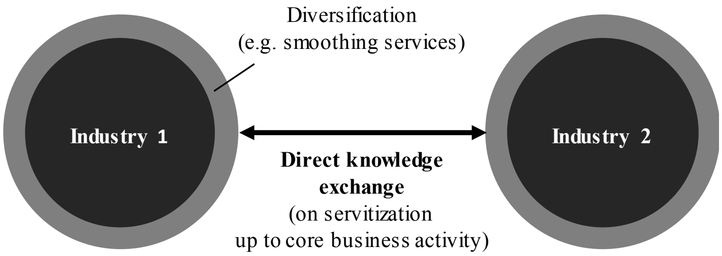


Figure 8.2: Cross-specialization type A: Diversification through direct knowledge exchange.

When firms in established specialization industries start to differentiate their product portfolio, this might involve experimentation with service concepts. According to

Cusumano et al. (2014, p. 4), firms in mature or declining industries are likely to turn towards "services that that 'smooth' the product sale or usage without significantly altering the product functionality". The services that are being added to the existing products are relatively standardized, like maintenance, repair, technical support, insurance or training. Nevertheless, for firms in a specialization that is traditionally oriented towards manufacturing artefacts, delivering such services can pose serious difficulties (Bowen and Ford, 2002; Neely, 2008).

A mutual learning opportunity that arises is that industries can jointly explore the shift towards producing services. The reason why knowledge flows between traditional specializations are of considerable interest, is that these are likely to go through the same struggle and thus become unexpectedly similar on this account. When specializations are unrelated, they might be willing to share experiences and practices regarding service infusion. Opportunities for mutual learning pertain especially to challenges that found to be common for any type of manufacturer making the transition to service provision (Olivia and Kallenberg, 2003). As summarized by Visnjic and Van Looy (2013, p. 170), such obstacles include, for instance, a lack of attention from top management, deficiencies in organizational design of IT, the lack of an appropriate culture (notably a cognitive bias against services) and insufficient capabilities for service management.

The challenge in this form of cross-specialization is not so much about inventing new services, but more about learning how to reorganize a firm in order to deliver them. Importantly, familiarity with different kinds of potentially suitable service concepts is likely to contribute to the success of a firm's transformation (see Chapter 3). The most obvious options are the line of basic services mentioned above: maintenance, repair, etcetera. At first sight, adopting common services is unlikely to make a stronghold truly stronger in the face of global competition. It should be noted, however, that also for services it is the case that combining existing elements in new contexts can already be innovative (Van der Aa and Elfring, 2002).[51] Moreover, even ordinary types of services can be implemented in advanced ways. An example is the raise of maintenance models in which a firm equips her products with sensors, like in Rolls Royce's 'Power by the Hour' (Davies et al., 2006). While gearing up attention for the maintenance part of her business activities, Rolls Royce has been exploring new ways for delivering such services. Having sensors on the equipment she is selling, the company is well aware of how her products are being used and when repair is necessary. This allows her to provide service solutions superior to a traditional way of only performing regular checks.

Novel ways for providing something which is essentially a smoothing service might be pioneered by firms from a technologically leading industry, but will often have a potential of strengthening other (stronghold) industries as well. In fact, as for the example of

51 To what extent service innovation can be regarded as a search process is discussed in more detail in Chapters 2 and 3.

sensor-based services, a widespread adoption throughout very different contexts is currently taking place. Although the onset of what is being called the 'internet-of-things' and 'Industry 4.0' seems to be driven by technological developments in sensors and connectivity, actual value creation depends largely on ideas regarding how to benefit from the information that is being generated. Since providing advanced maintenance is probably the most obvious use, equipping artefacts with sensors is leading to the co-evolution of business models sharing a high degree of similarity. A major implication for the argument we are developing is that firms in unrelated manufacturing industries do have possibilities for learning from each other's efforts to deploy services. Just like in the case of jointly learning how to produce services, we see possibilities for unrelated firms to exchange knowledge exactly because they are no competitors.

Perhaps an even stronger example of the convergence potential of services is found in cases where the role of technology is smaller, and delivering services really forms the only common factor between firms or industries. Here, one can think of the services of the Eye Care Network (ECN) described in Chapter 5. This particular organization is primarily occupied with improving the performance of healthcare institutions specialized in eye surgery. Rather than looking at practices deployed in other (eye) hospitals, the case-firm obtains her inspiration from the aviation industry. By focusing on similarities across the two seemingly unrelated industries, ECN helped hospitals to make improvements related to hospitality and safety. For instance, she was responsible for introducing the Dutch first valet parking service for hospitals. Also, she organized the adoption of pilot trainings in a hospital setting. Recognizing that a strong hierarchy perception can prevent assistants from correcting the doctors they are working with, ECN invited doctors to take place in a flight simulator. Appointing assistants as pilots, and doctors as co-pilots, turns out to break the strict hierarchical barriers that cause medical failures. Other aviation-practices that were adopted include welcoming services (at the hospital's entrance), 'time-outs' (one-minute checks before starting surgery), and using lines on the floor of the operation room to mark where equipment should be. Interestingly, ECN is now being asked to share her experience with organizations outside of either healthcare or aviation: also banks and firefighters appear to be interested in adopting service concepts that are not novel by themselves, but novel to their particular context.

The example of ECN shows that dissemination of ordinary service concepts can be a convergence factor even beyond the situation in which manufacturing firms from unrelated industries encounter parallels in their shifts towards services. However, it is not unthinkable that some of the practices ECN has been diffusing are in fact also valuable to servitizing manufacturers. Furthermore, there also is another reason why increased familiarity with service concepts can be of value to firms from any industry. A notable way for diversifying is by combining existing concepts into 'total solutions' (Normann, 1983). Examples include one-stop offerings like combinations of aviation and taxi services for door-to-door mobility, operational planning and strategic management of assets (see Chapter 3 for both examples), laundries and coffee-shops, etcetera. According to the idea of idea of Jacob's externalities, possibilities for identifying a successful bundle of service concepts are larger when firms do not only look in related industries, but search through the 'pool of service concepts' in unrelated industries as well. As argued before, we strongly recommend looking at industries with a valuable knowledge base.

B. Direct knowledge exchange leading to relatively unrelated products

A second form of cross-specialization concerns the (externally facilitated) interaction between actors from two industries, leading to the emergence of a niche that is relatively distant to the original products of both industries. While cross-specialization type A corresponds mostly with diversification based on solving anomalies within stronghold industries, type B fits more with the other side of the double-edged sword of knowledge recombination (Kaplan and Vakili, 2014). That is, this form is based on the finding that especially recombining knowledge from unrelated industries lies at the root of breakthrough innovations that are radically novel for all parties involved (Castaldi et al., 2014).

As observed in the evolution of many industries, the initial emergence and subsequent maturation of niches is highly determined by the types of knowledge that are present in established markets (Klepper, 2002; Agarwal et al., 2004). A well-known example is found in the onset of the automobile industry. Amongst the first firms to successfully enter this market were the ones having capabilities and knowledge stemming from industries like coach and bicycle manufacturing (Boschma and Wenting, 2007). For firms in either industry, making automobiles was something really different from developing yet another line of coaches or cycles. It is the recombination of such distinct specializations that can result in product lines lying beyond those that would be developed in regular branching processes. Another, less technical example is the recent rise of business activities like 'search engine optimization' services, which is probably most remote to being a mix of website development and branding consultancy.

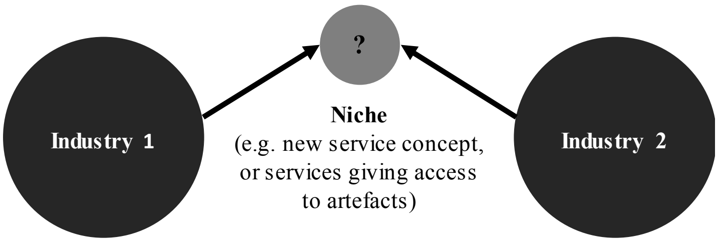


Figure 8.3: Cross-specialization type B: Niche creation emerging from direct knowledge exchange.

Innovative services tend to play an important role in the emergence of new markets. Here we are not interested in the well-documented knowledge brokerage function of service firms, but in the fact that services themselves (as in: service-based business models) have an important role in the emergence of new markets and even technological niches.

First, the new product that unites distant knowledge bases might be an entirely new solution or experience. This would concern a service concept that is uncommon in any of industries present within an economic system: the new service formula itself is then the link between strongholds. Contrary to the collection of service concepts that are of relevance for the cross-specialization type A, the service-based business models discussed here do have to possess a high degree of novelty. Think for instance of novel business intelligence services like digital 'dashboards' for presenting real time information on a firm's key performance indicators. Indeed this type of service can be seen as a product of knowledge from industries like management consultancy, data analysis, and web development, but at the same time it is considerably new to the type of services that firms in any of the individual industries have been providing. Also illustrative is the case of Kone. The 'People Flow' services it is providing build on expertise developed in the context of elevator manufacturing, combined with knowledge on urban architecture. Just like producing elevators and escalators is uncommon to architects, providing consultancy on urban liveability is probably equally new to most elevator manufacturers. The more this kind of service is delivered independently of these ancestor industries, the more it can be considered as a niche (cross-specialization type B) rather than a form of diversification relevant for two industries (type A). Although the example of Kone concerns successful innovation within only one single firm, it does demonstrate how a new service can connect knowledge bases that are hardly encountered within one single industry. The fact that such new services can spawn new industries has increasingly been gaining attention. According to Berry et al. (2006), the market-creating potential of service innovation is determined by drivers like scalability of the business model and comprehensive customer experience management.

In addition to novel service concepts, we consider the situation where the emerging market relies on a physical product rather than an intangible solution. Even in these circumstances, the first (and perhaps only) commercialization of that artefact will often have the form of giving access to its functionality. Cusumano et al. (2014) expect substitution services to be crucial in the ferment stage of the industry life cycle. These are services that allow a customer to make use of a product's functionality without being required to purchase it. A typical example is the case of telephones: for several decades, most people could only make calls by using services provided via public phone booths. The enthusiasm for calling has led many people to buy a phone when private phones became affordable, but by now most telephone companies have actually started to focus their business model again on the services they provide (often offering the phones even for free when one signs up for a service subscription). A similar trend can be observed in the market for printing and copiers, where firms first used to rely on printing services, then where able to buy their own machines, and now again mainly lease their equipment and the corresponding maintenance and document handling services. The reason why substitution services might be particularly relevant for new product-markets is that a high level of uncertainties might prevent transactions to occur. Given the scarce amount of evidence that a new product will work, the novelty of a product poses severe risks to the customer. As Cusumano et al. phrase it: "[…] there can be situations when customer and producer uncertainty may be so high, during the early phase of an industry, that services emerge as substitutes for products because many buyers are reluctant or unable to commit to the purchase." (2014, p. 7). By offering a service instead of the artefact itself, firms can avoid this deadlock situation.

Although Cusumano et al. develop their argument primarily in the context of highly novel as well as sophisticated technologies, there are also signals that access-providing services are of relevance to a much wider range of products. A focus on delivering actual experiences and solutions rather than only artefacts is the common denominator in perspectives like the experience economy by Pine and Gilmore (1999), the service-dominant logic that Vargo and Lusch (2004) developed from predominantly a marketing angle, and more recently the sharing economy (Botsman and Rogers, 2010). According to the latter, modern societies are heading for becoming an economy in which the possibility to use functionality is overtaking the importance of actually having the artefact that is providing that functionality. Popular examples of markets where the sharing economy is disruptively challenging the 'old economy' include the music industry (e.g. iTunes and Spotify) and the car industry (Cohen and Kietzmann, 2014; Frenken, 2014).[52] Any actor involved in offering access to assets is essentially engaging in service provision. Despite the fact that this development looks highly promising, economically as well as environmentally, it is not always clear which kind of sustainable business model fits best with such alternative way of creating and capturing value.[53] We do note, however, that also the currently booming interest for business model innovation (e.g. Teece, 2010; Chesbrough, 2010) is yet another perspective in which companies are encouraged to find new ways to create value for and with their customers (Witell and Löfgren, 2013). Often, such business model innovations rely to a large extent on service provision (Kindström, 2010; Visnnjic and Van Looy, 2013).

52 A related development is the widely encouraged pursuit of circular economies, which also is expected to give rise to an increasing demand for maintenance and repair services as well as inventive reuse.

53 It has also been argued that the shift towards accessing functionality offers possibilities for large scale technological and economic transitions to take place. Highly interesting in this respect is, for instance, the diffusion of the electric car. Car manufacturers might see this is a new but related activity. Still, it is possible that being successful in this market requires them to find models through which customers can get familiar with this type of vehicle before actually buying it. Development of the electric car and an access-based economy coincide at this point.

In order to succeed in introducing novel service propositions that unite distant knowledge bases – be it a pure service or a substitution service - , firms require capabilities that are different from the ones needed for regular service provision (Den Hertog et al., 2010). Again, this marks a contrast with the kind of competences and knowledge that is deemed necessary for the first type of service-based cross-specialization. The capacity for firms (and ultimately industries) to stay adaptive relies on the presence of dynamic capabilities, which are believed to be of a higher order than the capabilities and routines allowing a firm to perform its regular business activities (Teece et al., 1997). As shown in Part 2 of this thesis, and especially in Chapter 4, many authors have been looking into the question which dynamic capabilities are of most relevance for service innovation. Rather than continuing the ongoing efforts of identifying new (sets of) service innovation capabilities, we have taken up the perspective of investigating which capabilities are relevant under which conditions. One of our findings, for instance, is that providers of business services who engage in a high level of openness benefit most from having a conceptualizing capability (Chapter 5). This is a sharp contrast with regular business service providers, for whom a capability for sensing technological options was found to be of major importance for sales derived from innovativeness. Also, we demonstrated that the dynamic capability for sensing user needs might even have negative effects for innovation-pursuing service providers (Chapter 6). These findings show that firms engaging in service innovation should consider focusing their efforts on different innovation capabilities than those who stick to selling artefacts.

Despite the fact that the service-knowledge for this type of cross-specialization differs from the kind needed for mere ‘servitization’ (type A), the same logic applies with respect to the opportunities for knowledge exchange. Whenever firms form certain service or manufacturing industries pursue breakthrough innovations, driven by the combination of unrelated knowledge, they might benefit from having a solid understanding of how to develop and implement service-based business models. The fact that innovation theory and practice are largely oriented towards good-based innovation is to be regarded as a serious threat for economies to succeed in transforming itself.

C. Indirect linkages based on societal challenges / horizontal technologies

Apart from relying on direct interactions between actors from unrelated industries, knowledge exchange can also flow through inherently lateral interfaces connecting multiple specialized knowledge bases. This form of cross-specialization is somewhat congruent with the platform approach suggested by Asheim et al. (2011), be it that we are particularly interested in joining up unrelated rather than related knowledge domains. We distinguish two varieties of lateral interfaces: societal or system-level challenges (i.e. the *demand* for solutions), and horizontal technologies (i.e. the *supply* of technological opportunities).

Even when engaged in only economic or innovation affairs, most of the issues policy makers are facing are not orderly related to distinct industries. Rather, policy reality consists of challenges that occur at the level of the entire economic system. These challenges can concern, for instance, issues like education, unemployment, entrepreneurship, or environment. With the launch of the European framework programme Horizon2020, European innovation policy is increasingly being oriented towards societal challenges of a complex nature. Problems related to health, energy or climate demand solutions in which a wide variety of disciplines is involved. The resulting fact that system-level themes stretch over a broad range of industries implies that there are ample opportunities for actors from disparate industries to interact with each other. A topic like health might involve firms from industries as different as robotics, chemicals, web-solutions, and so forth. Whereas a regular branching process might lead those firms to pursue their idiosyncratic trajectories, being involved in fighting societal challenges can expose them to knowledge from domains they would otherwise never look at. The cross-specialization that thereby could occur is arguably more indirect than the types emerging from mutual learning (cf. type A and B).

Of particular relevance for the current context is that practically every system-level solution asks for the integration of technology and services (Gallouj et al., 2014; EPISIS, 2011). Only rarely can technology alone be an answer to grand problems: the way it is being offered is at least as important. In many cases, including examples like tele-medicine or cradle-to-cradle construction, services are a crucial element of the solution that is being provided (Windrum and Garcia-Goñi, 2008). For this reason, scholars have started to investigate topics like product-service systems (Rapaccini et al., 2013; Baines et al., 2007). Such studies aim to create a better understanding of how artefacts and human skills can jointly create value. The recognition that many solutions and propositions rely on a balanced configuration of a diverse set of elements, including but not limited to those of a technological nature, also resulted in multidimensional conceptualizations of what such solutions consist of (Gallouj and Weinstein, 1997; Den Hertog, 2000). In Chapter 2 and 3 of this volume, we devoted attention to the interdependencies that might exist between the six dimensions introduced by Den Hertog et al. (2010). Although our explorations concerned firms' individual offerings rather than society-wide service systems, the studies do point out that technological aspects are only one of the elements that can make up a proposition. In fact, neither the introduction of technology nor a change in the actual service concept (i.e. the very solution or experience that is being offered) was found to be crucial elements in our cases. Mapping which elements are involved in a certain innovation proves to be a useful way for going beyond simple distinctions of product- and process innovation (which are not applicable to services anyway, according to authors like Hauknes, 1998), thereby allowing one to get a more comprehensive view on which modifications actually constitute a new solution. Moreover, not only do service-specific elements like an organizational delivery system and customer interaction modes also matter: all of the dimensions are found to influence each other's functioning. The immediate implication for both policy makers and firm managers is that they need to overcome any technology-bias that might prevent them from looking at the service-side of possible answers to challenges - be it in a business or societal context. Awareness about the importance of services is a start, understanding interdependencies a useful next step.

The second type of lateral interface is formed by horizontal technologies. In section 3.1 of this chapter we already introduced the idea that generic technologies like GPTs are regarded as factors that might lead the knowledge bases of unrelated industries to converge. Equally interesting are the kind of research facilities that are of relevance for the development of knowledge that can be applied in very different contexts. This can range from facilities for very fundamental research, to laboratories for testing new materials and applications for 3D-printing. The latter is in fact an example of a research facility for something which might become a general purpose technology, since 3D-printing is already being used for fabrication of medical implants, houses, and even weapons.

Just like in case of the broad societal themes, horizontal technologies mark a possibility to unite actors from different knowledge domains. Rather than contributing knowledge for creating solutions to grand challenges, the focus of parties involved now typically lies on the shared wish to develop and especially utilize the opportunities of these technologies (Gambardella and McGahan, 2010). For a topic like advanced imagery, for instance, one can easily imagine a scenario where firms from very different spheres enjoy the benefits of jointly investing in facilities like microscopes and corresponding software. Again, learning effects can occur at various sides. Experience with using these facilities for various purposes can in the first place lead to improvements in the hard- or software. Secondly, and more interestingly, the fact that parties from diverse spheres interact with each other increases the chance that they learn from each other's experiences with the technology, or any other knowledge that might flow once linkages are established (Asheim et al., 2011).

Essentially, this last type of cross-specialization can be regarded as a variation on smart specialization (Foray et al., 2009). The core idea of smart specialization is to use GPTs for revitalizing industries in which a region has traditionally been excelling. A famous example is the use of nanotechnology in the Finnish pulp and paper industry (Foray et al., 2009). The kind of specialization that is envisaged here goes one step further, since the focus is at using generic technologies not only for boosting traditional industries (individually), but also for linking them to each other.

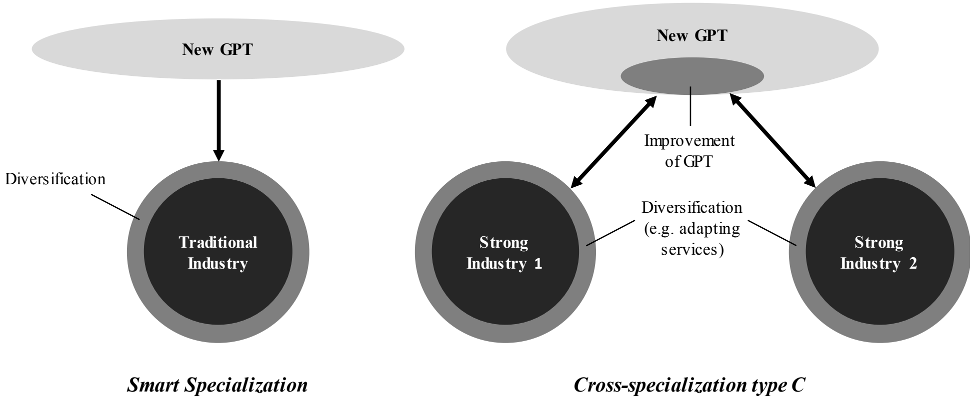


Figure 8.4: Cross-specialization type C (knowledge recombination through indirect linkages, e.g. generic technologies) as opposed to smart specialization.

Horizontal technologies, including GPTs, research facilities and knowledge platforms, in the end are only valuable when fitted to needs of particular markets (Gambardella and McGahan, 2010). Technologies can be adapted to specific conditions through extending services (Cusumano et al., 2014), consisting of efforts to customize a technology for being applied in a non-standard situation (in so far standard situations are actually existing). Services of this kind are designed to give a new functionality to a technology; a use that does not automatically emerges when a technology is placed in the context of a certain industry. Making technology work for such an industry requires knowledge-intensive customization and integration work (Cusumano et al., 2014; Murmann and Frenken, 2006).

To give an example of a leading firm that has been able to use a generic technology for transforming its business, we take another look at the ongoing transformation going under the label of Industry 4.0. The wide adoption of the underlying technology could nominate the internet-of-things (or sensor-based connectivity) as a GPT. As argued earlier on, success of connecting artefacts to the internet depends on question whether one can create value out of it. In the section on the first type of cross-specialization, we pointed at possibility for firms to use this information exchange for monitoring the use of their products, for instance in order to provide better maintenance services. This is an advanced version of a very basic service concept, which can be applied in a wide range of products. The reason why the development is so interesting, we reckon, is that it can also give rise to far more original ways of creating value. The 'Real time navigation' case from Chapter 3 is an excellent example in that respect. Initially, TomTom equipped her PND's with SIM-cards in order to provide live navigation services. Once there was actually a fleet of connected PND's driving around, TomTom also had a basis for making broader use of the data that is being transmitted by those navigation devices.

Apart from serving her own purposes (e.g. optimizing travel time predictions), the data is being commercialized in the form of information services supplied to for instance gas stations and authorities.

A broad collection of other examples of how horizontal technologies can be used for creating a variety of services is provided in Chesbrough's book on open services innovation (2011). Although the title of this volume might suggest it concerns open innovation *in* services, a large part of the work is devoted to illustrating how organizations with technological assets can open up *through* service provision.[54] For instance, Chesbrough discusses the case of the Taiwan Semiconductor Manufacturing Corporation (TMSC), which opened up by letting other firms using her foundry. This move gave TMSC the possibility to provide a wide range of extra services (related to testing, design and configuration) in addition to her regular business activities. Also, it gave her valuable insight in the issues her clients where dealing with. In case a certain facility is owned by a public rather than private organisation, roughly the same principles apply. Whenever multiple organizations can benefit from using the same technology, this opens the door to creation of solutions for serving one or multiple of these organizations, as well as for knowledge flows that can result in the creation of new products (be it of a tangible or intangible nature).

In sum, we expect adapting services to be highly relevant for the exploitation of horizontal technologies like GPTs and research facilities. Once such technologies start becoming accessible for wider use, they can only drive economic transformation when firms start to experiment with how to get market value out of it (Gambardella and McGahan, 2010). This requires that the technology is used for shaping functionality, preferably of the kind that is applicable in different contexts. The more functionality one manages to create, the more investments in horizontal technologies will be viable for both their producers and users. By pointing at the importance of extending services, we underline that services are also a key factor in this type of indirect or platform-based cross-specialization.

8.4.3 Governing service-based cross-specialization: creating synergies

Based on the belief that knowledge recombination from well-developed but unconnected industries holds a particularly strong potential for successful economic transformation, we introduced the notion of cross-specialization. By definition, cross-specialization implies bridging seemingly unrelated knowledge bases. When such knowledge brokerage is insufficiently supported by a system's existing knowledge infrastructures, including private organisations like KIBS, public authorities might consider to fill structural holes themselves. Our discussion of the forms of cross-specialization points at two

54 See chapter 5 and 6 of this thesis for more discussion on the link between open innovation and service innovation.

types of interfaces policy makers can use for creating service-based linkages between specializations.

Distributing knowledge on services and service innovation

First, the forms of cross-specialization that are based on converging knowledge bases and mutual learning (notably type A and B) require the existence of a kind of knowledge that can but is not yet linking stronghold industries. Service innovation, par excellence, is considered to be a topic with relevance for a broad range of companies and still largely ignored by policy makers, managers and to a lesser extent academia (Gallouj and Djellal, 2010). Illustrative is the quote that the importance of services is inversely proportional to attention innovation literature has been devoting to it (Baumol, 2010). Even today, scholars note the existence of a cultural and cognitive bias against services (Visnjic and Van Looy, 2013). On this basis, we chose the theme of service-knowledge as a useful example for demonstrating how generally relevant but neglected knowledge can figure as a key ingredient for creating cross-overs between strongholds.

More awareness about the possibilities to use services for transforming businesses and sustaining competiveness can bring firms and industries closer to each other. Paradoxically, the observation that pre-eminently service provision allows firms to distinguish themselves also implies that a wide range of firms can be expected to engage in processes of obtaining service-knowledge. Although the kind of relevant services might differ across firms, there is still a large body of knowledge that will be of similar relevance to any organization making the switch – be it partially or entirely (Consoli, 2007). The fact that organizations from disparate knowledge domains increasingly rely on service-knowledge implies that their cognitive distance is being reduced on some accounts. It is even possible that organizations exchange lessons and experience in the very shift towards developing more service-oriented activities. These knowledge flows, and the ones that might possibly follow, then form a first basis for recombination of components originating from so far unrelated fields. True combinations of deep knowledge are not so much to be expected when services are only delivered ‘around the product’, but especially in those occasions where service delivery starts to lay at the heart of a firm’s business activities.

In the previous section, we addressed for each form of cross-specialization which particular kind of service-knowledge is of importance for the associated types of diversification and innovation to take place (see also third column in the table in Appendix J).

As for knowledge on *business models and service concepts*, we stress that firms in traditional manufacturing industries can benefit from more insight in the alternatives for making services part of their product portfolio. This requires some familiarity with various sorts of service-based business models. One way to get a more comprehensive understanding of how services could look is by considering them as multidimensional systems (Den Hertog et al., 2010). In Chapter 2 and 3, we showed that such a multidimensional conceptualization can easily be applied to services from very different industries. By mapping heterogeneous services on the same framework, we provided empirical illustration of the various dimensions that make up a service. Moreover, we claim that each dimension can be manipulated according in novel ways, but also in ways that are relatively standard. Being aware of these dimensions and archetypical mutations is argued to be of guidance in the search for new service solutions. Also, a broader understanding of what innovation encompasses can help policy makers and managers to overcome a technology bias.

The second type of relevant knowledge concerns *capabilities for service delivery and innovation*. A major challenge for servitizing firms is to adapt their organization towards an increased service-orientation. As noted, various authors have investigated the capabilities that are useful in this respect. The literature review in Chapter 4 demonstrates that some sets of innovation capabilities are direct service-adaptations of frameworks developed in the context of manufacturing. Some scholars follow a different strategy, and propose innovation capabilities specifically for selected service industries. In the context of cross-specialization, however, it is particularly worthwhile to look at the approach which is focused at conceptualizing capabilities for service innovation in a wide range of industries (including manufacturing). Such a framework was proposed by Den Hertog et al. (2010) and operationalized in Chapter 4.

Both types of service-knowledge form a basis for creating cross-industry linkages. In order to exploit the potential of this convergence factor, governments face the task of spreading the service-knowledge across firms and industries not yet convinced about (or familiar with) possibilities to use services for transforming their businesses and sustaining their competiveness. More specifically, the main implication for policy makers is that they are encouraged to spread service-thinking in order to broaden the possibilities firms consider when adapting their businesses. It is up to policy makers to ensure that the idiosyncrasies of service innovation are sufficiently covered in instruments for supporting entrepreneurship and innovative behaviour. The finding that a wide variety of service innovation policy instruments has been developed over the years (Miles, 2007; Rubalcaba et al., 2006) indicates that selecting an appropriate intervention is far from a straightforward exercise.

As outlined in Chapter 7, there are four options for making service innovation part of innovation policy. Traditionally, innovation policies are largely oriented towards technological R&D. A common way to overcome this is by adapting such instruments towards the domain of services. The result of such an assimilation strategy is a policy measure that is sector-neutral and highly generic. Alternatively, following a demarcation approach, policy makers can honour the claim that services firms innovate in a fundamentally different way. This is typically done by deploying measures that explicitly address the peculiarities of a certain service industry. In the pre-synthesis approach as developed in this thesis (see Chapter 1), the focus lies on collecting all insights on the nature of service innovation activities - whatever industry they stem from – in order to advance innovation in any other part of an economic system. Associated policy measures focus on interventions that spur the knowledge diffusing and innovation-generating potential of services. Finally, the post-synthesis approach concerns policy measures in which goods-based and service-based innovation dynamics are addressed in an integrated manner.

If policy makers are to use service-knowledge as a means for making unrelated industries related, the assimilation approach is only of limited value: solely broadening measures to the domain of services is unlikely to truly increase service innovation awareness. The demarcation approach is neither a suitable option: by looking at service industries in isolation, this 'vertical' approach is by definition not an ideal candidate for creating cross-industry linkages. The post-synthesis approach seems already considerably more suited, since it considers services as an inherent part of all sorts of industries. Nevertheless, also this approach is focused on specific domains (be it thematic rather than industrial). What remains is the pre-synthesis approach, as pre-eminently this way of dealing with services is focused on infusing firms from other industries with service-knowledge. According to the OECD (2012, p. 168), embedding service innovation in the overall innovation policy mix is increasingly regarded as a matter of "finding common policy levers across service activities". Our pre-synthesis take at this view is that the leverage should not concern just the activities in service industries (as demarcationist would propagate), but service activities in any kind of unrelated strongholds.

Looking at actual policy measures related to service innovation, we see that some authorities have implemented interventions fitting the pre-synthesis approach. Notable examples of policies in which services form the interface between distinct industries (although not necessarily strongholds) are the service-lab by NESTA and the service factory by Fraunhofer SCS. Also, in the comparative case-study from Chapter 7, we paid extensive attention to developments currently taking place in the Limburg region (The Netherlands). Collaboration between regional government, universities and private companies has led to the establishment of initiatives like the Smart Services Factory, the Smart Services Hub, and Service Valley (including a Business Services School). Founded by Océ-Canon, the latter used to be focused on document services only, conform a demarcation approach. Recognition for the relevance of her knowledge for a wider audience of firms has led the former Document Service Valley to drop this specific focus, thereby shifting towards the pre-synthesis approach as well.

Facilitating platforms and platform-based services

Second, policy makers can establish lateral interfaces that contribute to knowledge development in different industries. When introducing the third type of cross-specialization, which follows the platform approach suggested by Asheim et al. (2011), we argued how both societal themes and horizontal technologies have a potential for creating interactions between distinct industries. The main challenge for policy makers is to create and manage interfaces that invite parties to actually interact with each other. A starting point, therefore, is to forecast which policy field (challenge, technology, 'megatrend') lie at the intersection of a region's key assets (Asheim et al., 2011).

In reality, policies for horizontal technologies like GPTs are often organized at a national and generic level, as also recommended by Frenken et al. (2007, p. 698). Such an approach neglects the fact that there is a select number of industries with a particularly high economic potential. Reversely, some policy schemes only support themes like GPTs only in the context of individual industries, which then again ignores the fact that they have a horizontal nature (implying they are relevant to wide range of economic activity). The 'golden middle road' for policy makers, we have been arguing throughout this chapter, lies in supporting horizontal themes in particular in the context of specializations.

By looking at horizontal themes in the context of multiple specializations, stakeholders can reap benefits stemming from scale economies. These benefits can emerge when multiple parties join their efforts on building knowledge with relevance for the horizontal theme. In technological spheres, this can be achieved through establishing research facilities like knowledge centres on nano-technology or labs for 3D-printing. In order to make sure that the jointly developed knowledge is still relevant for the particular contexts of the parties involved, it is advised that the facilities are designed for a limited range of firms only. As noted before, the most attractive candidates here are parties active in local stronghold domains.

Furthermore, joint initiatives for developing knowledge on horizontal themes can also benefit from economies of scope. By definition, knowledge and experiences related to a horizontal theme have a high potential for being applied in other domains. Central places for co-developing knowledge can thereby play an important role in exchanging and combining knowledge that can later be commercialized in other markets. It is especially in this trajectory from using a technology to providing a product where services enter the picture. Both substituting services as well as extending services might prove an attractive way for making technologies relevant to actors from diverse backgrounds, and helping them to create and capture value.

Coming back to the classification of service innovation approaches, this form fits mostly with post-synthesis. Only setting up platforms and waiting for services to emerge would be more assimilation-like, since a truly integrated approach requires the respective roles of technology and services to be well-considered. Likewise, when the role of service knowledge is heavily emphasized, elements of pre-synthesis would appear. Such a policy design is not unthinkable, since we pointed at several reasons why platforms can benefit from the in- and outflow of service-knowledge and expertise.

8.5 CONCLUSIONS

Besides placing the findings from earlier chapters in a wider perspective, thereby serving as a synthesis as well as an outlook, this chapter also has some contributions of its own. These are specifically related to the goal of finding an alternative way for policy makers to capitalize on traditional stronghold industries. A major caveat in this respect is the danger of confusing the status of specialized knowledge bases: instead of being a basis for future competiveness they sometimes only are the result of past excellence in certain domains. In order to sustain the success of path-dependent configurations of knowledge, experience and institutions, policy makers need to identify ways for making stronghold industries adaptive to changing market circumstances.

The proposition we make is that special opportunities reside in linking strong but unrelated knowledge bases. Since multiple domains can contain deep knowledge, recombining these used components unites the advantages of being well-positioned to identify anomalies and being highly familiar with components on the one hand, with the breakthrough potential of recombining unrelated knowledge on the other hand. Whether these propositions hold empirically remains to be tested.

Regardless if such form of knowledge recombination can truly be proven to be more successful than random knowledge recombination, we then provided insights on the evolution of relatedness. So far, this topic has hardly been touched upon in the literature (Castaldi et al., 2014; Neffke et al., 2011). This chapter, building on a wide body of studies on service innovation, provides specific pathways for future research on the dynamics underlying regional diversification.

Our claim that service-knowledge forms an excellent convergence factor is built on the widely accepted view that service innovation is just as much relevant for and neglected by a large share of economic actors. To a certain extent, this is a reflection of the fact that also in academic debates regarding evolutionary theories of economic and technological change, the role of services remains modest. Such ignorance can be harming successful economic diversification and scientific progress. As for the latter, most existing studies (also in this thesis) aim to use innovation theory for understanding service creation better rather than the other way around. The provided views on the role of services in industrial evolution therefore form a contribution to efforts of advance service innovation thinking towards all-encompassing theories. With respect to debates concerned with service innovation policy, we specifically stress our ambition to go beyond considerations of what particular service firms have to offer (e.g. KIBS) as we focus primarily on the relevance of service-knowledge for any kind of firm.

The respective potential of various kinds of service-knowledge is believed to depend on the way unrelated domains can be linked to each other. We introduced three forms of cross-specialization, all of them having the potential to spur the kind of knowledge flows that can drive economic differentiation. Specifically, policy implications associated with the various types of cross-specialization aim to exploit the existence of different specialist knowledge bases (developed through a path-dependent sequence of knowledge generation and application) by supporting uncommon but relatively promising forms of knowledge recombination. Compared to a backing winners approach, in which policy makers select a number of industries which will receive policy attention, focus on the intersection of strongholds might lead to a greater amount of variation in a region's overall knowledge base. While 'classical' industrial policy risks overlap with respect to the industries that are being regarded as unique, this problem holds less for the linkages between them (given that the number of possible linkages exceeds the number of industries). Moreover, Jacob's externalities suggest that exploration of novel knowledge combinations makes an economy more robust (future-proof) than exploiting the knowledge that proved to be successful in market conditions that might not last forever. In sum, cross-specialization tries to combine advantages of unique hard-to-imitate knowledge bases with the evolutionary imperative of increasing variation. Thereby, our propositions fit in ongoing efforts of using evolutionary economics as a basis for policy formulation (Schubert, 2014).[55]

To conclude with options for future research, we emphasize the need to verify our statements on the promises offered by cross-specialization. This involves in the first place a thorough test of the question whether firms or industries at the intersection of strongholds indeed perform exceptionally well (see Appendix K). Even meanwhile evidence for the alleged benefits of cross-specialization remains lacking, our comments on convergence-potential of services could still be of relevance. To our knowledge, few of the claims for service innovation policy have stressed why specific policy attention is required (an exception being the studies on market and system failures, e.g. Rubalcaba et al., 2010). The main question following from our claims on the diffusion of service-knowledge is how governments can succeed in creating service-based linkages between

55 We do acknowledge that a policy approach directed at exploiting the knowledge of particular industries (and also the idea of promoting the use of service-knowledge) seems to be at odds with the laissez-faire approach that is usually suggested by evolutionists. Two nuances can be given on this account. First, we build on the evolutionary-inspired principles of considering related variety when searching for ways to exploit a region's path-dependent configuration of knowledge and institutions (cf. Frenken et al., 2007). In fact, we extend this view by arguing how also unrelated knowledge bases can be used for creating novelty (Fleming, 2001; Castaldi et al., 2014). A focus on overcoming cognitive distance between disparate knowledge bases is substantially more evolutionary than the classical way of industry-policy. Second, our policy suggestion aimed at spreading service-knowledge concerns an extension (rather than a narrowing) of the options firms take into account when experimenting with novel propositions. Bringing services under the attention is essentially a very weak form of libertarian paternalism (Schubert, 2012), in which firms remain all the freedom to decide whether they respond to it or not.

unrelated industries. Also non-service based linkages remain to be investigated. A particularly relevant question is how to prioritize which specific intersections to address, given that most regions or states have more than two stronghold industries. Similarly, also the choice for a certain horizontal technology or system-level theme requires sound deliberation. One option to explore here is use technological roadmaps for identifying suitable candidates (Phaal et al., 2004). Probably needless to state, we argue for explicitly including the role of services in these roadmaps.

APPENDIX I: THE RELATION BETWEEN RELATED AND UNRELATED VARIETY

Related and unrelated variety are often thought of as opposites. However, by referring to different levels of hierarchy, the two types of variety essentially are "orthogonal in their meaning" (Castaldi et al., 2014). Indeed, multiple studies show they tend to be empirically correlated (Boschma and Frenken, 2011). These studies typically operationalize relatedness by looking at the concentration of economic activity according to hierarchical industry classifications like NACE and SIC.

Figure I.1 shows four extreme combinations of unrelated and related variety. In the lower left corner, one finds the situation where almost all economic activity is concentrated in main sector A. In this economic structure there hardly are any firms in the other unrelated sectors: main-level heterogeneity (i.e. unrelated variety) is very modest. Looking at lower levels of aggregation, the minor degree of distribution of economic activity over the subsectors (industries) means that the present firms are relatively similar to each other. The high share of firms in sector A is distributed over two subsectors, which we regard as being related, but apart from that most firms do not operate in an environment where there is a lot of economic activity in neighbouring subsectors. The degree of related variety is thus low as well. Related variety is higher when activity in one main sector is more distributed over the constituting subsectors. Similarly, unrelated variety increases when a substantial share of firms is active in other main sectors.

The fact that regions can be specialized in multiple unrelated domains holds important policy implications. A conventional approach, as noted, is to enhance the competitiveness and exploitation of such stronghold industries by nurturing further development of these distinct specializations. From an evolutionary perspective, the development of specializations would mostly benefit from having access to knowledge that can be used for innovative recombination.

Let us assume that a high concentration of economic activity in Figure I.1 marks a stronghold domain.[48] In the upper right quadrant, we have economic structures where such knowledge is available for actors in strongholds A1 and B1. Because there is a high level of related activity within their respective industries, those actors operate in the presence of parties with adjacent knowledge bases. The interactions that can naturally occur then form a basis for knowledge recombination within the stronghold industries.

The situation is different for economic structures corresponding with the upper left quadrant of Figure I.1. Here we also find multiple strongholds (A1, B1 and C1), but the high degree of concentration within each of the main sectors leaves relatively little

56 Scientific, technological or even economic strength (e.g. export potential) in a certain domain do not necessarily imply that this domain also accounts for a large share of an economy's employment or output. Our simplifying assumption only serves to clarify how possibilities for knowledge exchange differ per quadrant.

opportunities for generative knowledge exchange. The only knowledge that is locally available stems from industries with an entirely different knowledge base. If we ignore knowledge inflows from elsewhere, the present specializations can only be enriched with knowledge from another stronghold.

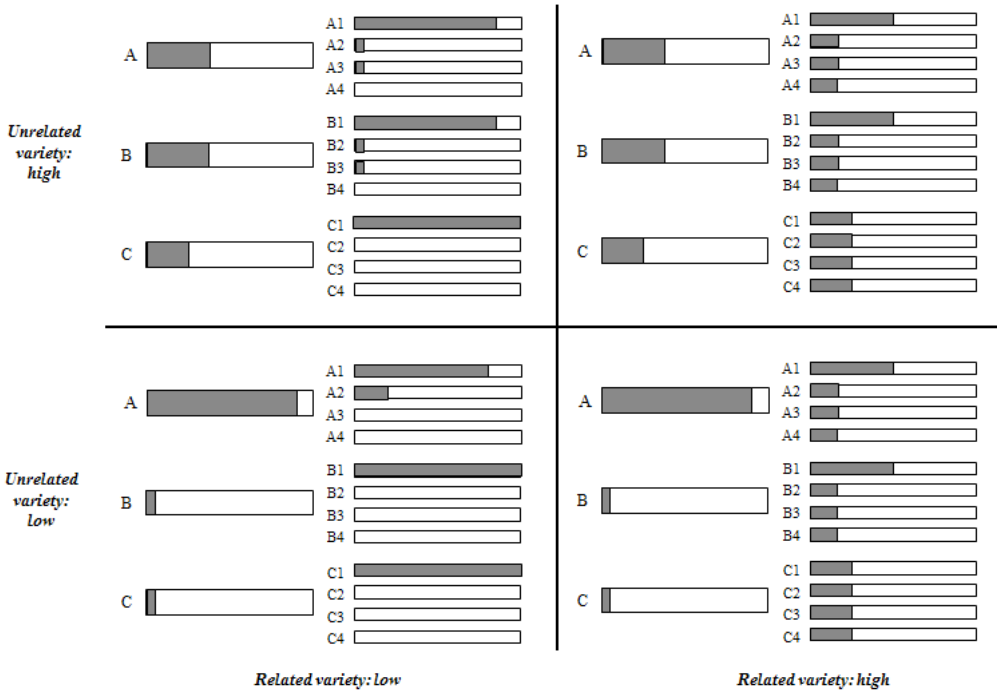


Figure I.1: Matrix with four combinations of related and unrelated variety. Bars represent how economic activity is distributed over three main sectors (together 100%), and over their respective subsectors (per sector together 100%).

APPENDIX J: CROSS-SPECIALIZATION FORMS AND RELEVANT SERVICE-KNOWLEDGE TYPES

Form of cross-specialization	Description	Type of service-knowledge that can link unrelated industries
A. Direct knowledge exchange leading to related products	Firms within an established stronghold industry diversify by using knowledge from other (unrelated) stronghold industries.	*Business models / service concepts* Diversification of mature (manufacturing) industries often involves a **shift towards service provision**. Although provision of smoothing services* can already be new, firms can also search for more original propositions. Seeing similarities between distinct industries might give inspiration; firms can **adopt service concepts** from seemingly unrelated contexts. Unfamiliar service concepts can also be combined in 'total' solutions that are broader than the existing ones. *Skills/capabilities* Firms from different (non-competing) industries can share knowledge on how to engage in servitization. Of key importance are insights in the **organizational transformation** required for **service delivery**.
B. Direct knowledge exchange leading to relatively unrelated products	Recombination of knowledge from unrelated industries can lead to niche emergence. The resulting breakthrough product/market is not adjacent to activities of the involved industries.	*Business models / service concepts* 1. The new product might be an **entirely new solution or experience**, built on knowledge from stronghold industries. This would concern a service concept that is uncommon in any of industries present within an economic system: the new service itself is then the link between strongholds. 2. Even if the niche concerns the market for an artefact, the first and perhaps only commercialization of that technology might have the form of giving **access to its functionality**. Substitution services* reduces the necessity for clients to acquire a (new) product. *Skills/capabilities* Developing novel services requires **innovation capabilities** that differ from those needed only for the mere production of services. Because of the importance of intangibility and coproduction, service innovation draws upon different (accents in) abilities than goods-focused innovation.
C. Indirect linkages based on lateral interfaces (system-level themes / horizontal technologies)	Unrelated industries jointly contribute to (and benefit from) developments in fields and technologies that span over industry boundaries.	*Business models / service concepts* 1. System-level themes like societal problems demand solutions in which **technology and services are integrated** (cf. **product-service systems**). 2. Horizontal technologies (including production/research facilities) are only valuable when fitted to the needs of a particular market. Adapting technologies to specific conditions can occur through **extending services***. These consist of efforts to customize a technology. Increased functionality makes investments more viable for both their producers and users. *Skills/capabilities* Developments related to system-level or horizontal themes build on an **understanding of interdependencies between technology and services**, which requires firms as well as policy makers to be aware of potential of services and to **overcome technology-bias**.

* For the taxonomy of smoothing services, substitution services and extending services: see Cusumano et al. (2014).

APPENDIX K: CROSS-SPECIALIZATION AND STRUCTURAL HOLES: THE CASE OF THE DUTCH TOPSECTORS

Cross-specialization is a matter of creating interfaces between disparate knowledge bases. Some knowledge bases contain components that have been used already in a wide variety of applications (Fleming, 2001). Such knowledge bases form unique assets for the current competiveness of an economy, but not necessarily for the future. The suggested way to identify promising forms of economic transformation consists of offering policy support for facilitating the recombination of used but (so far) unrelated components.

The technological relatedness of industries can be represented as a network. The nodes in the conceptual figure below refer to industries: a bigger node implies that an industry is performing better (economically and/or scientifically). The strength of the ties signals how related two industries are. Relatedness is usually measured by looking at trade-flows or co-citation in patents. Existing research often focuses on identifying optimal cognitive distance (e.g. closeness centrality, Neffke et al., 2011). Rarely, to our knowledge, do they take into account the economic significance of an industry.

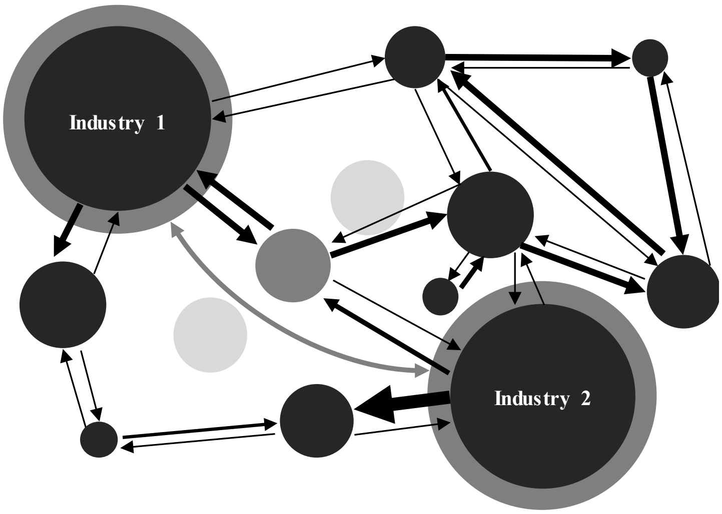


Figure K.1: Representation of cross-specialization as closing a structural hole. Node size represents economic/scientific importance of an industry; tie thickness stands for degree of relatedness between industries.

The theoretical arguments underlying our notion of cross-specialization imply that promising innovation opportunities reside in industries that are connecting unrelated but highly competitive knowledge domains. Firms nested in such 'structural holes' in the industry space can be expected to have a relatively high potential of identifying breakthrough innovations. This led us to suggest that policy makers should be concentrating their support on (overcoming the coordination problems that hamper) the emergence of cross-specialized niches, rather than on the existing specializations themselves. A problem here, however, is that it is hard to know beforehand which niches will emerge out of the interaction between specialized industries. What policy makers can do, we argue, is to investigate which industries have a knowledge brokering position in the existing industry structure. As firms in these cross-over industries are well-positioned for translating knowledge from one specialization to another, they might be important to involve in efforts aimed at creating cross-specialization interfaces (e.g. a joint innovation agenda, a shared research or production facility, a campus, a service innovation lab, a service delivery program, etcetera).

Which industries are cross-overs?

The main text of this chapter is focused on *why* and *how* policy makers can benefit from a (possibly service-based) cross-specialization strategy. Building on the observation that some industries are well-positioned to be involved in bridging strong but unrelated knowledge domains, we use this Appendix to discuss the issue of identifying such industries. Following from the logic described above (see also Figure K.1), which industries have a cross-over position can be determined by calculating cross-over centrality measure X:

$$X_i = \sum_{j}^{n} S_j * R_{i,j}$$

- X_i is cross-specialization-index for industry i.
- S_j is 'size' (economic/scientific importance) of surrounding industry j

  (j ranges from 1 to n).
- $r_{i,j}$ is relatedness in product space (between industry i and j).

The presented formula is based on the idea that specializations are covered by individual industries. In practice, most countries having industry policy focus on stronghold 'sectors' (or clusters) consisting of a number of closely connected industries. This implies that the most interesting cross-overs are not simply the ones linking unrelated but strong industries, but rather those who link unrelated but strong industries *from different stronghold sectors (clusters).*

In the sections below, we provide a tentative exploration of the cross-specialization logic. Specifically, we demonstrate how centrality calculation can be applied to identify cross-over industries in the context of an economy containing stronghold sectors. Already in the main text it was noted that the Netherlands are amongst those countries adhering to industry policy. Although the innovation policy mix also contains a large generic part (mainly tax incentives), the past few multi-annual R&D&I-programmes were marked by a specific focus. As of 2011, the government is supporting innovation in a total of 9 excellence domains. These so-called Topsectors were selected through a bottom-up process in which public and private actors could present themselves as candidates. Together, the Topsectors account for about 25% of Dutch firms, 36% of Dutch production value, 25% of added value, 20% of employment, 40% of exports, and 87% of R&D investments (2012 figures).[57] Recently, the linkages between the Topsectors have been gaining policy interest.

Identification of cross-over industries requires a measure for the relatedness between industries. Highly suitable in this respect is the concept of skill-relatedness, which refers to similarities between the skills and knowledge required for economic activity in different domains. While it is common to state that firms in different parts of a value chain share similar knowledge, a skill-based perspective underlines that activities in for example the first part of one value chain are more similar to activities in the first part of another value chain (rather than to activities later in the own value chain).[58] A database for inter-industry skill-relatedness was constructed by Neffke et al. (2011), who analyzed Swedish labour mobility over the period 1969-2002. A follow-up study in Germany has pointed at the robustness of the findings by Neffke et al. (2011), which makes their database suitable for application in a similar economy like the Dutch one (Neffke et al., 2012).

Using Neffke's skill-relatedness data, the network depicted in Figure K.2 represents a part of the industry space of the Netherlands.[59] The nodes (and their colors) refer to which Topsector a certain industry belongs; non-Topsector industries are not shown here. [60]

Due to the bottom-up nature of the selection process, the designated Topsectors are not easily captured by NACE-codes. However, several recent efforts have resulted in lists of which NACE-categories make up a certain Topsector.[61] While there is a slight amount of overlap, most of the Topsectors cover a distinct part of the industry

57 Netherlands Agency for Statistics (CBS) – *Top sector monitoring study 2014*. In Dutch.

58 This explains the emergence of the pattern captured by Shih's smiling curve, as described in Chapter 1.

59 For the sake of clarity and brevity, we exemplify cross-over identification by only using the *outward* flows in the data.

60 Symbols for the Topsectors taken from: Dutch Ministry of Economic Affairs (2013), *Progress report Enterprise Policy.*

61 We draw upon the classification presented in the report by EIM (2012): *Snelle groeiers in de topsectoren.* In Dutch. The industry classification based on NACE Rev 1.1 matches with the NACE-version used by Neffke et al. (2011). The numbers in Figure K.2 and onwards refer to the industries lasted in NACE Rev 1.1, where also the full industry name can be found.

structure.[62] For reasons of clarity, also edges with a skill-relatedness value below 15 and statistical significance above 0.05 have been excluded (see Neffke et al., 2011, for details on calculation of these values). The size of the nodes reflects employment in the remaining industries (2009 figures, CBS). Node position, finally, is determined by a multidimensional scaling algorithm which tries to minimize tie lengths. A result of this technique is that nodes with many ties tend to gravitate to the center of the network graph; we will highlight this when discussing the issue of cross-over centrality.

Looking at the network graph of the Dutch Topsectors, it immediately becomes clear that most of the chosen strongholds consist of a relatively coherent set of industries (in terms of skill-relatedness). The colored circles indicate which type of sector is most dominant in a certain part of the depicted industry space.

The green area in the right-hand side of the graph contains industries from both 'Agri&Food' as well as 'Horticulture & Propagation materials'. This mix is not surprising, as the overlap in Topsector-classifications concerns in particular this part of the economy: all shown horticulture-industries, except Wholesale of alcoholic beverages (NACE 5134), are also part of the agriculture-Topsector. We therefore will refer to the agriculture sectors as if they were one Topsector.

On the left-hand side of the graph we find a relatively homogenous set of industries (with respect to Topsector-type) belonging to 'High Tech Systems and Materials' (HTSM). This set borders to a 'clique' of Water-industries (upper part of the graph) and industries from the Topsector 'Life Sciences and Health' (LSH). According to the skill-relatedness measures by Neffke et al., (2011), professionals in HTSM share relatively a lot of knowledge and capabilities with both Water and LSH, but Water and LSH are not at all related to each other.

Right in between the HTSM and Agriculture sectors, industries from the 'Logistic' Topsector are situated along the vertical axis within the industry space. This reflects the notion that logistic service providers are of relevance to a wide variety of economic activities. Rather than that professionals specialized in transport or storage flow mostly to one particular Topsector, we find that the interconnections of Logistic industries are relatively diversified. For instance, Cargo-handling and to a lesser extent Sea and coastal water transport and Other water transport are found nearby the Water-clique; Storage and processing appears to share skills with the processing and sales of food (i.e. Agriculture-clique); and Logistic-related industries like Activities auxiliary to financial intermediation or to insurance and pension funding (respectively NACE 6713 and 6720) are similar to the activities common in the Creative industries.[63]

62 In the figures each industry has only one color, but in our calculations based on sector types we took into account that some industries have multiple sector types.

63 One could question whether these types of industries are rightly classified as Logistics, but this is no concern for the illustrative purposes of this section.

Together with the Logistics-industry Management activities of holdings (7415), we also find industries belonging to 'Chemicals' in the very core of the Topsector industry space. The relatedness-links of these industries are distributed over a relatively high number of Topsectors as well. This is what causes the Chemical-sector to end up as a circle in the middle of the graph: some chemical industries relate mainly to agriculture, others to HTSM, and yet others to LSH.

Industries classified as 'Creative industry' appear at the lower part of the graph, almost outside the main network. Although one might conclude that creative industries are not related to any other sector at all, the contrary might be true as well. Exactly because skills and knowledge are relevant for virtually every industry, there is no clear pattern of relations leading creative industries to be located near some particular other sector. Compare this with the Logistics and Chemicals sector, both of them consisting of industries mainly having *specific* cross-overs with other parts of the network. As knowledge from creative industries might be of common relevance, the only significant linkages emerging in the data of Neffke et al. (2011) are the ones within the creative domain.

Finally, only two industries from the 'Energy'-Topsector (yellow) have sufficiently high skill-relatedness values to appear in our network graph (SR>15). While Extraction and agglomeration of peat appears to be related to the Agriculture and Water-sectors, Manufacture of refined petroleum products is right in the middle of the graph. Indeed, this sector is adjacent to HTSM, Chemicals, Logistics, and the primary sector activities found in some Agriculture activities.

Not all industries shown in Figure K.2 seem to be part of a Topsector-specific clique. Remarkable exceptions are Manufacture of tractors and of 'other agricultural and forestry machinery' (NACE 2931 and 2932). Both industries are far more skill-related to the HTSM-industries than to the other agriculture industries. Similarly, firms in the industry Manufacture of industrial gasses draw on skill-base more related to Agriculture than to other industries of the Topsector Chemicals.

Now that we have introduced the composition of the Dutch Topsectors, we can assess which industries can be regarded as strategic cross-overs. Our first observations already provide some indications of which industries are boundary spanners. The basic formula discussed above allows for several more variations in the determination of cross-over centrality. We will discuss a number of alternatives while referring to the graphs depicted in the end of this Appendix.

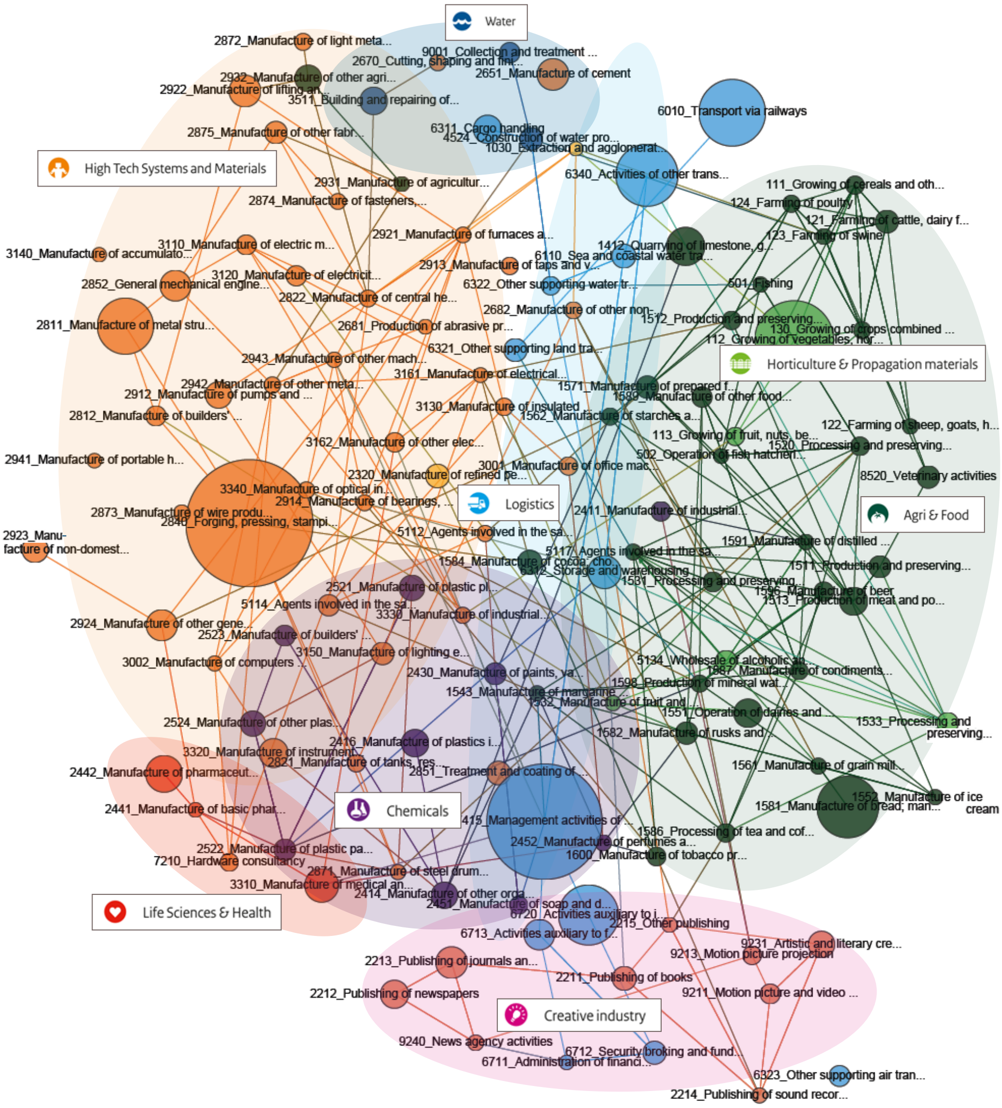


Figure K.2: Topsector industries in the Dutch industry space. Node size represents employment (2009 figures); tie thickness stands for degree of skill-relatedness between industries (SR > 15, p < 0.05; see Neffke et al., 2011).

Cross-over centrality type 1: The product of industry importance and relatedness

Our initially suggested way to calculate an industry's cross-over centrality is by summing the product of the economic importance of the industries it is related to (size 'S') with the strength of the skill-relatedness with these industries ('R'). Essentially this is just a size-weighted version of a regular centrality measure (based on summation of the number or strengths of ties), as captured in the formula introduced earlier on:

$$X_i = \sum_j^n (S_{j1} * R_{j1})$$

In Figure K.3, and in all subsequent network graphs, the calculated centrality values are visualized as an industry's node size. Also, the relative position of the nodes remains equal to the initial configuration in Figure K.2.

What Figure K.3 shows is that the centrally located nodes are typically those deeply embedded in a particular Topsector. The remarkable centrality of the industry Manufacture of metal structures (NACE 2812) exemplifies this rather well. With the exception of some other HTSM-industries, many of the central nodes are located at the edge of the industry space. Likewise, while nodes from for instance the Chemical-sector are connected to a high number of other sectors, there is no central Chemicals-industry to be found in Figure K.3. The provided results also show that being strongly related to one or a few big industries can already be enough for emerging as central. This is for instance the case for industry 6340, receiving it's centrality from its link with large industry 6010. Note that node 6010 is not central, since the network is directed rather than symmetrical (because we only take into account outward skill-flows, as mentioned in footnote 59). Something similar seems to hold for agriculture-node Manufacture of grain mill products (1561). In the upper right corner of the agriculture Topsector, we find four industries boosting each other's centrality due to their strong interconnectedness; all of them concern either farming or growing crops/cereals.

Our findings are consistent with the earlier observations that industries tend to be particularly skill-related to industries of their own Topsector. By defining cross-overs simply as industries having strong links with other (big) industries, we appear to arrive at a measure representing which industry is most central *within* a Topsector. In other words, many of the large nodes in Figure K.3 are only a cross-over between various parts of a single Topsector. Reasoning from cross-specialization logic, our interest lies more at centrality-measures determined by a wider part of the industry space than only the densely interconnected set of immediately adjacent neighbors. This is what we will turn to now.

Cross-over centrality type 2: Connecting unrelated industries

In order to avoid that cross-over centrality is determined by the degree an industry is embedded in a clique of industries sharing similar knowledge, we adapt our centrality measure by imposing a restriction to the node-tie combinations that are being summed. Whenever an industry is strongly linked to two industries that are linked to each other as well, these edges are dropped from the summation. The altered formula, showed and illustrated below, requires us to aggregate (for each industry i) the node-tie products of all combinations of non-closed triangles. This way of measuring centrality fits better with the notion of knowledge brokerage; industry *i* closes the structural hole between industry *j1* and *j2*.

$$X_i = \sum_j^n \left((S_{j1} * R_{j1}) + (S_{j2} * R_{j2}) \right), \text{ in which } Rj_{1,2} = 0.$$

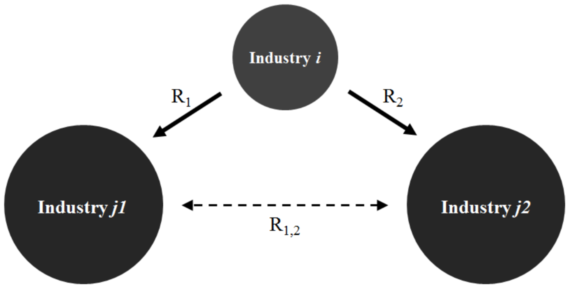
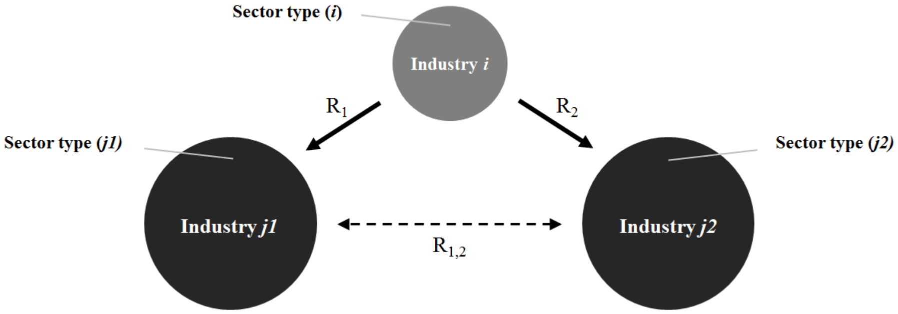


Figure K.4 reveals how the adapted centrality measure results in several shifts in the centrality hierarchy. HTSM-industry 2812 is still relatively central, although overtaken by Manufacture of grain mill products. This latter industry forms the hub between a number of food-industries hardly connected to each other (e.g. manufacture of rusks and biscuits; of ice cream, of fresh pastry goods; of mineral waters and soft drinks). Because the farming and growing industries in the upper right corner are so connected in each other, several of them now have a much lower centrality than before. Another remarkable change is the sudden cross-over centrality of two industries at the core of the graph. Both Management activities of holdings (7415) and Manufacture of perfumes (2452) are now part of most central nodes. As they have links to a wide variety of sectors, and most industries are especially linked to industries within their own sector, these sectors close relatively many triangles in the Dutch Topsector industry space. This result appears also because, although situated very nearby, both industries are not linked to each other.

Cross-over centrality type 3: Connecting unrelated industries of a sector type other than ego

The last centrality measure gave us a better impression of which industry truly lies at the interface of many unconnected but large industries. Yet, by introducing an extra constraint we can still enhance the cross-over identification procedure. The fact that policy support is often directed towards a knowledge domain (Topsector) covering multiple rather than one industry implies that cross-specialization opportunities occur especially in economic activity at the boundaries of these domains. We therefore modify our previous calculation by imposing the requirement that node-tie products are only added to an industry's centrality value when the related industry is of another (Top) sector type. The condition that only brokerage positions count is maintained here, which we express as follows:

$X_i = \sum_j^n((S_{j1} * R_{j1}) + (S_{j2} * R_{j2}))$, in which $Rj_{1,2} = 0$. Type(i) ≠ Type (j), but Type (j1) can be Type (j2).



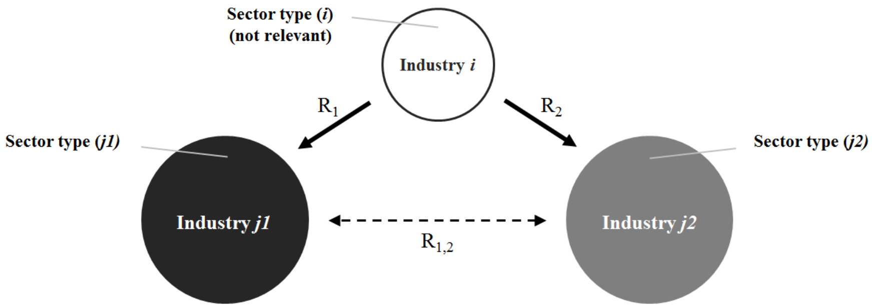
The pattern emerging from applying this third centrality calculation is highly different from the previous ones. Management activities of holdings (7415) and Manufacture of perfumes (2452) turn out to be the most central industries when it comes to being positioned as a cross-over between unrelated industries from different Topsectors. The fact that we do not count linkages with industries of their own Topsectors is hardly of any influence: industries from both Logistics and Chemicals were already found to be relatively dispersed rather than forming a dense Topsector-specific clique.

Figure K.5 also points at the cross-over centrality of the HTSM-industry Manufacture of industrial process equipment (3330). This result is explained by its strong connections with several tool manufacturing industries (2942, 2943, 3110) combined with a link to the fruit growing industry (113). As the latter industry happens to employ many people in the Netherlands, but is not connected to any of the tool making industries, it has a high impact on the centrality value of industry 3330.

Cross-over centrality type 4: Connecting unrelated industries having different sector types

The constraint introduced in the last centrality calculation can also be applied for identifying cross-over industries in an alternative way. Instead of focusing on relatedness-ties with industries having a different type than a focal industry's own, we now ask which industries lay in between industries that are unrelated and heterogeneous in terms of their sector type. Such a measure of 'betweenness centrality' approaches the notion of brokerage in a manner that slightly differs from the previous centrality measure. Whereas the third type of calculating cross-over centrality highlights industries related to especially non-ego Topsectors, this fourth and last type should reveal which industries form the link between large industries from different Topsectors. As the formula and illustration below indicate, a focal industry's own sector-type are of no concern here.

$$X_i = \sum_j^n \left((S_{j1} * R_{j1}) + (S_{j2} * R_{j2}) \right), \text{ in which } Rj_{1,2} = 0. \text{ Type(j1)} \neq \text{Type (j2). Type(i) is irrelevant.}$$



The last network graph, depicted in Figure K.6, appears to be almost identical to the one resulting from cross-over centrality type 2. The constraint that centrality is determined only by bridging industries stemming from different Topsectors proves to be of little influence, given that such linkages are scarce anyway (compared to within-Topsector linkages).

Although the fourth type cross-over centrality seems to be redundant with the second one, there still is a merit to focusing at linkages between different sector types. So far, we only have been looking at industries falling under one or more Topsectors. An interesting possibility for creating cross-overs emerges when we also take non-Topsector industries into account. Examining which of such industries are skill-related to important industries from different Topsectors opens a new perspective on which kind of knowledge to use for making strongholds more alike. Arguably, the skills and knowledge present in cross-over industries not belonging to any Topsector are of relevance for reducing cognitive distance exactly there where fruitful synergies between Topsectors so far fail to arise. As such non-Topsector industries might be overlooked by the joint activities (e.g. strategic R&D programs) set up by any of the individual Topsectors, it is possible that this neglect prevents the emergence of knowledge flows with a high potential for generating breakthroughs innovations or promising niches (see argumentation provided in main text).

Figure K.7 depicts the entire Dutch industry landscape, with node size still representing cross-over centrality type 4.[64] Non-Topsector industries are colored in blue. It is remarkable how many of the most central non-Topsector industries are situated

64 The construction of this measure is based on (Top)sector type. Non-Topsector industries do not have a Topsector-type, so being related to one of them does not contribute to an industry's centrality. However, of course it is possible to calculate the centrality of the non-Topsector industries themselves (while still only counting links with Topsector industries).

somewhere between Agriculture, Logistics, Chemicals, and the Creative Industries. A look at what type of activity is to be found in these cross-overs reveals that all of them are in fact trade industries, the most important one being: wholesale of coffee, tea and spices (NACE 5137), wholesale of meat and meat products (NACE 5132), retail sale of cosmetic and toilet articles (NACE 5233), and other retail sale of food, beverages and tobacco (NACE 5227).

As an exception to these findings, the non-Topsector industry ultimately best-positioned to fill a structural hole between large Topsector industries is Motion picture and video distribution (NACE 9212). Still basing our calculations on employment figures and the skill-relatedness measures by Neffke et al. (2011), we observe that the skills found in this industry are related to unconnected industries from three different Topsectors (and a number of other non-Topsector industries). This is shown in Figure K.8. While the similarity to other motion picture and publication activities is evident, the linkages with agriculture industries are perhaps more surprising. A reassuring result also shown in Figure K.7 and K.8, however, is that also Data base activities (NACE 7240) turn out to be a strong cross-(Top)sectoral link. This last finding is in line with our claims that services based on the collection and analysis of data are an example of activities with a high relevance for a high variety of industries. In the core of this chapter we described various possibilities for using this insight to create interfaces between unrelated sectors. Looking at the Dutch Topsector policy, we find that various instruments have been deployed to encourage especially SMEs in using facilities where they can experiment with novel ICT-technologies (for instance related to big data analysis or the Internet of Things).[65] The purpose of these initiatives is not just to help individual SMEs; by setting those firms together, the government is also allowing them to interact with and learn from each other.

How to benefit from cross-over analyses

Where do all these analyses leave us? Together, the various ways to examine cross-over centrality demonstrate which industry-intersections are particularly interesting when using cross-specialization logic. Industries observed to central in the Dutch Topsector landscape are, amongst others, one from Logistics (Management of holding companies) and one from Chemicals (Manufacture of perfumes). A closer inspection of the industry space reveals that it is not always sensible to focus on entire Topsectors; both the Logistics and Chemicals sector appear to be centrally located because they consist of industries highly related to industries from other Topsectors. For the Creative Topsector it seems that its industries are related to so many other parts of the economy that clear cross-over patterns can no longer be discerned. We also emphasized the importance

65 See: http://www.doorbraakmetmkb.nl/ (In Dutch).

of taking non-stronghold industries into account when searching for bridges between strongholds.

Following the discussion in the main text, we once more emphasize that we do not necessarily plea only for 'vertical industry policy' focused on the cross-over industries: the purpose of this Appendix is to demonstrate how we can get a better view of the skills and knowledge that can be relevant for overcoming unrelatedness between strongholds. While sometimes it might be promising to support knowledge production and application in a centrally located industry, other times it is merely the type of knowledge possessed in this industry that is of importance. An example here is the observed cross-over centrality of 'Database activities'; policy makers can choose to support firms from this sector in their innovation activities (risking that only these firms will appropriate the rents), or policy makers choose to support of the spread of data collection and analysis skills.

As noted in the discussion of policy options (section 4.3), there is a host of opportunities to make actors from unrelated strongholds interact with each other. One of the presented ideas, based on cross-specialization type C, is to establish collaboration around certain horizontal themes (notably societal challenges and multipurpose technologies). These horizontal themes might best be employed when fitted to the context of the specific strongholds that are being linked to each other (see the 'golden middle road', p. 163). The actual design of stronghold-interfaces is therefore likely to benefit from more focused investigations into the particular needs and trends relevant for the specific strongholds involved. While developments like the rise of 3D-printing technologies can affect business practices in any part of the economy, opportunities and needs shared by a select set of industries can perhaps best be unleashed by setting up a targeted rather than universal approach. This is to say, when boosting 3D-printing activities in for instance life sciences and chemicals, this asks for a different approach than policy efforts focused of the adoption of 3D-printing in general.

To conclude, we stress that the cross-over identification procedures presented in this Appendix are only some first explorations. Future research can benefit from the use of more recent data, especially of a type representing better which industries truly matter for an economy. Instead of dealing with employment figures, like we did, one could think here of data on added value, exports, profits, investments, etcetera.

Secondly, as the NACE classification is an international standard, it is recommended not just to look at absolute figures. Benchmarking the performance of industries against industries from other countries would also contribute to a better indication of which industries to regard as strongholds. The relative performance of an industry can be expressed via location quotients, which would then replace the Size-parameter in our formulae.

Finally, we invite scholars to examine under which conditions cross-over industries indeed show (themselves) or cause (in other industries) upsurges in economic performance. Particularly interesting is the question how policy intervention following cross-specialization logic plays a role in such dynamics. With this Appendix we hope to provide measures for analyzing structural change based on knowledge brokerage.

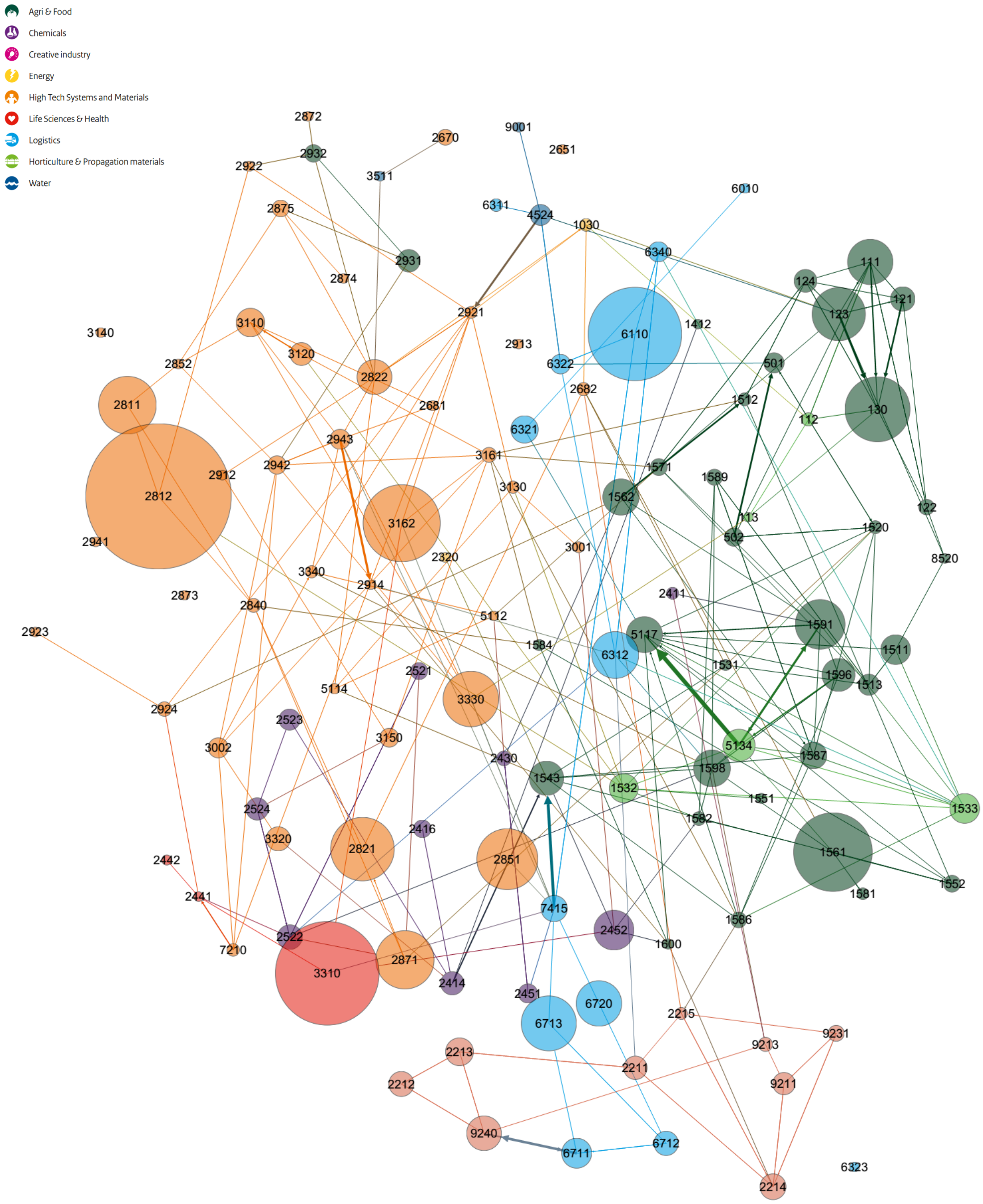


Figure K.3: Topsector industries in the Dutch industry space. Node size represents cross-over centrality type 1 (the product of industry importance and skill-relatedness).

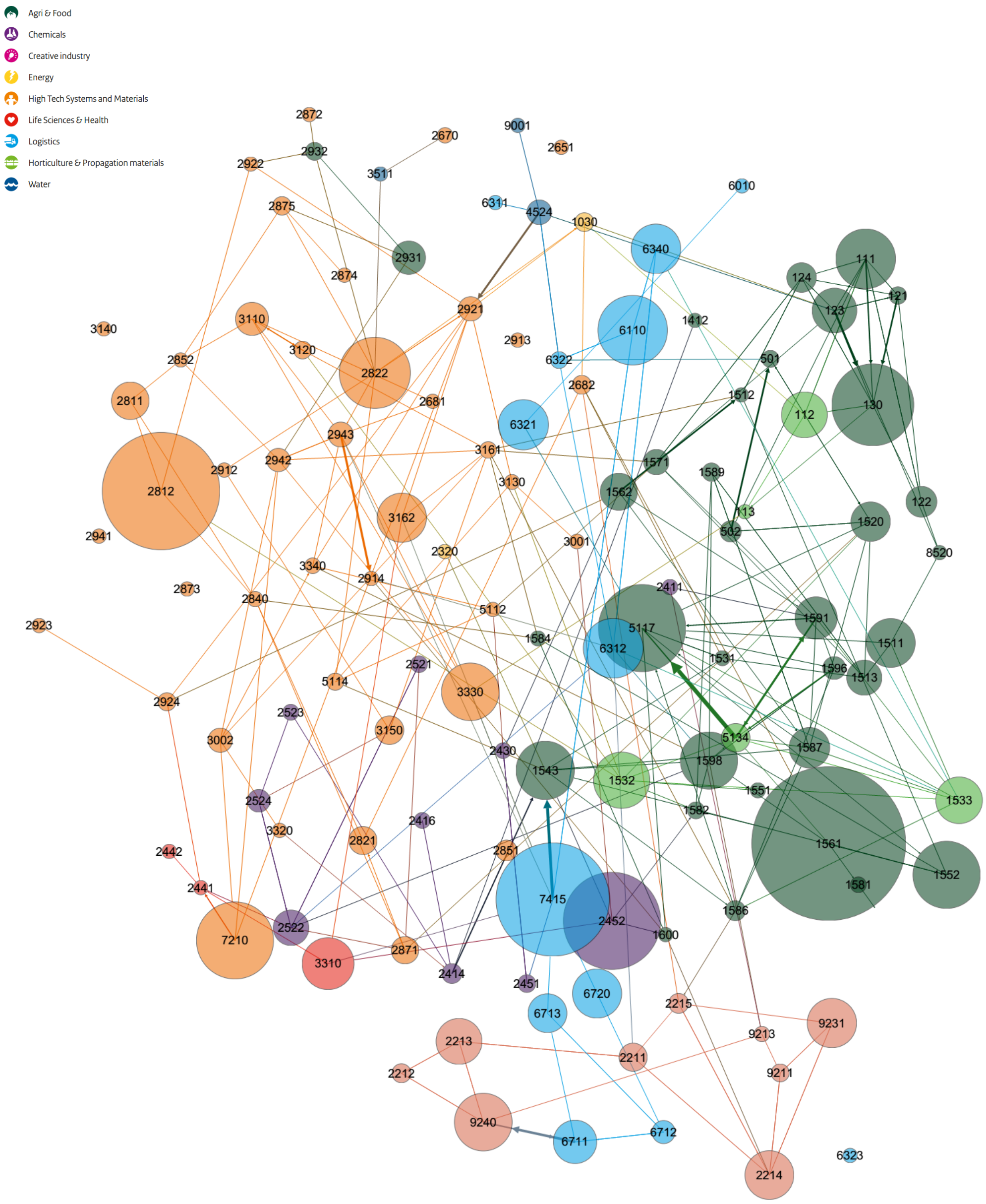


Figure K.4: Topsector industries in the Dutch industry space. Node size represents cross-over centrality type 2 (the product of industry importance and skill-relatedness, but only for combinations of unrelated industries).

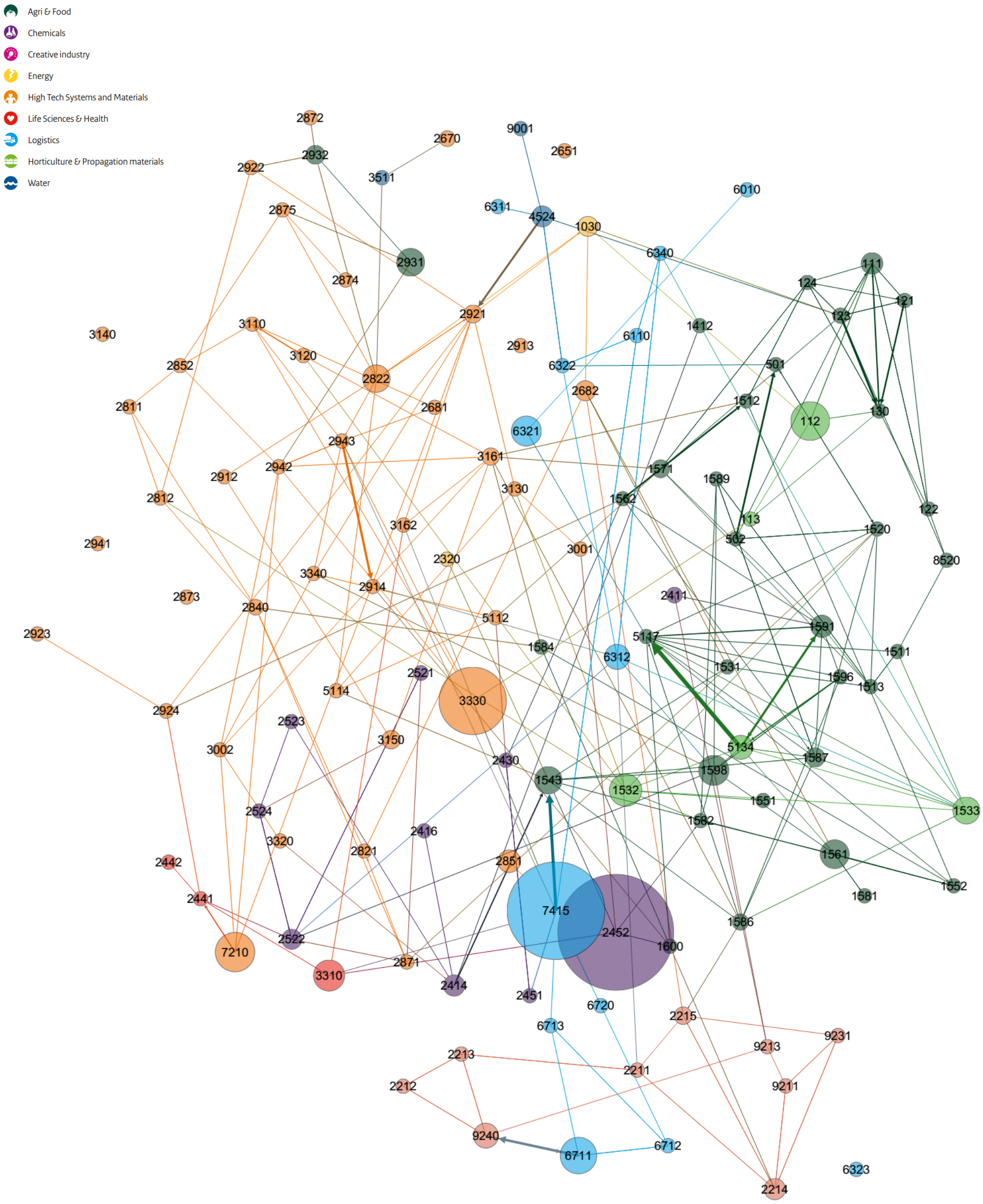


Figure K.5: Topsector industries in the Dutch industry space. Node size represents cross-over centrality type 3 (the product of industry importance and skill-relatedness, but only for combinations of unrelated industries of a sector type other than the focal industry's own).

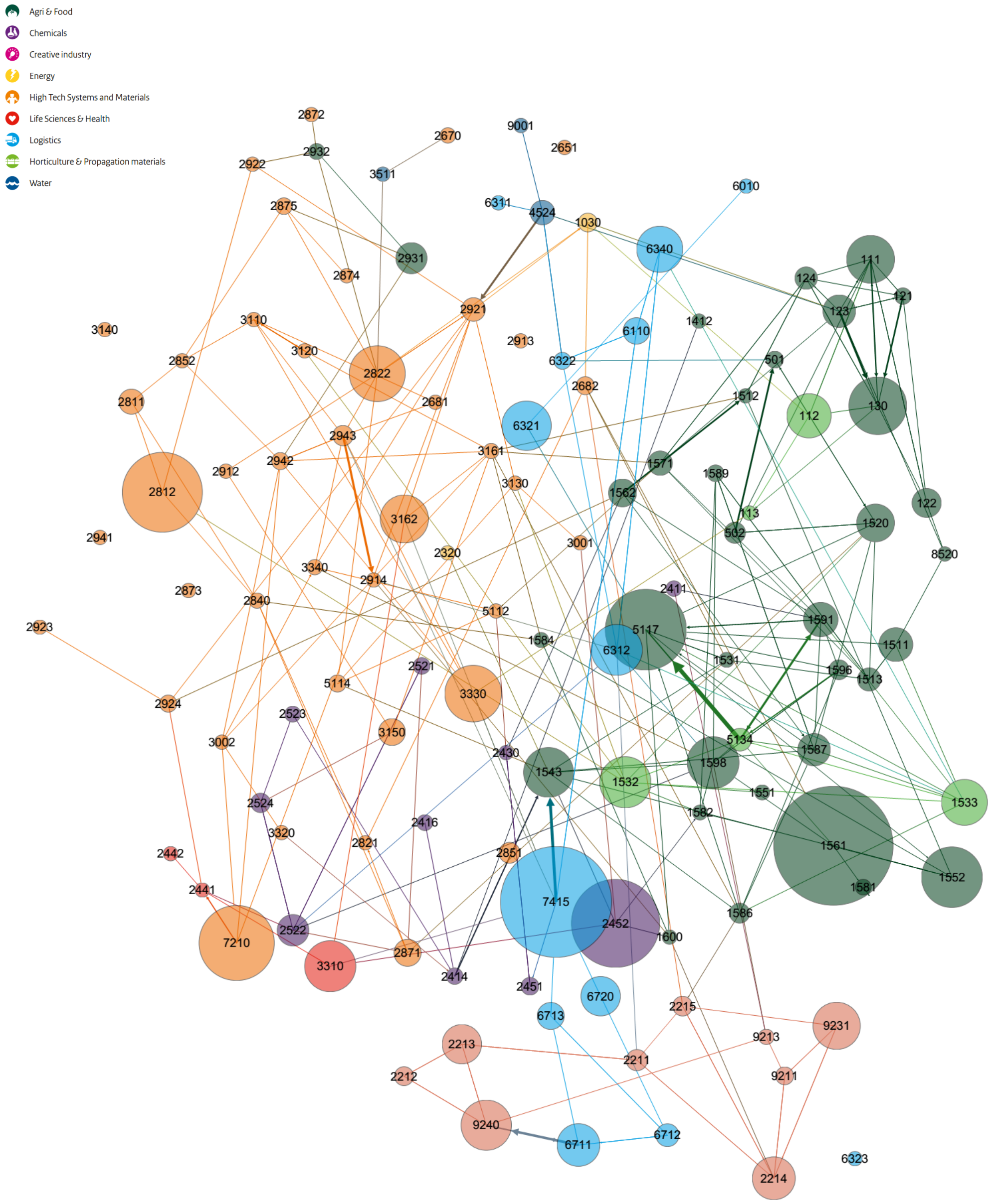


Figure K.6: Topsector industries in the Dutch industry space. Node size represents cross-over centrality type 4 (the product of industry importance and skill-relatedness, but only for combinations of unrelated industries having different sector types). The box contains a network element consisting of highly central non-Topsector industries (dark blue).

Figure K.7: The entire Dutch industry space. Node size represents cross-over centrality type 4. This also includes non-Topsector industries, in dark blue.

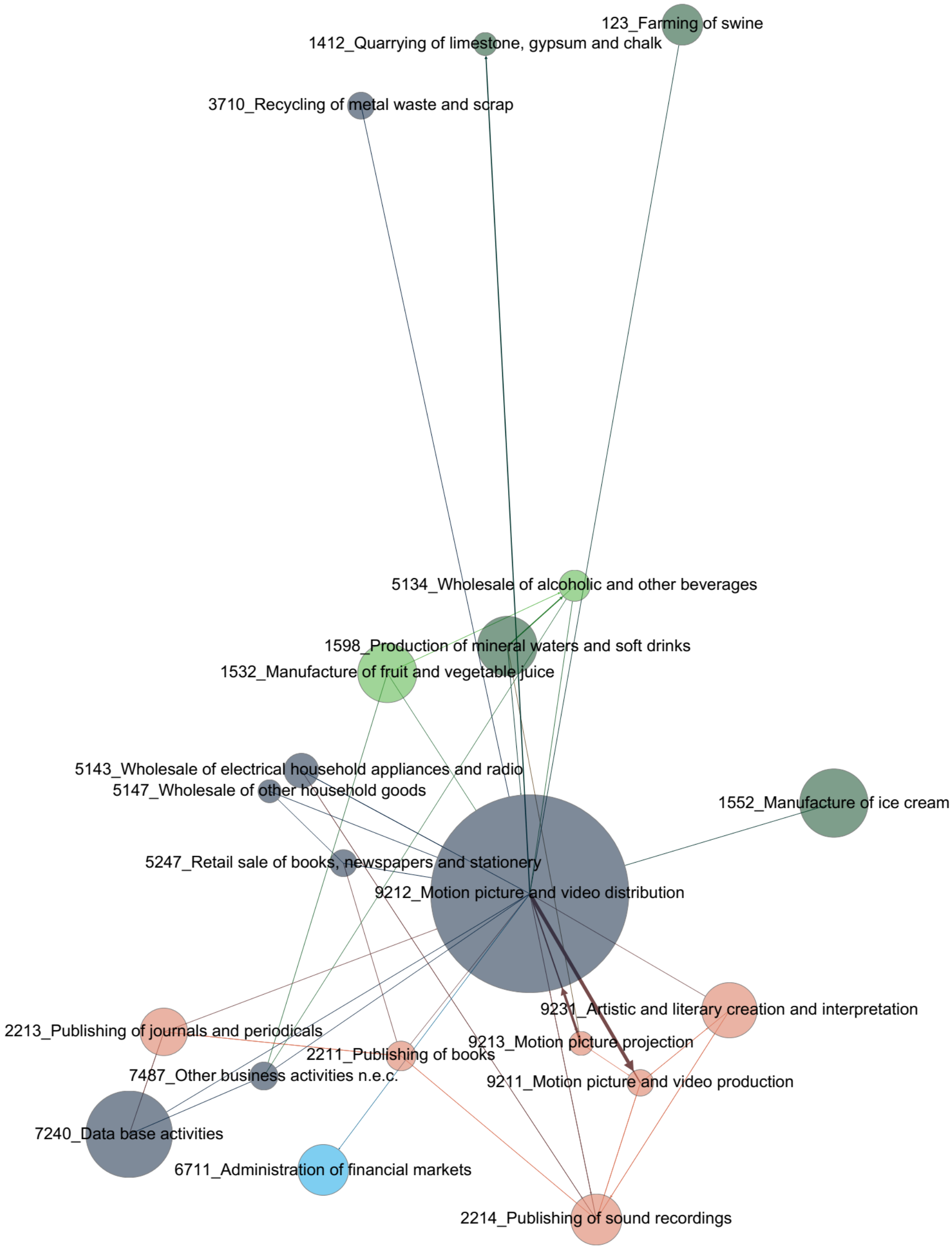


Figure K.8: Section from graph in Figure K.7.

Conclusions

Chapter 9

Where to go from here?

9.1 DISCUSSION OF CONTRIBUTIONS

This thesis aimed to advance our understanding of the nature as well as strategic and policy importance of service innovation. In our review of how thinking on service innovation has evolved, we stressed that the emergence of new services remains poorly understood as long as service research only considers innovation in pure service industries. Such 'demarcation'-efforts do shed light on specificities of innovation in particular service contexts, but fail to express their relevance for innovation efforts pertaining to other type of services (let alone physical products). Similarly, ignorance of the importance of services is also a risk when pursuing a 'synthesis'-view in which a broad scope goes at the cost of attention for interdependencies and synergies between various economic activities.

According to our arguments in Chapter 1, integrating services in innovation theory first requires a basic understanding of what is special about service innovation as such. The in-between step from demarcation to complete synthesis is what we coined *pre-synthesis*. Pre-synthesis can be regarded as the line of thinking that conciliates empirical findings retrieved from innovation efforts in a variety of service industries, in order to explore their relation with innovation dynamics within as well as beyond the domain of services. In our elaboration of this approach, we argued that placing service innovation research in one coherent body of theories is an essential pre-condition for understanding service innovation better. Acknowledging the rich potential of innovation studies, we posed the research question how evolutionary economics could be of help in attempts to embed services in an all-encompassing innovation theory. Specifically, we have built on product, firm and system level evolutionary theories to investigate the following service aspects (respectively):

- Nature: *"How can we use evolutionary economics to conceptualize service design options and processes?"*
- Management: *"Which capabilities matter most when seeking successful service solutions?"*
- Policy: *"How can policy makers steer and exploit service innovation?"*

In the following sections we discuss how we have answered those three sub-questions. By way of summary, we start each section with a brief description of the evolutionary foundations on which the corresponding contributions are based. The subsequent reflections on the scope of our research efforts indicate the progress we made with respect to the overarching mission of giving services a proper place in innovation theory. To describe how far we have come, we successively elaborate how our contributions are of relevance for (a) the domain of services, and (b) the wider domain of innovation. This relevance consists of implications for researchers, as well as for practitioners like managers (notably in studies belonging to Part A and B) or policy makers (Part C). Apart from discussing our contributions, this chapter also serves as an outlook on how the thinking on services and innovation might evolve towards a fully integrative synthesis approach.

9.1.1 The nature of service innovation: Design options and search processes (Part A)

Evolutionary foundations

Chapters 2 and 3 focus on the design options and processes faced by innovation managers wanting to improve or develop new services. We interpret the innovation process as a search journey through a fitness landscape. The novelty of an innovative service pertains to the identification of a new configuration of (interdependent) dimensions. A new configuration can be based on one or more modifications with respect to an existing service, or it is an entirely new combination of 'alleles'. Complexity arising from the interdependencies between dimensions is analysed with the help of NK-logic (Kaufman, 1993, 1995). This analytical structure helps us understand how changing one dimension can affect the fitness of another dimension, making it difficult to foresee what will happen to the overall fitness of a service offering. We discuss various search strategies for dealing with such complexities.

Contributions with relevance for the domain of services

Conceptualizing a service design space requires us to disentangle where novelty exactly occurs in services. Building on the work by Den Hertog et al. (2010), we have adopted a framework designed to cover the six main dimensions of any type of service: the service concept, form of customer interaction, value system (business partners), revenue model, organizational delivery system, and technological delivery system. By consisting of abstract dimensions, this framework is believed to be universally relevant when it comes to manifestations of service innovation. Its broad scope is highly similar to the one Gallouj and Weinstein (1997) had in mind when proposing the characteristics-based approach. Both frameworks have the potential to characterize a variety of organizational elements required for (co)producing value. A major difference, however, is that the characteristics-based approach invites researchers to identify new elements each time a product-service system is studied, whereas the framework devised by Den Hertog et al. (2010) always consists of the same key dimensions. This property is exactly what makes it possible to collect and compare insights from various (service) contexts. For instance, with respect to describing the novelty in services, Chapter 3 highlights the commonalities found in the way some dimensions are modified. The mutation of a certain dimension might seem original in the context of one service, but through the lens of multidimensional conceptualization, we observe that it is also being used in entirely different industries. This hints at possibilities for service innovators to learn from practices in other industries, something usually considered difficult due to the fuzzy nature of services. Also, deducing from the notion of interdependencies in design spaces, we interpret regularities in the number and type of key dimensions affected by different innovations.

This brings us to the scope of the *theory* we applied (in addition to the framework for describing the locus of novelty). Complexity theory like NK-logic is normally applied to products or 'technological systems' of a more physical nature (Frenken, 2006; Alkemade et al., 2009). The notion of interdependencies is perhaps most intuitive when the system-wide consequences of a mutation depend on uncontested physical laws. For the production of intangible products, it is less obvious what interdependencies entail. Although perhaps unsatisfactory, this is by no means a reason to ignore the analytical clarity NK-logic offers. As long as a product can be represented as a system of interdependent dimensions, there is a need to cope with the uncertainty a certain change can cause (regardless of where the interdependency comes from). One could even argue that NK-logic is *especially* relevant in situations where uncertainty exists: the apparent problem of a lacking understanding of what causes interdependencies only contributes to the value of applying appropriate complexity theory. As a matter of fact, management literature has frequently shown the relevance of applying NK-logic also to more abstract design contexts. Porter and Siggelkow (2008), for example, look at 'activity systems', which equally apply to manufacturing and services. They demonstrate the strategic value of examining interdependencies between abstract dimensions. Our work is in line with such studies, but (as noted) differs in the sense that we do not study each context by defining an ad-hoc set of dimensions. Nor do we choose to leave the design space's dimensions undefined (Desmarchelier et al., 2013) or very broad (Chae, 2012a, 2012b). Instead, we use one single framework and examine if there are regularities in the changes that characterize innovations from different contexts. On this basis, we refute the claim that either service or technological aspects are always involved (thereby supporting researchers to look beyond the traditional ways of characterizing novelty), and show that service innovations can be executed without affecting all dimensions.

Especially when relying on one single framework to represent the design space of services, there is no point in trying to understand what causes interdependencies. A simple take-away message is that managers should realize that they cannot just modify individual service elements without taking potential changes in other dimensions into account. One of our suggestions for further research is to apply the proposed mapping technique for studying the sequence of changes that establishes the development trajectory of a certain service. Perhaps, such a sequencing exercise does reveal regular interdependencies for particular services.

Contributions to the field of innovation at large

The relevance of Part A for the general innovation community might initially seem relatively limited. Our primary contribution lies in combining the multidimensional perspective on services with the theoretical foundations related to design spaces. Indeed, the scope can be considered on the pre-synthesis side of synthesis (i.e. uniting and comparing insights from various contexts, but no attempts to go beyond the domain of services). Framing service innovation as a recombinant search process, however, does provide a basis for the type of studies reported in Part B. Those studies do have wider implications.

A question not touched upon in Chapters 2 and 3, but worth debating, is whether the framework can also be used for innovations not pertaining to pure services. The fact that it has been developed in the context of services does not imply it is by definition exclusive to service activities only. Arguably, a framework so broad that it encompasses all sorts of services must also have relevance for other types of products. A closer look at its specific dimensions reveals that only the 'service concept' apparently is service-specific. The definition of this dimension states that it covers the actual proposition being delivered, which can be an experience or a solution. Thereby, the dimension's focus on the functionality being delivered fits in the perspective of the service-dominant logic (SDL), which states that *any* product can be described by the service it renders (Vargo and Lusch, 2004). Although a dimension like 'customer interaction' might feature more prominently in service delivery, most of the other dimensions are relatively neutral with respect to the (in)tangibility of the product they aim to describe. In fact, also the technological elements required for delivering a given functionality are captured by a dimension. All in all, despite its (pre-synthesis-like) service-specific origins, the multidimensional framework devised by Den Hertog et al. (2010) also fits rather well in a post-synthesis approach to innovation.

If we acknowledge that the multidimensional characterization of services actually is broad enough to describe any type of product, even though we did continue the tradition of only using it to analyze service innovation, the audience we speak to might be substantially larger. Specifically, we draw attention to the observation that a post-synthesis-like interpretation of the multidimensional framework is analogous to the idea of a business model. Just like the six dimensions Den Hertog et al. (2010) jointly apply to describe the factors involved in delivering a proposition, also the business model canvas consists of various organizational elements that need to be aligned. Innovating by changing the content of these key elements is the core of business model innovation, a topic currently receiving ample attention in the innovation literature (e.g. Teece, 2010). Therefore, should the framework by Den Hertog et al. (2010) be regarded as an equivalent (or actually a precursor) of the business model canvas, our explorations into an evolutionary interpretation might have wider relevance. To our knowledge, research on business model innovation has made little effort to examine the strategic issues we raise in part A of this thesis. Perhaps our studies form a first step for investigating search strategies like changing business model dimensions simultaneously or sequentially, identifying original ways to design a certain dimension, drawing analogies between the business models (innovations) of distinct contexts, etcetera.

Reflecting again on the evolution of service innovation thinking, we do not consider it evident that research on service innovation will only nurture research on business model innovation without the reverse direction of learning taking place. Admittedly, the general nature of business model innovation has the potential to attract the interest of firms in any economic domain. This is in stark contrast with the label of service innovation, which might disenchant researchers, policy makers or managers mainly interested in the 'hard' forms of innovation, thereby leaving them ignorant about the potential service innovation has even for manufacturing firms. What should be noted, however, is that it is exactly this integrative nature of business model innovation that can spur interest in services. Since many powerful examples of business model innovation are service-based, it is likely that firms wishing to use business model innovation for reinventing themselves will actually end up providing solutions and experiences rather than physical artefacts. In such cases, it is essential for these firms to have the knowledge and capabilities required for developing and delivering services. Why exactly such knowledge matters, is the core of Parts B and C of this thesis.

9.1.2 Managing service innovation: A capability perspective (Part B)

Evolutionary foundations

Following the dynamic capability view (DCV), we gauge a firm's ability to develop and introduce new or improved services by looking at its innovation capabilities. According to the evolutionary mechanism underlying novelty creation, organizations need to be able to acquire, transform, and deploy knowledge when pursuing successful innovation. We operationalize a set of dynamic capabilities for service innovation in Chapter 4, and investigate their relative importance (for knowledge-intensive business services) in Chapter 5. Acknowledging that external partners and especially users can provide valuable input to the innovation process, both Chapters 5 and 6 discuss the notion of open innovation. We use the NK-model in Chapter 6 to develop a formal argument for why listening too carefully to users can cause firms to get stuck in a local optimum of the design space they are exploring. Apart from providing an in-depth investigation of particular innovation dynamics, both Chapter 5 and 6 also serve to exemplify how one can benefit from the theoretical perspectives and concepts explored in Chapters 2 to 4.

Contributions with relevance for the domain of services

Chapter 4 extensively reviews the possibilities to conceptualize dynamic capabilities for service innovation. The framework we ultimately selected, based on work by Den Hertog et al. (2010), combines Teece's (2007) general structure of common capabilities (reflecting three sequential stages for acquiring, converting and applying knowledge) with the findings from service-specific studies. Primarily shedding light on innovation abilities related to renewing services, whether or not pursued by a manufacturing or service-focused firm, the scope of Chapter 4 corresponds mainly with the pre-synthesis approach.

Again, we could ask whether these capabilities are specific for (pure) services only. In order to get more hold on the particularities of service innovation processes, it is desirable to have constructs allowing for comparison across a wide range of innovation behaviors. An important first comment in this respect is that operationalized and validated capabilities are at no point presented as being constructs whose actual 'existence' we have verified. Looking at capabilities is nothing more than taking an analytical perspective: the question is not whether they exist, but whether there is any use in working with these constructs.

Just like in our analyses of service dimensions, the chosen set of capabilities is merely considered as a convenient structure for appraising relative differences. Asking firms how strongly they developed certain activities, linked to the various aspects of knowledge processing, allows us to study the relevance of the respective capabilities. Various similar conceptualizations have been proposed over the years, but the particular aspect of the operationalized set of capabilities is that it is designed to be relevant *also* in a services context. The framework is comprehensive in the sense that it avoids a bias towards dynamic capabilities and micro-foundations that are only relevant for creating and commercializing material objects. One might perhaps expect sensing user needs or conceptualizing to be specifically relevant in a services context (contrary to sensing technological options), but only by having a broadly applicable framework can we examine such differences. As Chapters 5 and 6 reveal, sensing user needs turns out to be of very limited discriminative value for highly customizing firms (who interact with their users anyway), whereas having a strong sensing technological options capability generally matters most. Only if KIBS engage intensively in innovation-oriented partnerships, does the strength of their conceptualizing capability become a better predictor of their innovativeness. These findings hold important implications for managers wondering which capabilities they should be investing in.

Based on the contributions of Chapter 5 and 6, we can take another look at what service innovation really is. Traditional schools of thought would say the following: the adoption of innovation *by* service firms, innovation processes *in* service industries or service firms (yet possibly resulting in new goods), innovation *through* services (including goods-based innovation supported by KIBS), or simply the *development of new services* (be it by pure service firms or by servitizing manufacturers). If we now stick closely to service peculiarities relevant to the innovation process, as examined in Part B, service innovation could also be regarded as a specific *mode* of innovation. This mode is then characterized as any form of novelty-seeking process that occurs in firms who interact intensively with their users on a frequent basis, and who deliver a partially intangible and customized product (e.g. an experience or solution). As claimed earlier, such a notion of service innovation applies to the innovation activities of an increasing number of manufacturers as well.

Contributions to the field of innovation at large

From comparing the importance of the operationalized set of capabilities across various types of service innovators (including those formally classified in manufacturing industries), it is only a small step towards also looking at innovation efforts not focused on service innovation at all. In fact, the capabilities themselves mainly pertain to the presence of activities deemed relevant for novelty creation in general: what type of innovation emerges from executing these activities is not inherently determined by the nature of the capabilities we examine. While the studies reported in this thesis did occasionally include the word services in the measurement items, we contend that the capability constructs themselves present opportunities for analyzing innovation efforts beyond this specific context as well. Introducing minor adjustments in the phrasing of the items should be enough to have a measurement scale that allows us to pursue integrated (post-synthesis) perspectives in future research.

Apart from our claim that the measurement scale proposed in Chapter 4 has a broad applicability, also some of Part B's other results extend beyond the services context. In line with authors urging to move towards integrated accounts of innovation, we consider our studies to be relevant because they concern features increasingly prevalent in modern economies (Miles, 2007).

In Chapter 5, the study is not presented as an investigation into service innovation *per se*. Rather, the starting point is the general finding that the characteristics of openness and interaction are more common in KIBS than in other firms. The observation that KIBS operate at the forefront of openness prompts us to draw lessons regarding capability prioritizing for firms that are in the trajectory of opening up their innovation processes. As noted, our results suggest that firms coming from closed innovation settings especially need to reconsider the value of their sensing and conceptualizing capabilities.

By taking a firm's degree of openness as a distinctive feature, the analyses described in Chapter 5 are only conducted in a sample of KIBS. There is no evidence whether our results are also valid for manufacturing firms who deploy open innovation practices while still sticking to the production of goods (known open innovation practices are hardware-focused, like licensing IP and selling patents). The observation that the conceptualization capability seems indispensable for highly open firms because they can hardly rely on external parties, for instance, might only be generalized to firms dealing with implicit rather than explicit knowledge. If so, our results would be specific for situations where openness is complemented with intangibility of the product being delivered. On the other hand, the reality is that many contemporary manufacturing firms are opening up by their very shift towards service-inclusive and thus co-production-based business models (Neely, 2008; Visnjic and Van Looy, 2013). At least with respect to user interaction, servitization is inherently connected to a higher degree of openness.[66] This development thus implies that our findings might be relevant for a wide range of firms after all, provided that they meet the characteristics of being inherently open and working with knowledge that is hard to codify.

Also in Chapter 6, despite outlining the 'paradox of sensing user needs' as an issue primarily visible in services, service firms are not considered as a domain in itself. The study focuses on customizing firms receiving high amounts of user feedback. Although these characteristics happen to be common for service provision, the scope of the study is explicitly not restricted to service providers. To support the claim that the negative interaction between having a strong sensing user needs capability and receiving ample feedback is a consequence of myopia (i.e. 'over-pleasing' customers), we tested customized service providers against those who deliver standardized services. This comparison group, for which we find contrasting results, is chosen because it differs from customized services only in the specific dimension we are interested in. As noted, our explanation for the adverse effect of listening carefully to users could apply to any sort of firm that aims to deliver superior products by tailoring solutions to their customers' demands.

9.1.3 Policy options concerning services and innovation (Part C)

Evolutionary foundations

Acknowledging that the adaptability of an economy relies on its ability to generate and apply new knowledge, Chapter 7 builds on the notion of innovation systems. This line of theorizing states that the tasks (or functions) required for knowledge processing are distributed over various private and public actors. According to the functional perspective, governments can create a systemic policy mix by intervening when such system functions are only weakly developed. Chapter 7 describes various approaches

66 Innovation in services is characterized by peculiarities on various accounts. Although these individual peculiarities often seem only a better of gradual differences, service innovation is generally marked by a coherent set of features that are 'displayed simultaneously' (Miles, 2007). This is a major reason to consider service innovation as a distinct field of study.

for how to achieve this, each of them having a different way of dealing differently with the peculiarities of goods and service-based innovation.

In Chapter 8, we ask how an economy's stronghold sectors, developed during a path-dependent process of knowledge accumulation, can form a basis for sustaining competiveness. The starting point is again the idea that changing market circumstances demand industries to stay adaptive. In order to diversify in new directions, the knowledge base of such industries has to be enriched with knowledge that is uncommon to the sector itself, yet sufficiently familiar to be properly absorbed. Relying on insights from evolutionary economic geography, we argue why, rather than (only) supporting related variety, policy makers should create linkages between strong but disparate industries. We stress which types of knowledge about service delivery and service innovation can be an impetus for each of the three 'cross-specialization' forms we introduce. By regarding mutual learning (with respect to service knowledge) as a factor that can bridge the cognitive distance between knowledge bases, we also extend the discussion on the role of services in industrial evolution.

Using skill-relatedness data (Neffke et al., 2011) and the Dutch Topsector classification, the analyses in the last appendix of Chapter 8 illustrated our methods for identifying knowledge domains with a cross-over position in the industry space. When looking for options to implement cross-specialization interventions, it seems worthwhile to take a look at the particular skills and knowledge present in the industries that are located in between unrelated stronghold industries.

Contributions with relevance for the domain of services

While the first two parts of the thesis focus on creating a better understanding of service innovation in itself, this part stresses how service peculiarities play a role in broader economic dynamics. Insights in this matter allow policy makers to determine when (and when not) there is a strategic basis for deploying 'service innovation policy'.

In Chapter 7, the key question is not how service innovation can be supported: it is rarely the case that service innovation is a policy priority in itself. Instead, the starting point is the question how to strengthen an innovation system's functions. Only when analyses reveal which system functions are poorly developed, do we have a basis for determining which policy measures could be considered. Our contribution lies in providing a framework for analysing and comparing policy mixes, in particular when it comes to identifying policy measures to avoid a technology bias (or, phrased differently, ensuring service-inclusiveness) and unleashing the potential advantages that services can offer.

In order to structure our description of how to deal with services when striving for a well-functioning innovation system, we rely on the four approaches of service innovation thinking that feature centrally in this thesis. Policy makers adopting an assimilation approach can support manufacturing and service industries with the same measures (e.g. one single fiscal facility for stimulating entrepreneurial activities). The demarcation approach, on the contrary, is a policy style in which the domains of manufacturing and services have distinct sets of policies. This leads to duplication of similar measures; e.g. one instrument for funding manufacturing R&D and another for funding innovation in service industries. The pre-synthesis approach acknowledges that some system functions fit better with the manufacturing domains (e.g. knowledge development), while particular types of services have a relatively high potential for executing other system functions (e.g. knowledge diffusion, generating innovative business models). Finally, post-synthesis is associated with measures whereby manufacturing and service peculiarities are carefully aligned, like in some forms of cluster policy or thematic measures aimed at solving societal challenges.

Previous research on service innovation policy has equalled systemic policy with post-synthesis-like policy (Rubalcaba, 2006; Den Hertog et al., 2010). In contrast, by reasoning from system functions, we show that all service innovation approaches can form a basis for systemic policy. At the same time, we also emphasize that especially the all-encompassing scope of the full synthesis approach allows policy makers to focus on more than just the (economic) performance of the innovation system.

Whereas Chapter 7 only provides an analytical framework for classifying the goods or service-orientation of policy instruments, Chapter 8 discusses extensively how a pre-synthesis and thus service-oriented policy strategy can possibly support economic development. Nevertheless, in this latter chapter, services and service innovation feature more as an answer to the question ("How can diversification in stronghold industries be supported?") than as the very subject of a question (e.g. "How can service innovation be managed?").

The chapter's primary aim is to argue that creating linkages between extensive but unconnected knowledge bases may well be a promising way to transform industries. Such a policy strategy, coined as cross-specialization, unites the advantages of being well-positioned to identify anomalies in deeply explored knowledge bases on the one hand, with the breakthrough potential of recombining unrelated knowledge on the other hand. The three forms of cross-specialization we distinguish are: direct knowledge exchange leading to related products, direct knowledge exchange leading to relatively unrelated products, and indirect linkages based on lateral interfaces (system-level themes / horizontal technologies).

Since actors from unrelated fields are unlikely to engage in knowledge exchange, the ultimate policy challenge is to establish these distant knowledge flows. Given the background of this thesis, we look especially at the potential of services to be used as 'convergence factor'. For each of the three forms of cross-specialization, we describe which specific kind of service-knowledge has the potential to link unrelated industries. In particular, we distinguish the types of service concepts that are appropriate, and the type of service capabilities. The fact that firms from unrelated industries form no competitive mutual threat might contribute to their willingness to exchange ideas and experiences regarding the delivery and development of new services.

More attention for services is explicitly presented as one of the possible ways to shape cross-specialization. A key argument here is that the forms of cross-specialization based on converging knowledge bases and mutual learning require the existence of a kind of knowledge that can but is not yet linking stronghold industries. As noted throughout this thesis, service innovation is a great example of a topic with relevance for a broad range of companies yet still largely ignored by practitioners like policy makers or managers. Supporting service-oriented learning might be a promising way to spur development in directions that fit best with a country's or region's current sector composition, but it certainly is not the only way. Alternative convergence factors that policy makers could consider include 'technologies' in the narrow sense of the word (e.g. multipurpose technologies like ICT and biotech). However, the more obvious it is that a technology has relevance for disparate industries, the more likely these industries are already experimenting with it. Government intervention is deemed particularly promising if, in the existence of information asymmetries about possible synergies, a natural base (e.g. platform) for knowledge flows is absent.

In sum, the purpose of the provided argumentation is purely to stress how, *amongst others,* knowledge about services can be used to rejuvenate existing manufacturing industries. By shedding light on the place of services in industrial evolution and economic transformation, we aim to go against the tendency of policy debates to take a binary perspective and oppose manufacturing against services (e.g. when attaching value to employment and productivity rates in both domains). Despite solely relying on theoretical arguments, Chapter 8 makes a case for why it is healthy to pursue economies in which both manufacturing and service activities are represented.

Contributions to the field of innovation at large

Innovation scholars have long been pointing out that the domains of goods and service production are intermingled, but little attention has been paid to how the interaction of manufacturing and services innovation affects the direction in which firms and industries develop.[67] Building upon the pre-synthesis approach used in Parts A and B of this thesis, Part C aims to clarify the role of services in innovation systems (Chapter 7) and industrial evolution (Chapter 8).

67 As mentioned in Chapter 1, there are notable exceptions such as research investigating structural change by modelling relative economic, employment, or productivity growth in sectors (e.g. Lorentz & Savona, 2008; Castaldi, 2009).

By taking into account the respective peculiarities of goods and service-based innovation, the last part of this thesis forms the most far-stretching step towards an integrated innovation perspective. It therefore should be clear that we do not wish to plea for a highly or entirely service-based economy. What we recommend, at most, is more (policy) attention for the role of services in economic and technological change. Provided that supporting learning and capability development in firms are the ultimate objectives of innovation policy (Bleda and Del Rio, 2013), service-knowledge has an unexploited potential for also keeping industrial industries fit. As increasing globalization leads to cost-optimization of value chains, caused by higher reliance on natural resources and labor forces from elsewhere, many economies face a decline in their manufacturing industries. Reasons to counter this development are manifold, ranging from purely economic benefits (e.g. Jacobs' externalities derived from a more varied industry composition), political advantages (less dependency on input from other countries), and social merits (maintaining employment in industries of historical and cultural importance), to environmental conservation (e.g. reducing transportation costs). In our view, a promising way to 're-industrialize' or shape what is sometimes called 'industrial renaissance' is not by abandoning services, but by benefiting from their very potential to revitalize manufacturing industries.

9.2. REFLECTION ON SERVICE INNOVATION APPROACHES

By studying service activities at the product, firm and system level, we have illustrated how researchers, managers and policy makers can deal with the topic of service innovation. A central element in our discussions is the ambition to move towards a fully synthesized account of innovation. This development is presented in relation to different lines of thought with respect to the ontology of service innovation (Gallouj, 1994; Coombs and Miles, 2000).

Having arrived at the end of this thesis, one might wonder how our contributions fit in the structure of approaches. This is what Table 9.1 summarizes. Relying on the findings and debates from earlier chapters, we indicate how the respective approaches translate into views on the nature, management, and policy side of service innovation. As discussed in the previous three sections, many of the concepts and theories we explored are not strictly bound to one of the approaches only. It is the way how these concepts are applied that determines at what points we have been contributing to pre-synthesis lines of thought, and at what points we aimed even beyond the domain of services. Taking the dynamic capabilities central in Part B, for instance, we stressed lessons relevant for firms engaged with service innovation (pre-synthesis) just like we discussed implications for non-service firms (post-synthesis).

The overview in Table 9.1 illustrates once more the difference between the two synthesis approaches we have been distinguishing throughout this thesis. While pre-synthesis can be regarded as a step towards post-synthesis, it has become clear that both approaches in fact have merits of their own. The often-heard observation that services and goods are interwoven does by no means imply that looking at services only is becoming archaic. Instead, the more services are part of wider dynamics, the more situations and problems emerge in which knowledge about the peculiarities of services innovation will be of great value. Because such knowledge is of most use when service activities are properly seen in relation to the systems and interactions they are part of, the pre-synthesis approach will benefit from advancements in the post-synthesis approach perhaps just as much as the other way around. Therefore, we expect the evolution of service innovation thinking to *develop towards* but not to immediately *end* in a post-synthesis phase; for the time being, the perspectives are more likely to keep co-evolving.

Table 9.1: The differences between the various service innovation approaches: Projection on thesis' core themes.

	A. Nature	**B. Management**	**C. Policy**
	What is service innovation?	*How can service innovation be managed?*	*How can policy makers steer and exploit service innovation?*
Assimilation	Service innovation activities are fundamentally equal to innovation efforts in manufacturing contexts; any observed differences are only a matter of degree.	Any classical innovation model is equally applicable for manufacturers as it is for service firms. E.g.: traditional stage-gate model.	Existing innovation instruments, often originating from industrial policy, are eligible for service firms or are simply being broadened up.
Demarcation	Innovation in service industries displays significant differences with innovation efforts in the generally studied context of manufacturing industries. These differences are typically related to the intangibility and co-produced nature of services.	Developing financial services requires a different approach than when creating physical artefacts, but also when compared to introducing new tourism concepts or ICT solutions. Each domain has its own models and strategies.	Distinct measures for distinct service industries, without necessarily embedding the support for these industries in a wider perspective of how they contribute to the innovation system.
Pre-synthesis	There are commonalities in innovation efforts focused specifically on creating services. These similarities provide opportunities for service innovators to learn from each other. Also, it allows for placing 'service innovation' in perspective (with respect to interdependencies with other types of innovation).	Creating new services requires particular (accents in the) capabilities and skills of an organization. Close interaction with customers and other parties makes external knowledge relatively easily accessible, but translating market signals in a viable service concept is challenging when products are fuzzy and intangible.	Knowledge on how to deliver and develop services can be exchanged across service providers, including servitizing manufacturers. This can be via dedicated service innovation programs and centres. When focusing on innovation *through services*, support for disseminators like KIBS or creative firms is also an option.
Post-synthesis	Innovation is a phenomenon in which economic agents create novelty. This novelty can take different forms, including goods and services. Many (innovative) products rely on the synergetic interplay of these various forms.	Firms should take a holistic view on the value they create, and use this as a basis for determining where they should innovate. This can be either in the technology or in the services they provide, as long as both domains are in alignment. The strategies and competences needed by firms who customize and co-produce solutions might be useful for goods-based firms who share similar business characteristics.	Innovation can be spurred by setting up programs that stretch over the domains of goods and services; for instance by supporting innovation along the value chain, focusing on large-scale societal challenges, or the development *and application* of multipurpose technologies.

9.3 FINAL REMARKS: SERVICE INNOVATION, A 'GOOD' THING?

In this thesis we have endeavored to enhance our understanding of how to research, manage, and govern service innovation. Central to our inquiries is that the search for new services is not diametrically opposed to the search for new goods. The distinction between the two, never solid in the first place, is blurring due to their intermingled co-evolution: service products are starting to look like goods, and goods are being sold as services. All in all, it is our conviction that the service innovation literature is not coming to an end now that industry boundaries are fading. Developments like the diffusion of multipurpose technologies and the widespread interest in business model innovation might detract attention from analyses focused on sectors, and thus from the manufacturing-versus-services debate, but this is exactly the development this thesis supports. Knowledge can be commercialized in many ways, and it is increasingly in a disembodied or 'dematerialized' form. Whether consumers satisfy their needs by purchasing services or renting equipment to fulfill their needs, in the near future, firms hoping to simply keep on producing commodities might have a hard time. Physical artefacts are of course still expected to play a significant part in economic traffic, also in Western countries, but less and less in the leading role. Ultimately, a knowledge-based economy is characterized by the performance and qualities of people in service professions just as much as by the sophisticated technologies it produces.

For those economic actors wishing to take the step to service-based business models, be it a hybrid or a pure service product, knowing how to provide distinctive services is a key ability. Because firm activities like user-interaction look different when providing intangible solutions, also the innovation process requires an approach that differs from ordinary product development. However, not every economic actor manages to acquire the essential mind-set and skills all by itself. To gain the maximum benefit from the knowledge available in an economy, it is crucial to realize that economic development evolves along the lines of trajectories that are not just 'technological' in the narrow sense of the word; nor is service innovation only a matter for pure service firms. We highly support the perspective in which (especially knowledge-intensive) services are regarded as boundary-spanning and cross-sectoral, just like ICTs, which offer plenty of opportunities to boost other industries' performance. There is ample evidence that providing services offers several strategic advantages over selling goods. The more customers are willing to pay for receiving the exact service they desire, the better grounds there are for shaping new solutions and experiences. For firms to actually do so, it might be helpful to have a comprehensive perception of the forms new services can take, as well as insight in the capabilities and processes underlying the successful development of new services. Improving that perception and insights is what this thesis aimed to do.

Do all these statements imply that service innovation should receive extensive policy support? Not necessarily.

Like any type of innovation, service innovation can be pursued for a variety of reasons, including commercial, social or environmental grounds. Service innovation is not inherently ‘good’, although services might have characteristics that are sometimes regarded as favorable. Topics that have unfortunately found no place in the scope of this thesis, but are certainly worthy of attention (perhaps in future research), include the following and many other questions: could the rise of services give economies suffering from global competition a fair chance, does service firms’ dependency on human factors have any other socio-economic advantages (e.g. less profit being accrued by those possessing most of the capital), do the interactions in service occupations offer greater job satisfaction, can the focus on actual user demand help service providers to overcome the technology push causing avoidable damage to our environment, and do service-based business models indeed have solutions to sustainability issues (conform for instance the ideas underlying the sharing economy)?

Even if the rise of service activities does have undisputedly desirable consequences, governmental intervention is not automatically required. Apart from being a political and ideological matter, economic theory concerning market and system failures dictates that policy makers should only act when there are structural deficiencies in an economy’s dynamics. The scope of this thesis provides an analytical basis for identifying what type of policy measures might suitably complement an existing policy mix. What we do encourage, is that policy makers (and managers) at least make sure they are familiar with the nature and differentiated potentials of service innovation. Indeed there is a host of strategic benefits service innovation can bring about, but none of them implies that service innovation policy is always legitimate. The cross-specialization strategy introduced in this thesis is one example of a policy approach not focusing on services per se, but taking services as one of the elements suitable for triggering a mechanism which theoretically might enhance competiveness and adaptability (in this case: by linking unrelated stronghold industries). How precisely to benefit from services requires policy makers to dive into the composition and challenges of their economy, in order to craft an intervention most appropriate in their particular context.

In sum, because services are so heterogeneous in their manifestation, and intermingled with so many economic activities, practitioners have a responsibility in properly understanding which exact potential is of relevance in their specific case. Only when economic actors truly grasp the peculiarities and importance of services, can we achieve the ‘emancipation’ of services in innovation theory. Until that time, it is paramount to continue exploring and explaining the importance of service innovation for economic transformation and adaptation.

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DATA SOURCES AND CO-AUTHORSHIPS

The studies in this dissertation draw on both qualitative and quantitative empirics. Some of the sources have been used for multiple chapters. To clarify the background of the data, as well as the role of co-authors, we describe here the research projects on which the presented studies are based. Publications resulting from the projects are listed in the author's curriculum vitae.

United we Stand: Open Service Innovation in the North-Wing of the Netherlands

The United we Stand (UWS) project ran from 2010 to 2012. Its purpose was to shed light on manifestations and importance of open innovation as well as service innovation in the Greater Amsterdam and Utrecht area. This area, known as the Randstad, concerns the broad central region of the Netherlands where most national economic activity and population are concentrated. UWS was funded under the Peaks in the Delta programme (grant no. PID 091007) and has been receiving financial support from the Dutch Ministry of Economic Affairs, the Provinces of North-Holland and Utrecht, and the Cities of Amsterdam and Utrecht.

The three year project was executed by researchers from Dialogic, the Amsterdam Centre for Service Innovation (AMSI; a joint initiative by the University of Amsterdam and the VU University Amsterdam), and Utrecht University. Project coordination was in hands of Pim den Hertog (Dialogic, former UvA) and Wietze van der Aa (UvA). The studies on which the chapters in this thesis are based were part of the work package on Strategy, consisting of survey research as well as a number of case studies. Data collection in the form of survey development and distribution was done by this author in collaboration with Alexander Alexiev (VU) and Pim den Hertog, while the case studies were conducted together with Wietze van der Aa, Pim den Hertog, and Carolien de Blok (former UvA).

Survey

The questionnaire data used in chapters 2, 4, 5 and 6 stems from a survey distributed in 2011. Items in the questionnaire covered a variety of topics, including general company characteristics, service innovation dimensions, dynamic capabilities, innovation processes, innovation partnerships, innovation barriers, company profile, management team characteristics, market environment, and vision on management styles. Not all questions have been used in this thesis. The ones who have are listed below. For details about the origins and use of the scales, see the corresponding chapters.

Almost all of the questions in the survey are based on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree". Most of the items were retrieved from existing scales. Exceptions are the items for service innovation dimensions and dynamic capabilities; measurement scales for these constructs have been developed in Chapter 2 and 4, respectively. Details on the instrument design and validation are in the chapters themselves. The entire survey has been subjected to rigorous pre-testing procedures, including feedback collection from academic peers as well as having respondents over to fill out the questionnaires and discuss where confusion might arise. Asking respondents from different types of firms to complete the survey led us to rephrase ambiguous questions in the items used for scale development.

As for the sampling profile, the questionnaire was sent to single-business firms or business units with more than 10 full-time employees. Using databases from Bureau van Dijk, we retrieved contact information of Dutch firms located in the Northern Randstad. Availability of demographic information about the entire population allowed us to stratify in terms of sector and firm size; we created a multi-industry sample representative for the industry composition in the Northern Randstad.

The questionnaire was sent, in two consecutive waves, to 8054 firms. We addressed the questionnaire and accompanying letter to the CEOs or senior executives, in order to ensure that the respondents were knowledgeable about the key firm processes under investigation in this study. The questionnaire was administered by mail with the option to be filled in via the web if preferred. We obtained responses from 458 unique firms, which amount to a response rate of 5.69%. As the survey was of considerable length, and the sample did not have any particular relation with the researchers nor the research project, the response rate was regarded as sufficient and common for similar types of research. Phone calls following up on our survey distribution learned that a large share of the addresses were outdated; out of 100 non-respondents contacted by phone, about 50 were either no longer active in the same function or no longer contactable at the address the survey was directed to. Our comparison of the demographic characteristics of respondents with those of non-respondents only showed modest differences between the two groups. This suggests that the final response was largely representative for the population we sampled.[68] To characterize the final set of 458 respondents; the majority of respondents were small (84%) or medium-sized firms (13%), mostly stemming from services (76%), industry (11%) or construction sectors (8%).

As each of the chapters drawing upon this survey has its own focus, and therefore relies on a particular combination of survey items, the number of fully completed cases differs per chapter. Details are summarized in the table below. In Chapter 2 we are

68 With respect to concerns of results being determined by biases in our sample: please note that chapters in this thesis hardly make claims about properties of specifically the entire Randstad population. Neither do the studies rely heavily on analyses in which we link survey findings to demographic characteristics (e.g.: "small firms from manufacturing sectors have few service innovation capabilities"). Instead, the core of our empirical examinations is focused on relations between variables measured in the survey itself, for instance by asking "which capability is relatively most important, and how is this affected by a firm's degree of openness?" (Chapter 5). Although analyses of the latter kind are more prone to common method bias (which we take into account in our methodology), they do enhance opportunities to generalize findings.

specifically interested in the dimensions affected by the innovation efforts of service providers. Including pure manufacturers might have caused a bias towards some of the dimensions typical for goods (e.g. 'new technological delivery system'), thereby obscuring our attempt to develop measurement scales for the six distinct service dimensions. All three chapters in Part B of this thesis rely on survey data as well. In our development of measurement scales for dynamic service innovation capabilities, Chapter 4, no selection of cases has been applied. The number of complete cases is limited because some respondents did not fill out questions related to particularly turnover composition and competitive position. Chapter 5 deals with the question whether engaging in innovation-based partnerships also holds implications for the relative importance of dynamic capabilities. Since we set out to investigate firms in the 'forefront of openness', our sample is restricted to knowledge intensive business services (KIBS). Finally, in Chapter 6, our focus lies on the strategic importance of receiving and sensing user feedback. In our analysis we compare customizing firms against non-customizing firms.

Chapter	Sample	Variables	Nr. of cases (n)
2	Service providers [a]	- Service innovation dimensions - Firm characteristics (size, age), business characteristics - Turnover stemming from innovation-based sales	341
4	All firms	- Dynamic service innovation capabilities - Turnover stemming from innovation-based sales - Competitive performance - Service innovation dimensions	391 (386 for final model)
5	KIBS (selected on basis of industry codes)	- Dynamic service innovation capabilities - Innovation-oriented openness - Service innovation dimensions (index) - Firm size, formalization of innovation, market dynamism, competitive pressure	125
6	Customizing versus non-customizing [b] service firms [a]	- Dynamic service innovation capabilities (Sensing user needs) - Turnover stemming from innovation-based sales - Degree of user feedback (taken form 'market dynamism' items) - Firm size, formalization of innovation, market dynamism (other)	292

[a] Service firms: Firms scoring ≥4 on survey item "Our turnover mainly stems from services" (about 80% of cases).

[b] Customizing firms: Firms scoring >5 on survey item "We tailor our services to customers' needs." (75% of cases).

Survey items used in this thesis (translated from Dutch)

Business characteristics 7-point Likert scale: *I strongly disagree – I strongly agree*	*This statement holds for my firm:* Our turnover mainly stems from services. Our services are linked to the physical goods we are delivering. We provide services to a large number of clients. We tailor our services to customers' needs. We mostly deliver our services to consumers (B2C).
Service innovation dimensions 7-point Likert scale: *I strongly disagree – I strongly agree*	Our organisation developed new (service) experiences or solutions customers. We combined existing services into a new formula. We developed a new way of creating value for ourselves and our customers. Our organisation developed new channels for communicating with her customers. The way we have contact with our customers is renewed. We changed the task distribution between ourselves and our customers. The role of external parties in producing our services is renewed. We involved new partners in the delivery of our services. By introducing new services we changed the way we generate revenues. The way we get paid (financial construction) is altered. We changed our organisation in order to produce our new services. Our production of new services requires new skills from our employees Technology plays an important role in the renewed production of our services. We renewed our service offerings by new or different use of ICTs.
Dynamic service innovation capabilities 7-point Likert scale: *I strongly disagree – I strongly agree*	We systematically observe and evaluate the needs of our customers. We analyze the actual use of our services. Our organization is strong in distinguishing different groups of users and market segments. Staying up to date with promising new services and technologies is important for our organization. In order to identify possibilities for new services, we use different information sources. We follow which technologies our competitors use. We are innovative in coming up with ideas for new service concepts. We find it hard to translate raw ideas into detailed services. Our organization experiments with new service concepts. We align new service offerings with our current business and processes. Our organization has problems with initiating and maintaining partnerships. Collaboration with other organizations helps us in improving or introducing new services. Our organization is strong in coordinating service innovation activities involving several parties. We are able to stretch a successful new service over our entire organization. In the development of new services, we take into account our branding strategy. Our organization is actively engaged in promoting its new services. We introduce new services by following our marketing plan. We find it difficult to scale up a successful new service.
Innovation success	*Percentage of revenues coming from (100% in total) ...* …unchanged goods and/or services. …improved goods and/or services. …new goods and/or services.
Competitive performance 7-point Likert scale: *I strongly disagree – I strongly agree*	I*n comparison to our competitors, ...* ...our organization generated a higher return on equity in the past year. ...we had more profit growth in the past year. ...we had more turnover growth in the past year. ...we had a faster growing market share last year.
Innovation-oriented partnerships 7-point Likert scale: *Very unimportant – Very important*	*The following partners have been important for our service innovations of the past three years:* Suppliers of equipment, materials, services, or software Companies purchasing your services Customers Competitors or other businesses in your industry Consultants and external advisors Commercial labs or private R&D institutes Universities or other higher education institutions Government or public research institutes Professional organizations, trade unions Freelancers
Formalization of innovation 7-point Likert scale: *I strongly disagree – I strongly agree*	We evaluate the progress of our development of new services systematically The development of new services occurs via specific guidelines and procedures The final decision to introduce a new service is the result of a formalized process New services are being developed according to a schematic plan Progress in the development of new services is documented in writing
Market dynamism 7-point Likert scale: *I strongly disagree – I strongly agree*	Environmental changes in our local market are intense. Our clients regularly ask for new products and services. In our local market, changes are taking place continuously. The speed of changes in our market is modest.
Competitive pressure 7-point Likert scale: *I strongly disagree – I strongly agree*	Competition in our local market is intense. Our organizational unit has relatively strong competitors. Services and goods are easily imitable in our local market. Price competition is a hallmark of our local market.

Case-studies

In the UWS-project, service and open innovation have also been examined in a qualitative research setting. Multiple case studies, performed between March 2010 and February 2012, form the basis for Chapter 3. Furthermore, one case has been used for to illustrate the open service innovation dynamics discussed in Chapter 5.

The case selection procedure we adhered to was oriented towards finding organizations willing to share their experience with developing a new or improved service through collaborative efforts. Due to the UWS-project being concerned with specifically the Randstad-area, the focal organization preferably had to be located within these geographical boundaries. Organizations were contacted through events organized by the universities involved in UWS, as well as through professional contacts of the individual researchers. Following a case study protocol developed at the start of the UWS research project, we conducted between 5 and 10 semi-structured interviews per firm, each conversation lasting on average 75 minutes. Amongst the interviewees we find individuals involved in developing, managing and implementing an innovation. In all cases, this included employees from the focal firm, as well as external stakeholders.

In total, 9 firms of highly different sectors (and firm sizes) have participated. In some of them, multiple suitable cases were identified. The case study included in Chapter 5 explicitly addresses the variety in innovations, while in Chapter 3 the author selected the cases he was most acquainted with. Due to joining the UWS-project only in January 2011, the author of this thesis did not conduct all interviews personally. The author was the primary interviewer in cases 1, 3, 4, 5, and 6 listed in Table 3.1 (as well as the cases from Chapter 5), while original data for the other three cases was provided by co-authors Pim den Hertog and Wietze van der Aa. As all of the interviews were recorded and transcribed, the thesis' author had ample opportunity to familiarize himself with the details of every case. Moreover, by having a leading role in the case analyses, the author was in charge of performing the in-depth investigations presented in the research projects final output.

Further details about the actual research design, including methodology for interpreting and validating data, are provided in Chapter 3 itself.

Service innovation policies: Rationales, strategies, instruments (commissioned by OECD)

Chapter 7 is partially based on framework for plotting the sectoral orientation of innovation policy measures (Figure 7.2). An initial version of this framework, without any links to the functional perspective, was developed in a study for the OECD.[69]

69 See: Janssen, M., Kaashoek, B., & Den Hertog, P. (2012). Service innovation policies: Rationales, strategies, instruments (commissioned by OECD). Utrecht: Dialogic

European Service Innovation Centre (commissioned by European Commission)

After the full analytical frameworks have been outlined in section 7.3, Chapter 7 illustrates the various service innovation policy approaches by presenting two case studies. This work is based on research conducted by the European Centre for Service Innovation (ESIC), a two-year initiative commissioned by the European Commission's Directorate-General for Enterprise and Industry. The aim of ESIC was to capture and demonstrate the dynamics and large-scale impact of service innovation, as well as to assess how service innovation impacts on competitiveness, industrial structures and regional development. The case study in Upper-Austria was performed together with Pim den Hertog (Dialogic), while the Limburg case benefits from collaboration with Kincso Izsak and Martijn Poel (Technopolis).

Further details about the case studies are reported in the studies available at: http://ec.europa.eu/enterprise/initiatives/esic/index_en.htm

Overview of co-authorships

The conceptual development, empirical analysis and writing of all chapters has primarily been performed by the author of this dissertation. Apart from contributing significantly to the data analyses presented in Chapters 2 to 5, the extensive discussions with (and thorough reviews by) Carolina Castaldi (Eindhoven University of Technology) have led to improvements throughout the entire thesis. As noted in the project descriptions, data collection for the survey and case studies occurred in collaboration with Alexander Alexiev (VU) and Pim den Hertog (Dialogic, former UvA). The formal model of Chapter 6 was developed jointly with Koen Frenken (Utrecht University, former Eindhoven University of Technology), while it was Elena Mas Tur (INGENIO CSIC-UPV) who taught the author how to program the corresponding simulations.

Overview of co-author contributions. Numbers in the cells refer to chapters.

	Co-author				
Contribution	*C. Castaldi (supervisor)*	*A. Alexiev*	*P. den Hertog*	*K. Frenken (promotor)*	*E. Mas Tur*
Conception and design of the study				6	6
Data collection		2, 4-6 (survey)	2 (survey), 3 (cases)		
Analysis and interpretation of data	2-5	2, 4			
Writing	7				

SAMENVATTING

De opkomst van diensteneconomieën

De wereld om ons heen verandert in hoog tempo. Hoewel men bij relevante ontwikkelingen misschien vooral denkt aan de introductie van hightech artefacten of robotisering, is het niet alleen fysieke technologie die bepaalt hoe onze professionele en private gedragingen er tegenwoordig uitzien. In veel economieën zijn diensten de afgelopen eeuw een centrale rol gaan spelen. Diensten worden gekenmerkt als de "intentionele transformatie van economische eenheden als goederen of personen". Deze transformatie kan betrekking hebben op de fysieke staat van deze eenheden (denk aan onderhoud en verzorging), maar ook op de juridische of – bij personen - zelfs cognitieve staat (bijvoorbeeld als gevolg van de werkzaamheden van consultants of entertainers). Bedrijven wier producten niet slechts bestaan uit goederen, maar (ook) uit diensten, proberen om zo dicht mogelijk aan te sluiten bij de wensen van hun klanten: daar waar de verkoop van fysieke artefacten ervoor zorgt dat klanten een bepaalde ervaring of oplossing kunnen realiseren, zijn diensten er vaak op gericht om direct in een klantspecifieke behoefte te voorzien. Omdat bedrijven zich door goede dienstverlening kunnen onderscheiden, en een duurzame relatie met klanten kunnen opbouwen, zien we dat veel maakbedrijven hybride business-modellen gaan voeren waarin ze goederen en diensten combineren.

Het feit dat diensten zelf weinig zichtbaar zijn verhult een beetje hoezeer hun economische belang zich heeft ontwikkeld. Sinds halverwege de 20e eeuw wordt het BNP van landen als Groot-Brittannië en de VS hoofdzakelijk bepaald door dienstverlening. Deze 'de-industrialisatie' heeft zich in de navolgende jaren in landen over de hele wereld doorgezet. In OECD-landen berusten zowel werkgelegenheid als toegevoegde waarde inmiddels voor 70%-80% op diensten. Verderop zullen we beargumenteren waarom dit niet per se betekent dat de maakindustrie aan belang verliest, en waarom juist de interactie tussen diensten- en goederenproductie (en –innovatie) zo interessant is.

Economische theorieën

Neoklassieke economische theorie leert ons waarom de werkgelegenheid en productie met betrekking tot diensten zo'n opmars hebben gemaakt. Aangereikte verklaringen zijn hoofdzakelijk gebaseerd op veranderingen in vraag en aanbod, waarbij prijsaanpassingen voor nieuwe marktevenwichten zorgen. Afgezien van de vermeende lage productiviteitsgroei in diensten, in vergelijking tot goederenproductie, wordt hun toenemende aandeel in de economie verklaard door een relatief grote groei in zowel zakelijke als consumentenvraag naar diensten.[70] De neoklassieke economie vertelt echter maar weinig over de manier waarop nieuwe diensten ontstaan. Ook heeft ze nauwelijks aandacht voor de rol van diensten in technologische ontwikkelingen en industriële evolutie. Dergelijke onderwerpen komen veel nadrukkelijker aan bod in een vorm van economie die de afgelopen decennia aan belangstelling gewonnen heeft bij zowel wetenschappers als beleidsmakers: de evolutionaire economie.[71]

Evolutionair economen houden zich bezig met de vraag hoe de technologische en economische elementen van maatschappijen transformeren, en hoe ze elkaar daarbij beïnvloeden. Dat wil zeggen dat innovatie niet langer een fenomeen is dat van buitenaf op de economie inwerkt: het wordt juist gezien als een endogene factor. Om zich aan te passen aan veranderende omstandigheden, of om die zelf teweeg te brengen, experimenteren economische actoren met het ontwikkelen van nieuwe proposities. Bedrijven investeren bijvoorbeeld in R&D of gebruiken andere (minder geformaliseerde) methoden om op zoek te gaan naar manieren om te hun aanbod te verbeteren en te diversifiëren. Deze zoekprocessen gaan doorgaans gepaard met een hoge mate van onzekerheid over het technische en commerciële succes van een nieuw concept. Daar komt bij dat bedrijven beperkt zijn in hun zoekcapaciteiten. Evolutionair economen gaan er niet van uit dat managers altijd in staat zijn om optimale uitkomsten te verkrijgen door zorgvuldig alle informatie te verzamelen die voor een innovatie relevant is. In plaats daarvan neemt men aan dat deze managers, net als ieder mens, maar een beperkte hoeveelheid cognitieve capaciteit aan hun keuzes kunnen besteden en soms afwegingen maken die niet volledig rationeel zijn. Om een verandering te bewerkstelligen moeten bedrijven en hun werknemers bovendien in staat zijn nieuwe vaardigheden en kennis te verwerven. Vaak bouwt men hierbij voort op reeds bestaande kennis, die dan op een nieuwe manier gecombineerd wordt. Dit kan gaan om kennis waar een bedrijf al over beschikt of die ze extern kan verkrijgen, maar ook de kennis die belichaamd is in de technologie waar ze mee werkt. Welke innovaties een bedrijf weet te ontwikkelen hangt daarnaast ook af van de specifieke economische en maatschappelijke structuren waarin ze opereert (het 'ecosysteem'). Innovatie en industriële evolutie zijn daarmee dus pad- en locatieafhankelijke processen die zich voltrekken langs 'technological trajectories'.

70 De zakelijke vraag is toegenomen doordat waardeketens steeds meer gefragmenteerd raken, onder andere als gevolg van digitalisering en veranderende marktdynamiek. Om een voorbeeld te geven: waar de fases van ontwikkeling/design, productie en commercialisatie voorheen ongeveer evenveel potentie hadden voor waardecreatie, observeren we nu steeds vaker dat vooral de eerste en laatste fase aantrekkelijk zijn. Bedrijven kunnen hun competitiviteit en winstgevendheid vergroten door kennis op te doen over het vervullen van snel veranderende behoeften; daar zitten immers meer mogelijkheden dan concurreren op de grondstoffen en arbeidskosten die vooral belangrijk zijn voor de tussenliggende fase (productie). Dankzij ICT-oplossingen kunnen bedrijven zich specialiseren in kennisintensieve pre- en post-productie, wat we terugzien in statistische cijfers over de dominantie van diensten in sectorstructuur van geavanceerde economieën. De consumentenvraag naar diensten neemt onder andere toe doordat huishoudens die kapitaalkrachtiger zijn verzadigd raken van goederen, en relatief meer gaan uitgeven aan 'ontastbare' vormen van zaken als ontspanning, entertainment en reizen.

71 De evolutionaire economie is het hoofdbestanddeel van de innovatiewetenschappen; vaak worden beide begrippen als synoniem gebruikt.

De hierboven beschreven factoren wijzen erop dat de zoektocht naar nieuwe proposities, bijvoorbeeld nieuwe diensten, meer behelst dan enkel statische verschuivingen in de economische activiteiten die men binnen een economisch systeem vindt. Door vanuit een evolutionair perspectief naar diensten te kijken beoogt dit proefschrift een beter begrip te kweken van wat diensteninnovatie is, en hoe haar strategische en beleidsrelevantie eruitzien.

Onderzoek naar diensteninnovatie

Het bestuderen van het ontstaan van diensten, en hun belang voor (de ontwikkeling van) andere economische activiteit, heeft sinds de jaren '90 een enorme vlucht genomen. Tot die tijd hadden innovatiewetenschappers vooral oog voor 'technologie' in de nauwe zin van het woord, waardoor de focus lange tijd lag op vernieuwing zoals die vooral in de maakindustrie plaatsvindt.[72] Het diensteninnovatie-onderzoek, dat meer recht doet aan de economische dominantie van diensten, voltrekt zich grofweg langs drie lijnen.

Volgens de zogenaamde *assimilatie*-benadering kan diensteninnovatie vanuit theoretisch oogpunt precies zo behandeld worden als enige andere vorm van innovatie. De vergelijking met innovatie in goederen wijst soms op grote verschillen, maar men beschouwt deze eerder gradueel dan fundamenteel van aard. Kenmerkend voor deze aanpak is dat onderzoekers vooral bestudeerd hebben hoe dienstensectoren technologieën als ICT adopteren. Aanhangers van de *demarcatie*-benadering bepleiten een radicaal andere aanpak: zij stellen dat dienstverleners ook innoveren, en dat het fenomeen diensteninnovatie juist het best begrepen kan worden door aandacht te hebben voor de bijzondere karakteristieken van dienstverlening. Doordat onderzoekers dit vooral aantonen door in hoge mate van detail te kijken naar innovatie in dienstensectoren wordt deze stroming ook wel de differentiatie-benadering genoemd. Tot slot is er de laatste jaren toenemende belangstelling voor de *synthese*-benadering. Deze aanpak heeft als doel om de assimilatie- en demarcatie-benaderingen te combineren in één allesomvattend perspectief. In plaats van diensteninnovatie te bezien als fundamenteel gelijk of fundamenteel verschillend streeft men naar een overkoepelende perspectief op innovatie. De bijzonderheden van diensten dienen daarbij geïntegreerd te worden in de algemene innovatietheorie, zodat zij beter past bij een werkelijkheid waarin goederen en diensten in toenemende mate met elkaar verweven zijn.

Opmerkelijk is dat geen van de drie aanpakken echt over 'diensteninnovatie' gaat. De assimilatie-benadering, om te beginnen, ontkent enig onderscheid tussen diensten- en goedereninnovatie. De demarcatie-benadering wijst erop hoe innovatie er in specifieke dienstensectoren uitziet (bijv. financiële dienstverlening, toerisme), maar legt de nadruk vooral op wat er allemaal anders is in deze sectoren. Er is vanuit dit perspectief maar

72 Definiëren we technologische kennis als de kennis die benodigd is voor het verrichten van economische activiteit, dan valt kennis over het leveren van diensten hier ook onder.

beperkte interesse in sectordoorsnijdende lessen die relevant zijn voor iedere vorm van dienstverlening- en innovatie. Het is precies dit gemis dat ertoe leidt dat de synthese-benadering maar langzaam van de grond komt. Deze benadering gaat evenmin echt over diensteninnovatie, omdat zij juist een integraal innovatieperspectief nastreeft waarin niet langer sprake is van een dualistisch onderscheid.

Het onderzoek in dit proefschrift stelt dat er behoefte is aan een aanpak die de stap van demarcatie naar synthese kan bespoedigen. De *pre-synthese*-aanpak die hier geïntroduceerd wordt vult de leemte tussen deze benaderingen, doordat ze gericht is op de vragen (1) wat verschillende verschijningen van diensteninnovatie met elkaar gemeenschappelijk hebben, (2) hoe deze vanuit eenzelfde theorie beschouwd kunnen worden, en (3) hoe diensteninnovatie zich verhoudt tot innovatie in goederen. Wat dit laatste punt betreft ligt de nadruk niet op contrasten, maar juist op synergiën en afhankelijkheden. Onderzoek met focus op diensteninnovatie als centrale thema achten we noodzakelijk om te beter te begrijpen wat diensteninnovatie nu eigenlijk is, en hoe het van belang is voor andere economische activiteiten in een innovatie- of maatschappelijk systeem.[73]

Het voorliggende proefschrift omvat drie thema's, die we bestuderen aan de hand van evolutionaire theorieën op het niveau van, respectievelijk: producten (cq. technologieën), bedrijven, en systemen. Allereerst staan we stil bij de aard van diensteninnovatie: Hoe zien nieuwe diensten eruit? Hoe kunnen we het innovatieproces omschrijven? Het tweede deel gaat over het managen van diensteninnovatieprocessen, en in het bijzonder de vaardigheden die organisaties daarvoor moeten hebben. In Deel C verschuift de focus van manager naar beleidsmakers: welke mogelijkheden heeft de overheid om innovatie in en door diensten te benutten?

Deel A: Wat is diensteninnovatie? Vorm en processen

De zoektocht naar succesvolle nieuwe dienstenconcepten is in het verleden vaak omschreven als ongeorganiseerd, ongestructureerd, inefficiënt en weinig precies. Toch staat tegelijkertijd ook vast dat overal nieuwe diensten blijven opduiken, in welke sector dan ook. Waarschijnlijk is het de 'vage' aard van ontastbare producten die maakt dat er ook maar weinig zicht is op hoe ze tot stand komen. In het eerste deel van dit proefschrift verkennen we hoe ons begrip van diensteninnovatie kunnen vergroten

73 Het is niet zo dat deze benadering nog niet eerder gevolgd is. Het is bijvoorbeeld al decennia lang bekend dat diensten, ongeacht de sector waarin ze geproduceerd zijn, diverse algemene eigenschappen hebben. Onderzoekers wijzen er onder andere op dat diensten ontastbaar zijn, dat kwaliteit en productiviteit berusten op coproductie (zowel dienstverlener als klant hebben hier een aandeel in), en dat productie en consumptie gelijktijdig plaatsvinden (waardoor diensten niet zomaar opgeslagen kunnen worden). Deze eigenschappen van dienstverlening maken dat ook het innovatieproces wezenlijk anders verloopt. Wat er zo karakteristiek is aan het diensteninnovatieproces, en welke rol diensteninnovatie inneemt in de dynamiek van innovatiesystemen, werd voorheen echter niet vanuit één gefocuste aanpak onderzocht. Studies die wij onder het pre-synthese-perspectief scharen werden voorheen gerekend tot demarcatie of synthese, waardoor de scheidslijn tussen deze benadering sterk is vervaagd.

door zowel het zoekproces als de uitkomst daarvan te analyseren met raamwerken uit de evolutionaire economie.

Om met de vorm van diensten te beginnen: hoe nieuwe diensten accuraat omschreven kunnen worden is voor velen al een behoorlijke uitdaging. Men kan zich nou eenmaal moeilijker een voorstelling maken van een abstracte (want ontastbare) propositie, dan van een concreet fysiek artefact. Verschillende onderzoekers hebben daarom raamwerken ontwikkeld waarmee men aan de hand van een set dimensies omschrijft hoe een dienst eruit zit. Met behulp van dergelijke multidimensionale conceptualisaties kan vervolgens ook omschreven worden, als we kijken naar een innovatieve dienst, op welke punten er sprake is van vernieuwing. De conceptualisatie van Den Hertog et al. (2010) maakt bijvoorbeeld onderscheid naar het dienstenconcept zelf, de manier waarop klantinteractie is vormgegeven, de business-partners die betrokken zijn (i.e. het waardesysteem), het verdienmodel, en de organisatorische en technologische inrichting van de wijze waarop het (diensten)product geleverd wordt. Net als een 'business model canvas' verschaft het raamwerk een basis om te bepalen welke aspecten van een (diensten)product vernieuwd kunnen worden. Waarom, hoe, en hoeveel dimensies in een innovatieproces veranderd worden is een vraag die in de literatuur echter nog nauwelijks aan bod is gekomen.

Vanuit de innovatietheorie gezien kunnen we multidimensionale raamwerken beschouwen als een afspiegeling van de 'design space' waarin een bedrijf naar nieuwe proposities zoekt. Design spaces representeren de verzameling van alle mogelijke manieren waarop afzonderlijke productelementen vormgegeven kunnen worden. Sommige configuraties zullen commercieel aantrekkelijker zijn dan andere, hetgeen we aanduiden met het begrip 'evolutionary fitness'. Voor veel producten geldt dat enkele of alle dimensies afhankelijk zijn van elkaar: het wijzigen van één dimensie is dan van invloed op de mate waarin andere dimensies nog passend zijn. Omdat elke configuratie hierdoor een eigen fitness kent, wordt een design space geassocieerd met een 'fitness landschap' dat de fitness-waarden voor iedere configuratie representeert.

Door het innovatieproces te interpreteren als een kwestie van dimensies muteren kunnen we meer grip krijgen op de vraag hoe de zoektocht naar nieuwe dienstenproposities eruit ziet. In hoofdstuk 2 ontwikkelen en valideren we meetschalen waarmee we kunnen vaststellen hoeveel dienstendimensies er echt veranderd zijn als gevolg van de innovatieactiviteiten van een bedrijf. We gebruiken hiervoor survey-data afkomstig van zo'n 400 bedrijven uit de Noordvleugel van de Randstad (de regio's Groot-Amsterdam en Groot-Utrecht). Beschikbaarheid van dergelijke schalen stelt ons ook in staat om een 'service innovation index' te introduceren die de mate van veranderingen in één getal samenvat. Zoals later in dit proefschrift ook zal blijken lenen zowel de meetschalen als de index zich voor een groot aantal onderzoeksdoeleinden.

In hoofdstuk 3 verkennen we de multidimensionale aanpak in meer detail. In plaats van een kwantitatieve benadering volgen we hier een kwalitatieve onderzoeksmethode om nieuwe diensten te bestuderen. Dit doen we met behulp van een meervoudige casestudie op basis van innovatietrajecten van bedrijven in acht verschillende dienstensectoren (o.a. TomTom, KLM, Achmea, Havenbedrijf Amsterdam, Trade Mart Utrecht, en DHV). Door vernieuwingen in hun producten op eenzelfde wijze te beschrijven, namelijk door ze in een zes-dimensionale design space te plaatsen, verkrijgen we een basis om te vergelijken welke dimensies veranderen, hoe ze veranderen, en in welke combinatie de veranderingen voorkomen. Dit leidt onder andere tot de observatie dat sommige dimensies vaak op dezelfde 'archetypische' manier worden gewijzigd (ook al kijken we naar hele verschillende innovaties), terwijl andere dimensies juist veel meer variatie in hun mutaties laten zien.

Om te begrijpen waarom de meeste innovaties meerdere dimensies bestrijken, besteden we uitvoerig aandacht aan de afhankelijkheden die zich tussen dimensies kunnen voordoen. Hiervoor maken we gebruik van complexiteitstheorie die NK-logica wordt genoemd. Deze logica, afkomstig uit de biologie, verschaft een structuur om zoekprocessen te formaliseren en te modeleren. De complexiteit die uit de afhankelijkheden voortvloeit maakt dat bedrijven verschillende zoekstrategieën kunnen gebruiken. Zo kunnen ze nieuwe mogelijkheden verkennen door incrementele veranderingen volgordelijk door te voeren, door meerdere dimensies gelijktijdig te veranderen, of door op modulaire wijze te werk te gaan (waarbij men een set dimensies verandert die alleen onderling gerelateerd zijn). We illustreren deze strategieën met behulp van onze casestudies.

Deel B: Diensteninnovatie managen: een vaardighedenperspectief

Het tweede deel van dit proefschrift is gewijd aan de meer organisationele aspecten van diensteninnovatie: welke vaardigheden zijn het meest bruikbaar bij de processen van kennisvergaring, - transformatie, en –toepassing die uiteindelijk leiden tot de introductie van een nieuwe dienst?

Wanneer men kijkt naar de mate waarin een organisatie aan innovatie doet, worden dikwijls de R&D-investeringen geraadpleegd. In de context van diensteninnovatie stuiten we echter op het probleem dat het begrip R&D, zoals dat doorgaans gehanteerd wordt, maar in beperkte mate van toepassing is op de ontwikkeling van nieuwe ervaringen en oplossingen. In vergelijking met strikt 'technologische' R&D is de zoektocht naar nieuwe diensten vaak impliciet in plaats van geformaliseerd, wat blijkt uit de relatieve schaarste van R&D-budgeten bij 'pure' dienstverleners.[74] Een andere beperking bij het werken met R&D-statistieken is dat ze feitelijk alleen een maat zijn voor kosten: ze

74 Pure dienstverleners zijn bedrijven die enkel diensten leveren. We merken op dat we in dit proefschrift, geheel volgens het voorgestelde pre-synthese-perspectief, zoveel mogelijk kijken naar alle verschijningsvormen van diensteninnovatie (ook bij bedrijven met een hybride portfolio).

geven weinig inzicht in hoe goed een organisatie echt is in het bedenken, ontwikkelen en implementeren van nieuwe producten. Om die reden is er in de management- en innovatiewetenschappen veel belangstelling voor de vaardigheden die organisaties op dit vlak ontwikkelen. De afgelopen jaren wordt er vooral gekeken naar de activiteiten die bedrijven ontplooien voor het uitvoeren van meta-vaardigheden als het vergaren, transformeren en exploiteren van kennis. Net als andere onderzoeksrichtingen in de innovatieliteratuur houdt het debat over zogenaamde 'dynamic capabilities' vooral bezig met innovatie in de vorm van goederen. Dat is spijtig, als we bedenken dat ze veel potentie heeft om ons begrip van diensteninnovatiemanagement te vergroten.

In hoofdstuk 4 gaan we deze uitdaging aan. Het doel is om een set van innovatievaardigheden te operationaliseren die generiek genoeg is om relevant te zijn voor diensteninnovatie in iedere willekeurige sector, terwijl ze ook voldoende specifiek moet zijn om daadwerkelijk te meten in hoeverre bedrijven kennisverwerkende vaardigheden bezitten.

Middels een literatuurreview bespreken we eerste de recente pogingen om vaardigheden met betrekking tot diensteninnovatie te conceptualiseren en operationaliseren. Er is één raamwerk dat zowel de voornoemde kennisverwerkende stappen bestrijkt (vergaren, transformeren, exploiteren), als dat het voortbouwt op studies waarbij de bijzonderheden van innovatie in dienstensectoren worden benadrukt. Dit raamwerk, eveneens afkomstig uit de studie door Den Hertog et al. (2010), voldoet daarmee uitstekende aan de vorm van synthese die wij hier pre-synthese hebben genoemd.

We operationaliseren deze conceptualisatie door onze survey-data in twee willekeurig gekozen helften te verdelen. De eerste helft gebruiken we om een nieuwe meetschaal mee te ontwikkelen en verfijnen, op basis van verkennende factoranalyses (EFA). De tweede helft dient vervolgens om de meetschaal mee te testen, wat we doen met bevestigende factoranalyses (CFA). De resulterende set van vaardigheden bestaat uit het signaleren van klantwensen, het signaleren van technologische mogelijkheden (beide kennisvergaring), het conceptualiseren van een concreet concept (transformeren van kennis), het orkestreren van de productie, en het opschalen ervan (beide kennistoepassing). Met behulp van SEM-analyses bestuderen we ook de onderlinge relaties tussen de uitgemeten vaardigheden. Hieruit blijkt dat vaardigheden voor latere stadia van kennisverwerking sterker ontwikkeld zijn als ook de vaardigheden voor kennisvergaring sterk aanwezig zijn. Tenslotte relateren we de vaardigheden aan gegevens over innovativiteit (op basis van de dimensies en innovatie-gebaseerde omzet) en competitiviteit. Deze analyses tonen dat de vaardigheden hier vaak mij samenhangen, zij het dat de accenten soms verschillen. De belangrijkste bijdrage van het hoofdstuk is echter de meetschaal zelf, die de weg vrijmaakt voor vergelijkende analyses met relevantie voor verder onderzoek, managementtoepassing, en beleidsontwikkeling.

In hoofdstuk 5 stellen we de vraag welke vaardigheden nu werkelijk het belangrijkst zijn voor het creëren van nieuwe of verbeterde diensten. Ook kijken we in hoeverre dit afhangt van de mate waarin een bedrijf in 'openheid' innoveert. Deze vraag is relevant omdat diensten per definitie samen met een klant geproduceerd worden, wat betekent dat er een mate van klantinteractie is die relatief ongewoon is voor maakbedrijven die enkel goederen maken en verkopen. Vooral bij kennisintensieve dienstverleners (knowledge intensive business services; KIBS) is er sprake van veel kennisuitwisseling. Het is daarom opmerkelijk dat deze bedrijven maar weinig aan bod komen in studies naar open innovatie. Uiteraard kan de stap naar een open innovatiemodel vooral grote veranderingen teweeg brengen bij bedrijven die vooralsnog heel gesloten opereerden. Om beter te begrijpen hoe een open strategie van invloed is op wat een bedrijf zelf moet kunnen achten we het echter ook zinvol om de aandacht te vestigen op bedrijven die van nature al heel open zijn. De (pre-synthese) gedachte dat onderzoek in een dienstencontext inzichten levert die van belang zijn voor de innovatieliteratuur als geheel vormt hier wederom het uitgangspunt.

De essentie van hoofdstuk 5 is een onderzoek naar de relatie tussen routinematige en innovatie-specifieke openheid enerzijds, en het belang van sterke innovatievaardigheden anderzijds. De conceptualisatie uit hoofdstuk 4 maakt het mogelijk om te meten hoe goed bedrijven in staat zijn deze vaardigheden te ontplooien. Volgens de zogenaamde 'resource-based view' kennen bedrijven minder noodzaak om dergelijke vaardigheden te ontwikkelen wanneer er veel mogelijkheden zijn om de kennis en vaardigheden van externe partijen te benutten. Onze literatuurreview en een casestudie in de zorg laten zien dat zulke mogelijkheden zich vooral voordoen bij de fasen van kennisverwerving en kennistoepassing. De tussenliggende fase, waarin opgedane ruwe ideeën vertaald moeten worden in concreet uitvoerbare proposities, is moeilijker aan anderen over te laten. Om deze reden verwachten we dat juist conceptualiseren van belang is voor bedrijven die in hoge mate open opereren. Meervoudige regressieanalyses laten zien dat de vaardigheid om technologische mogelijkheden te signaleren normaliter het meest belangrijk is voor ons sample van KIBS, maar dat conceptualiseren inderdaad aan belang wint wanneer ze meer met externe partijen aan innovatie werken. Opvallend is verder dat de vaardigheid om klantwensen te signaleren niet significant gerelateerd is aan innovatiesucces. En dat terwijl dienstverlening toch bij uitstek draait om het in vervulling laten gaan van klantwensen. Deze observatie vormt het uitgangspunt van hoofdstuk 5.

Voor bedrijven die zo goed mogelijk de ervaring of oplossing willen benaderen die de klant verlangt, zoals dienstverleners die hun aanbod personaliseren en interactief te werk gaan, is het belang van kennis over klantwensen evident. Toch hoeft dit niet te betekenen dat ze op dit punt ook het meest onderscheidend kunnen opereren. Hoewel de vaardigheid voor signaleren van klantwensen in hoofdstuk 4 sterk gecorreleerd bleek met het innovatiesucces van al onze survey-respondenten, bleek uit de simultane tests (hoofdstuk 5) dat haar rol ten opzichte van de andere vaardigheden soms maar marginaal is – en wel bij de selectie van KIBS. Een mogelijke verklaring voor deze paradox is dat een bedrijf ook teveel kan luisteren naar wat haar klanten willen. De valkuil die zich dan voordoet is dat innovatieactiviteiten volledig gericht worden op het vervullen van deze klantwensen, waarbij een bedrijf aantrekkelijkere kansen uit het oog verliest. Het risico op deze vorm van 'myopia' is het grootst wanneer een bedrijf haar aanbod niet standaardiseert, maar steeds weer aanpast aan wat een specifieke klant wil.

Door voort te bouwen op de conceptuele en theoretische verkenningen uit Deel A van dit proefschrift onderzoeken we waarom KIBS (die al zo nauw in contact staan met hun klanten) zich nog actief zouden moeten bezighouden met het signaleren van klantwensen. Als startpunt onderscheiden we vier situaties, gebaseerd op de combinaties van weinig/veel feedback van klanten en zwakke/sterke signaaleer-vaardigheden van KIBS. Door gebruik te maken van NK-logica kunnen we vervolgens deze vier situaties modelleren als zoekstrategieën in een fitness-landschap. De onderzoeksmethodiek bestaat hier uit simulatiestudies waarin we 'agents' (bedrijven) in een zes-dimensionale design space laten zoeken naar productconfiguraties met een zo groot mogelijke fitness. Door telkens nieuwe fitness spaces te genereren verkrijgen we robuuste resultaten over de uitkomsten van iedere zoekstrategie. De simulaties tonen dat de vaardigheid om klantwensen te signaleren en (vooral) de mate van klantfeedback beide positief gerelateerd zijn aan innovatiesucces, maar dat hun combinatie juist negatief uitwerkt. Deze bevindingen verschaffen een hypothese die we ook empirisch kunnen testen. Niet alleen blijkt er in onze tests inderdaad sprake van positieve individuele effecten en negatieve interactie; ook zien we dat dit effect zich enkel voordoet bij dienstverleners die daadwerkelijk hun aanbod personaliseren. Het feit dat bedrijven die hun aanbod standaardiseren minder gevaar lopen om 'klantgezwicht' in plaats van klantgericht te innoveren is een les die ook buiten de dienstencontext van belang is.

Deel C: Beleidsopties met betrekking tot diensten en innovatie

Het laatste deel van dit proefschrift is gericht op de praktijk van beleidsmakers. Doordat er veel verschillende interpretaties gegeven worden aan het begrip 'diensteninnovatie' is het vaak onduidelijk waar nu echt kansen liggen om socio-economische doelstellingen te realiseren. Ook de wijze waarop beleid kan worden vormgegeven verdient nog altijd de nodige verduidelijking. In Deel C introduceren we eerst een analytisch raamwerk waarmee diverse vormen van diensten-inclusief innovatiebeleid gecategoriseerd kunnen worden. Vervolgens beargumenteren we hoe beleidsmakers strategisch gebruik kunnen maken van diensteninnovatiebeleid volgens (in het bijzonder) de pre-synthese-benadering.

De evolutionaire imperatief die stelt dat men fitheid en 'adaptiviteit' dient na te streven is evenzeer van toepassing op individuele organisaties als op maatschappijen en economische systemen. Of deze systemen nu lokaal, regionaal of nationaal zijn, ze ontkomen er niet aan om op zoek te gaan naar manieren om kennis te genereren en toe te passen. Hierbij speelt een verscheidenheid aan actoren een rol, die samen een innovatiesysteem vormen. Volgens het functionele perspectief op (technologische) innovatiesystemen dienen private en publieke actoren gezamenlijk een aantal activiteiten te verrichten: deze moeten ertoe leiden dat een aantal cruciale systeemfuncties vervuld worden (bijv. ondernemerschap, kennisproductie, of kennisverspreiding). Doordat de functies van elkaar afhankelijk zijn hebben beleidsmakers als belangrijkste taak om eventuele zwak ontwikkelde functies te ondersteunen. Zij dienen hiertoe een beleidsmix te ontwikkelen die aangrijpt op de knelpunten die op een bepaald moment het meest belemmerend zijn voor innovatie-inspanningen.

Om het innovatiesysteem zo goed mogelijk te laten functioneren dienen beleidsmakers te waarborgen dat ze niet een te beperkt (strikt technologisch) beeld van innovatie hanteren. In hoofdstuk 7 beschrijven we hoe men bij het beleidsontwerp om kan gaan met diensten. Hierbij baseren we ons op de vier perspectieven die centraal staan in het denken over diensten: we onderscheiden innovatie *voor* diensten (cf. dienstverleners die innovaties implementeren; assimilatie), *in* diensten (vaak bestudeerd in pure dienstensectoren; demarcatie), *door* diensten (dienstverleners hebben soms een belangrijke rol bij het aanzwengelen van innovatie bij andere partijen; pre-synthese), of *met* diensten (nieuwe diensten zijn verstrengeld met andere vormen van innovatie; synthese).

Door de vier perspectieven van elkaar te onderscheiden verkrijgen we een basis om te analyseren in hoeverre goederen- en diensteninnovatie worden geadresseerd door innovatiebeleid, en in hoeverre dit op een samenhangende manier gebeurt (voor wat betreft de systeemfuncties). We illustreren dit middels een vergelijkende casestudie waarbij we de beleidsmixen van twee regio's in kaart brengen. Zowel de regio Oberösterreich (Oostenrijk) als de regio Limburg (Nederland) laat zich kenmerken door een economische structuur die lange tijd op industrie georiënteerd is geweest. Door de te beleidsmixen van deze regionale innovatiesystemen naast elkaar te leggen observeren we op welke systeemfuncties de regio's hun beleid kunnen versterken door te kijken naar instrumenten in het innovatiebeleid van de ander (aangenomen dat er zich ook daadwerkelijk een knelpunt voordoet). Ook ontwaren we punten waar beide regio's voor eenzelfde uitdaging staan, en waar ze dus gezamenlijk kunnen leren.

Gebruikmakend van inzichten uit de evolutionaire economische geografie zetten we in hoofdstuk 8 uiteen waarom beleidsmakers er, in onze optiek, verstandig aan doen om te verkennen hoe ze de pre-synthese-benadering kunnen gebruiken bij het aanzwengelen van economische diversificatie. Dit laatste hoofdstuk uit Deel C borduurt niet alleen voort op de descriptieve benadering uit hoofdstuk 7, maar plaatst ook de bijdragen uit eerdere hoofdstukken in perspectief.

De centrale vraag in hoofdstuk 8 is hoe de sterkst ontwikkelde industrieën van een economie de basis kunnen vormen voor competitiviteit. Beleidsmakers hebben soms de neiging om verticaal industriebeleid te voeren door zelf een aantal industrieën aan te wijzen als 'speerpunt'-gebieden, daarbij vooral geleid door de positie die deze domeinen reeds hebben bemachtigd in het internationale speelveld van handel en wetenschap.[75] Het feit dat een sector in huidige marktomstandigheden goed presteert is echter geen garantie voor de toekomst. Om profijt te blijven hebben van de kennis en ervaring die binnen een domein aanwezig is, zal dit domein zich aan moeten passen aan technologische en economische veranderingen. Het mechanisme van economische transformatie en industriële evolutie kan beschouwd worden als een proces van kennis-recombinatie. Of een speerpunt-domein competitief blijft is daarmee sterk afhankelijk van de aanwezigheid van kennis waarmee zij haar kennisbasis kan verrijken. Actoren in het speerpunt-domein zullen uiteraard zelf veel aan kennisontwikkeling doen, maar om tot originele kennis-recombinatie te komen is input uit andere domeinen vaak essentieel. Omdat kennis vaak vloeit tussen sectoren die veel gemeenschappelijk hebben, liggen er ontwikkelingsmogelijkheden op het snijvlak van sectoren die technologisch opzicht gerelateerd aan elkaar zijn. Ook het stimuleren van deze snijvlakken kent echter een nadeel. Hoewel het stimuleren van deze snijvlakken de kans verkleint dat overheden inzetten op de verkeerde sector, kent ook deze beleidsstrategie een nadeel. Recente studies wijzen namelijk uit dat echte doorbraken vooral voortkomen uit de combinatie van kennisbases die nauwelijks aan elkaar gerelateerd zijn. De kans dat bedrijven in een economie originele trajecten identificeren om hun speerpunt-positie te handhaven is dus groter naarmate zij meer in contact komen met kennis die voor hun sector ongewoon is. Het is echter ook bekend dat kennisuitwisseling lastig is wanneer partijen een hoge mate van 'cognitieve afstand' kennen.

In hoofdstuk 8 zetten we uiteen waarom overheden innovatie kunnen aanjagen door niet zomaar in te zetten op afzonderlijke speerpunt-gebieden (en de meest verwante vormen van economische activiteit), maar door juist de relaties daartussen te verstevigen. Aangezien bedrijven uit ongerelateerde specialisaties weinig met elkaar samenwerken, zullen zijn niet in staat zijn om gebruik te maken van elkaars kennis over de stand van technologie en andere relevante ontwikkelingen. De overheid kan dit verhelpen door 'cross-specialisatie' te stimuleren. Mogelijkheden hiervoor ontstaan doordat technologische gerelateerdheid en cognitieve afstand geen statistische condities zijn: bedrijven kunnen nader tot elkaar komen als ze met elkaar interacteren en meer van elkaar weten. In hoofdstuk 8 benoemen we verschillende 'convergentie-factoren' die dit proces kunnen bespoedigen.

75 Opmerkelijk in dit kader is dat verschillende overheden vaak dezelfde sectoren aanwijzen als domeinen waarin ze relatief sterk zijn.

Bij het bespreken van convergentie-factoren staan we vooral stil bij de wijdverspreide behoefte aan meer kennis over diensten-gebaseerde business-modellen en dienstverlening. Dergelijke kennis is bij uitstek een convergentie-factor, omdat ze relevant is voor bedrijven uit welke sector dan ook (zeker ook voor maakbedrijven die zich willen onderscheiden door ook diensten aan te bieden).[76]

Beleidsmakers kunnen op verschillende manieren diensten-gebaseerde links creëren tussen ogenschijnlijk ongerelateteerde sectoren. Zo bediscussiëren we de mogelijkheid om bedrijven te laten samenwerken bij hun verkenning van wat diensteninnovatie is en hoe het voor hen interessant kan zijn. Onderzoek uit Deel A van dit proefschrift kan daar een belangrijke rol bij vervullen, omdat het houvast biedt bij het bepalen van hoe die nieuwe diensten eruit zien en door welke veranderingen ze gekenmerkt worden. Bedrijven die in hele verschillende sectoren actief zijn, en in termen van concurrentie geen bedreiging voor elkaar vormen, kunnen inspiratie opdoen door van elkaars experimenten te leren. Volgens dezelfde logica liggen er ook kansen om te gezamenlijk te werken aan het wikkelen van vaardigheden om diensten te produceren en te vernieuwen (cf. Deel B).

Een ander soort interventie die oog heeft voor het transformatie-potentieel van diensten is het opzetten van horizontale structuren waarin bedrijven uit ongerelateerde sectoren elkaar kunnen vinden. Dit kan bijvoorbeeld de vorm hebben van onderzoeksfaciliteiten met een brede relevantie, bijvoorbeeld als het gaat om 3D-printing of analyse van 'big data'. Ook zien we kansen om ongerelateerde bedrijven (en andere maatschappelijke partijen) te verenigen in platforms die zich bezighouden met eenzelfde uitdaging. Veel hedendaagse problemen vragen immers niet om een afzonderlijke technologie of dienst, maar om een aanpak waarbij meerdere disciplines (en dus sectoren) betrokken zijn. De kennisuitwisseling die hieruit volgt kan vervolgens tot innovatie leiden.[77] Voor de economie als geheel is het daarbij niet van belang of deze innovatie vooral de positie van een bestaand speerpuntgebied verduurzaamd, of juist het startpunt vormt voor een niche die kan uitgroeien tot een hele nieuwe sector.

76 In het hoofdstuk zelf staan we uitvoerig stil bij de trends die ertoe leiden dat maakbedrijven zich steeds minder bezig houden met het produceren van goederen die ergens 'op de plank' komen te liggen, maar ook dienstverlening in hun business model opnemen. Relevante ontwikkelingen zijn onder andere de opkomst van technologieën die een langdurigere relatie tussen producent en klant bewerkstelligen (cf. the Internet-of-things / Industrie 4.0), of die zo'n brede relevantie hebben dat er veel diensten aan één technologie gekoppeld kunnen worden (bijv. 3D-printing). Ook beschouwen we de toenemende focus op toegang (tot ervaringen/oplossingen) in plaats van bezit, zoals we dat zien in de uitgangspunten van de deeleconomie en de 'experience economy'.

77 We erkennen dat een beleidsstrategie gefocust op het exploiteren van kennis uit specifieke industrieën haaks lijkt te staan op de laissez-faire benadering die evolutionair economen vaak aanhangen. Twee nuances zijn hier op hun plaats. Ten eerste bouwen we op evolutionaire principes wanneer we beargumenteren hoe technologische gerelateerdheid een uitgangspunt kan vormen bij het bestendigen van de competitiviteit van een regio's padafhankelijke configuratie van kennis en instituties. We verdiepen dit debat door te wijzen op de potentie van het verbinden van ongerelateerde sectoren, wat een substantieel andere aanpak is dan het voeren van verticaal industriebeleid. Ten tweede wijzen we erop hoe het verspreiden van kennis over diensteninnovatie dient om bedrijven méér mogelijkheden te laten bekijken wanneer ze zoeken naar nieuwe proposities. Meer opties onder de aandacht brengen is feitelijk een zwakke vorm van libertijns paternalisme, waarbij eenieder zelf de vrijheid behoudt om hier iets mee te doen. Dit sluit aan bij de gedachte dat de overheid wel kan aangeven in welke richting ze haar maatschappij graag ziet ontwikkelen, maar dat innovatieactiviteiten uiteindelijk van bedrijven zelf moeten komen. In essentie is de voorgestelde benadering geen industriebeleid, maar focust ze op coördinatie tussen ongerelateerde domeinen.

Om de beleidsrelevantie van het gepresenteerde onderzoek te vergroten bevat de bijlage van hoofdstuk 8 een verdieping van de vraag: “welke kennisgebieden zijn geschikt om een brug te vormen tussen ongerelateerde speerpuntgebieden?”. De methodologie die we aanreiken om deze vraag te beantwoorden heeft als vertrekpunt dat economische structuren gezien kunnen worden als een netwerk van sectoren die in bepaalde mate aan elkaar gerelateerd zijn (de ‘industry space’). We beschrijven verschillende manieren om vast te stellen welke industrie een centrale ligging heeft, en dus bijzondere aandacht verdient bij het identificeren of creëren van verbindingen tussen de zwaartepunten binnen een economie. De diverse manieren om centraliteit te berekenen illustreren we aan de hand van de Nederlandse Topsectoren. Uit de analyses blijkt hoe activiteiten in ieder van de Topsectoren zich tot elkaar verhouden, en wat nu echte cross-overs zijn.

Tot slot

Afgezien van een samenvatting bevat het laatste hoofdstuk uit dit proefschrift ook een verkenning van de wijze hoe toekomstig onderzoek naar diensteninnovatie eruit zou kunnen zien. Om deze discussie te kunnen voeren bespreken we eerst in hoeverre onze studies specifiek zijn voor diensteninnovatie (cf. pre-synthese). Voor sommige elementen geldt dat ze reeds belicht zijn vanuit een perspectief waarin inzichten over diensten- en goedereninnovatie al volledig met elkaar verweven zijn (cf. volledige of ‘post-’synthese). Toch voorzien we niet dat het einde van onderzoek naar diensteninnovatie snel in zicht is. Op vele plekken in het proefschrift betogen we dat diensten- en goedereninnovatie niet diametraal tegenover elkaar gezet moeten worden als ware het twee volstrekt verschillende domeinen, maar dat de onderlinge relaties nog altijd veel aandacht behoeven. Naarmate meer bedrijven product-dienst-systemen produceren wordt het steeds relevanter om voldoende kennis te hebben over de praktijk van dienstenproductie en –innovatie. Ook de cross-sectorale aard van diensten kan het best bestudeerd worden vanuit een pre-synthese-perspectief. Het verder uitwerken van deze lijn van denken is wat dit proefschrift in gang probeert te zetten.

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Many people have had a play in the undertaking leading to the accomplishment of this dissertation. Before I go on and thank them, however, I should spend some words on those who sparked my curiosity in the first place. More than the desire to shed light on unlighted matter, curiosity can correctly be regarded as main determinant of the outcome now lying in front of you.

For long time, and still, my parents have supported me to search and to question. I'll get back to them later. Another inquisitiveness-driving factor was of course the educational system, as it should. From the beginning to the end, my studies in Eindhoven have been a great deal of fun in all sorts of ways. It was during those years that I got enthusiastic about exploring the ways technological and socio-economic change are related to each other. If I would trace back the exact roots of my eventual enquiries, one remarkable event popping up is a little trip to Lille taking place on 2010's Queensday (as the last day in April used to be called). Koen, later to be my promoter, invited me to join a working session of an international research consortium running a project for the European Commission. It was a one day meeting only, but looking backwards the occasion contained many of the ingredients I became to appreciate about the wonderful world of science: I saw how researchers gathered to study important but ill-understood phenomena, how exchanging and enriching academic knowledge resulted in a product supposedly of use for practitioners (the EC), how this collective mission brought people from different places together, and: how much they enjoyed their being-together. My affection for such conditions led me to stay half a year in Lille, attending lessons by service innovation guru Faïz Gallouj. Already on the first day of class Faïz handed me a freshly pressed dissertation, written by someone called Pim den Hertog from Dialogic. At that moment I did not suspect that the end of Pim's PhD-journey would mark the start of my own, but during my internship at Dialogic half a year later it became clear I ended up in a situation allowing me to start participating in science myself. The PhD trajectory I had entered led me to encounter a great number of fantastic people and places. Without doubt, I consider the courses, conferences and otherwise academically motivated journeys amongst my dearest professional experiences so far.[78] By which, by the way, I do not wish to play down the joy I had meanwhile browsing through texts or trying to produce some of my own. Reading about interesting ideas never has been a problem - it was my primary drive to start all this -, but I am happy to have found

78 This includes, amongst others, that time I was the only one traveling by train from a conference in Nice to one in Barcelona, which eventually resulted in a 36-hours Mediterranean sightseeing event due to airline strikes being replaced for railway strikes (at least I had a flight home, but almost did I miss it as I was unaware that Rudi and I had a flight at the same itinerary/hour but from a different terminal); some Danish conference which seemed to end in an all-night happy hour in a gym, but in fact was not ended at all due to a snow storm blocking all flights home; having a beer with Sydney Winter meanwhile debating how services could be properly integrated in evolutionary economics (I kept my promise of giving it a try); the trip to receive a Research Paper Award in Madrid, where I had the pleasure to meet Ian, but also Emmanuel, the greatest rock-and-roll scientist of all (thanks for the Strasbourg-course on this account); and of course all trips where Clara was willing to join.

many people around me willing to help me with creating academic output myself. As the majority of chapters in this thesis have been written between summer 2013 and the end of 2014, I only just began my efforts to expose this output to academic peers. Being appointed at Utrecht University now certainly is helpful in this respect. Nevertheless, the colleagues I have there are only one part of the environment that has been supporting me. This is where I would like to start my words of thanks.

Carolina, the way you guided me through my PhD has been absolutely marvelous at all times. From the start I have been enjoying the fact we can get along so well, but over time I also got to respect your subtle ways of confronting me with hard reality (e.g. the unfruitful research avenues I started walking down) without ever causing demotivation. The discussions we had always seemed productive, no matter the nonsense I initially came up with. As I have experienced your style of supervising as remarkably convenient, it is good to know that my switch to Utrecht actually implies a reduction of geographical distance; I'm confident that also in the future our collaboration will remain fruitful (especially as there are still some papers waiting to be published).

Koen, above I already touched upon your major influence on my career choices. Coming back to that anecdote, I especially recall strolling through the zoo in Lille while discussing the universality of evolutionary mechanisms (perhaps it was then that I selected science; or did science select me?). Many pleasant conversations have followed, on locations ranging from terraces to trains. And always did we have plenty to discuss. Meanwhile I was slogging with my thesis you refined your skill of conducting and coordinating (and attracting attention for) research that excels by combining scientific and societal relevance. I'm very much pleased you gave me the possibility to join you in Utrecht, and I hope I'll be able to contribute to many more research endeavors, be it related to the sharing economy, breakthroughs, or some related variety.

What I should thank both supervisors for (and the whole TIS-group at TU/e) is their flexibility with respect to my working places. By this I do not only refer to our numerous meeting place somewhere on the trajectory between Eindhoven – Utrecht – Amsterdam, but also to offering me the possibility to spend (in total) multiple months abroad every year. If there is anything in this thesis you like, odds are high it is based on an idea that sparked during a journey rather than when sitting behind a desk. I'm thankful I was encouraged to visit as many scholarly events as possible. Over the past years I met numerous wonderful and inspiring persons, and it's great to be befriended with so many of them (Elena, you still owe me a paella by the way). Alex, I hope you don't mind me counting you as one of those friends, although in many respects you have managed to combine this with a position as informal supervisor. If there is anyone who taught me how to be a critical scholar, it certainly is you.

By now I definitely should have started declaring my gratitude to all those great people at Dialogic. Factually HHP is where I spent most of my time during the last years, not

in the least place to read articles and revise papers 'while shifting between projects'. At times, especially the busy ones, I occasionally became to think of by dissertation being the result of a good deal of creative distraction. Which is a compliment to everybody at Dialogic: for offering me the possibility to pursue my science dreams, and for providing such an outstanding working ambiance. I am delighted to be part of this bunch of curiosity-driven researchers incessantly occupied with an obscure mix of engaged discussions and bad word jokes. This though-provoking environment, as well as the (vegetable?) croquets, certainly have delivered a good dose of inspiration.

Pim, of course I should have stressed your part in the story on how my PhD came about. Wasn't this whole thing your idea, actually? I realize how noble-minded your support has been, given that all the minutes I have been spending on this hobby of mine, I could not be assisting you in our daily Dialogic-projects. Fortunately HHP is rich of very capable people, so actually I am making this sacrifice look bigger than it is. But thanks, also for all the wise lessons and trust you have put in me. What I explicitly want to mention is how much I appreciate your mentorship over the past years, as you have been guiding me in virtually any element of being an (advising) researcher. I'm not quite sure how your lessons on different species of sloops fit in this, and I still can't tell a pigeon apart from an eagle, but your influence on my professional development is as pleasant as it is substantial.

Arthur, David, Tommy, Menno; I guess the fact that some of my dearest friends also walk around in Dialogic is quite a miracle (what's keeping you, Stijn?). After completing university we discussed how our natural way of hanging out would now become a matter of deliberate initiative: who would have guessed we now share coffee every morning. And before lunch. And after lunch. And in the afternoon. Twice. I'm very glad I can also consider all my other colleagues as friends. Or do you prefer to be referred to as 'roomie', Jaap? That label somehow doesn't really cover the bond we developed after you and your 5-berry juice discovered how to cheer me up. Is it 17.00h, already?

This concise overview of acknowledgements wouldn't be complete without thanking my non-office intimates. The start of my PhD paralleled a move to Amsterdam, but never have I felt lonely there. Irene, Darío, Alváro, Marco, Daan, Mireia, Dani, Marije, Victor, Alicia; thanks for making me feel at home. You all have contributed substantially to my efforts of letting research rest in the weekend. Especially your lessons in 'drinking mojito's combined with losing games of poker' have been helpful. For sure I didn't read nor write a letter on those Sundays that followed. By the way, it was until now that I didn't realize where all my dimes went, but I would be glad if my poker losses are part of the reason you people suddenly started doing expensive things like getting babies or married. Double the blinds, and double the tiramisu!

I surely should also thank my long-time friends from Heeze. Actually, if writing all the pages in this book has come with a black one, it concerns my failing attempts to see

each other enough. Rick, Kevin, Stephan, Jeroen, Robert, and all the others; I hope that as of now it will be easier to have a beer again. Or some 'dry bread'. Whatever, as long as we see hang out more often. I always think of it as a guarantee for good times, and it definitely is time for good times.

Mum, dad, Paula, Basten; you thought I would forget you guys? No way. You know how much I appreciate all the care and love you always have been giving, so I won't feel obliged to stress that in lengths here. This whole text is starting to sound like one giant cheesy Christmas card anyway. But I do want to mention that I consider having you around, and being sure everything is fine, as a prerequisite for being able to undertake any kind of effort. It simply is wonderful to know you're there for me.

To conclude, I should acknowledge there is someone deserving more than just a special thanks. Clara, it is remarkable in how many ways your place in my life and the course of my PhD are interwoven. Strangely enough it all started with a volcano eruption in Iceland, preventing me from visiting you in Seville a few years ago. Exactly because my rendezvous with you did not take place, I had the opportunity to join Koen that weekend on the trip that brought me to Lille, get Pim's book, and eventually start a PhD (path-dependency at its best here!). By that time we just started to live together, and many joint undertakings were still to follow. Your relentless desire to enjoy and discover is a welcome alternative to my tendency to get work done first, and helps me to remind that conducting research is just one of many ways to have fun (I also should thank your parents for this, as they contributed in many ways). It is true I use to be kidding about doing a PhD 'despite you'. Well, actually I was not kidding. Spending time with you is so much pleasure that I'm not sure if there is any good excuse for doing otherwise. Thanks for your support and your patience, especially considering the fact that most work came after I told you "almost there". I wish I can mean to you what you mean to me, and we'll keep being at each other's side for many years still to come.

Amsterdam, 21-02-2015

CURRICULUM VITAE

Matthijs Janssen was born on the 29th of May 1988 in Woerden, the Netherlands. Most of his youth was spent in Heeze, from where he started studying 'Innovation Sciences' at the Eindhoven University of Technology (TU/e) in 2006. He completed his studies with a Bachelor degree (2009) and Master's degree (2011), both awarded with the highest grade of distinction. At the TU/e, Matthijs followed a two-year Honors Program which ultimately led to the development of health care-oriented service innovation. He also achieved a Master's certificate in philosophy.

The Excellent Student Award Matthijs obtained from the French Embassy allowed him to reside a semester at the Economics department of University of Lille 1, known for its contributions to the field of service innovation. Back home, in January 2011, Matthijs started investigating this topic in more depth as part of his internship at Dialogic. While Matthijs continued to stay at this research-based consultancy firm in Utrecht, he also embarked upon writing his PhD thesis at the TU/e. From mid-2011 to 2012, Matthijs was affiliated to the AMSI Amsterdam Centre for Service Innovation (Amsterdam Business School, University of Amsterdam) as well.

As of November 2014, Matthijs holds a position as postdoc researcher at the Copernicus Institute of Sustainable Development, Utrecht University. His current research still covers the topic of service innovation, but more and more as an element of broader themes like innovation policy, innovation systems, and economic specialization / diversification. In addition, he recently caught special interest in the rise of the sharing economy. In his work at Dialogic, Matthijs specializes in evaluating policy instruments and advising policy makers on the positioning and design of innovation policy strategies. As a consultant he is also increasingly oriented towards the domain of innovation management.

Scholarly publications

The majority of chapters included in this dissertation have been written as independently readable articles. At the moment of printing, most of them were still under review or had the status of conference paper / working paper. Below the list of studies in which Matthijs was the first author:

- Janssen, M., Castaldi, C., and Den Hertog, P. (2015). *Exploring the multidimensionality of service innovation.* In: Agarwal, R., Selem, W., Roos, G., and R. Green (ed). The Handbook of Service Innovation. Springer.
- Janssen, M. (2015, working paper). *Cross-specialization and structural holes: The case of The Dutch Topsectors.*
- Janssen, M. (2015, working paper). *Cross-specialization: (Using services for) Making unrelated strengths related.*
- Janssen, M. (2015, working paper). *The emancipation of service innovation: From pre-synthesis to post-synthesis.*
- Janssen, M., Mas Tur, E., and Frenken, K. *Why 'going out there' when being exposed to user knowledge anyway? A simulation and empirical examination of the sensing paradox in service innovation.* Accepted for presentation

at EGOS 2014 and the EURAM'14 Conference, presented at the Strategy, Entrepreneurship and Innovation (SEI) Colloquium 2014, Milano.

- Janssen, M. and Castaldi, C. (2014, working paper). *In the vanguard of openness: Which innovation capabilities should KIBS focus on?* Presented at DRUID'14 Academy Aalborg, and DRUID'14 Summer Conference Copenhagen.
- Janssen, M. *Service innovation in relation to economic and societal challenges: Four approaches for developing systemic policy mixes.* Presented at evoreg workshop (BETA Strasbourg) 2014, DRUID'14 Summer Conference.
- Janssen, M., Alexiev, A., Den Hertog, P. and Castaldi, C. *Examining dimensionality and interdependencies in service innovation.* Presented at DRUID'13 Summer Conference (Barcelona) and EMAEE'13 (Nice).
- Janssen, M., Alexiev, A., Den Hertog, P. and Castaldi, C. *Management Innovation and Firm Performance in Service Innovation Management.* Presented at Academy of Management Annual Meeting 2012 (Boston). Winner of UAM-Accenture Annual Research Award 2012.
- Janssen, M., Alexiev, A., Den Hertog, P. and Castaldi, C. *Dynamic capabilities for service innovation: conceptualization and measurement.* Presented at Academy of Management Annual Meeting 2013, DRUID'12 Summer Conference, and EURAM'12 Conference. Published as ESIC working paper 2014-07.
- Janssen, M., Alexiev, A. and Den Hertog, P. *Open innovation practices in service innovation: the relation with size, partnerships and environmental turbulence.* Presented at European Academy of Management EURAM'12 Conference.

Professional reports

As indicated in the appendix on the background of data sources, most chapters result from the author's research work conducted at Dialogic. By now, some of the theories, concepts and views developed in this thesis have in turn been applied in other professional reports. The following list contains a selection of studies with relevance for the domains of innovation management and innovation policy:

- Janssen, M., den Hertog, P. (2015). Research & Innovation policy Country Report for The Netherlands 2014. Commissioned by: European Commission (Joint Research Centre / RIO).
- Janssen, M. (2015). The export propensity of service providers – The case of the Netherlands. Commissioned by: Strasbourg Conseil / Ministry of Economic Affairs, France.
- Den Hertog, P., Janssen, M., Minne, B., Veldkamp, J., Korlaar, L., Bongers, F., Erven, B. (2015). Evaluation of the Innovation and Entrepreneurship Policy mix 2009-2013. Utrecht: Dialogic. Commissioned by: Ministry of Economic Affairs, NL.
- Vankan, A., Janssen, M., Van de Vorst, T. (2015). Cross-overs in South-Holland Food-cluster(s). Commissioned by: Hillenraad Partners.
- Gillebaard, H., Janssen, M., Bongers, F., Erven, B. (2015). Nautical services and innovation. Commissioned by: Ministry of Infrastructure and the Environment, NL.
- Janssen, M., Vankan, A., Minne, B., Den Hertog, P. Van Rijnsoever, F. (2014). Evaluation Subsidy scheme Innovative Shipbuilding 2007-2012. Commissioned by: Ministry of Economic Affairs, NL.
- Te Velde, R., Veldkamp, J., Janssen, M. (2014). The Dutch software sector – Survey 2014. Commissioned by: NederlandICT & Netherlands Organisation for Scientific Research (NWO).
- Den Hertog, P., Minne, B., Bongers, F., Janssen, M., Korlaar, L. (2013). *Evaluatie Programmaonderzoek MKB en Ondernemerschap.* Commissioned by Ministry of Economic Affairs, NL.
- Iszak, K., Janssen, M., Poels, M., Den Hertog, P. (2013). *The innovation system of Limburg (NL): Assessment by the European Service Innovation Center (ESIC).* Commissioned by European Commission (DG E&I).

- Janssen, M., Den Hertog, P., Kuusisto, J. (2013). *The Upper Austrian innovation system: Assessment by the European Service Innovation Center (ESIC).* Commissioned by European Commission (DG E&I).
- Hertog, P. Den, Janssen, M., Kaashoek, B., Korlaar, L., Minne, B., Veldkamp, J. (2013). *Third Syntens Evaluation, 2007-2011*. Commissioned by Ministry of Economic Affairs, NL.
- Korlaar, L., Janssen, M. (2013). *Policies in support of high-growth innovative enterprises: country studies for the USA, France and the UK.* In: Empirica, Dialogic & University of Applied Sciences Northwestern Switzerland: Policies in support of high-growth innovative enterprises (2013). Commissioned by: European Commission (DG R&I).
- Janssen, M., Den Hertog, P., Kaashoek, B. (2012). *Service innovation policies: rationales, strategies, instruments*. Utrecht: Dialogic. Commissioned by OECD.
- Bongers, F., Veldkamp, J., Korlaar, L., den Hertog, P., (2012). *Evaluation investments Vlerick Leuven Gent Management school.* Utrecht: Dialogic. Commissioned by: Department of Economy, Science and Innovation, Flandres.
- Den Hertog, P., Janssen, M., Korlaar, L. (2012), *Country report for the Netherlands– Service innovation policy.* Utrecht. Commissioned by: European Policies and Instruments to Support Service Innovation (EPISIS), PRO INNO Europe.
- Van der Aa, W., Alexiev, A., Den Hertog, P., Janssen, M. (2012). *De praktijk van open diensteninnovatie.* In: Van der Aa, W., Den Hertog, P. (ed.): Open diensteninnovatie in Nederland. Den Haag: SMO.
- Den Hertog, P., Janssen, M., Minne, B., Wolven, M., Korlaar, L., Veldkamp, J., Bongers, F. (2011). *Evaluation of the Programmatic Approach to Innovation Policy.* Utrecht: Dialogic. Commissioned by Ministry of Economic Affairs, NL.