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UNIVERSITY SPIN-OFF COMPANIES AS GAME CHANGERS IN ECONOMIC DEVELOPMENT OF SEMI-PERIPHERAL REGIONS:

AN ANALYSIS OF THE EASTERN NETHERLANDS

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University spin-off companies as game changers in economic development of semi-peripheral regions

The aim of this dissertation is to obtain a doctoral (PhD) degree in the scientific field of „Management and Business”

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DECLARATION

I undersigned (name: **Jacob Cornelis Bazen**, date of birth: 24-04-1979) declare under penalty of perjury and certify with my signature that the dissertation I submitted in order to obtain doctoral (PhD) degree is entirely my own work.

Furthermore, I declare the following:

- I examined the Code of the Károly Ihrig Doctoral School of Management and Business Administration and I acknowledge the points laid down in the code as mandatory;
- I handled the technical literature sources used in my dissertation fairly and I conformed to the provisions and stipulations related to the dissertation;
- I indicated the original source of other authors' unpublished thoughts and data in the references section in a complete and correct way in consideration of the prevailing copyright protection rules;
- No dissertation which is fully or partly identical to the present dissertation was submitted to any other university or doctoral school for the purpose of obtaining a PhD degree.

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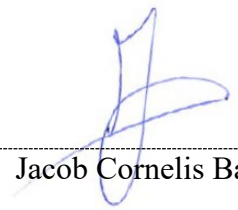

Jacob Cornelis Bazen

signature

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Introduction and research context

Regional economic development is an important issue for many local and regional governments, in terms of providing economic security for their residents (Artobolevskiy, 1997, pp. 2-3; Isard, 1975). Regions and their economic development also have the attention of virtually all national governments, as well as the European Union (EU) on the European level. The EU has a commissioner for regional development in its highest executive body, the European Commission. Expenditures on economic, social and territorial cohesion are one of the largest items on the EU budget (European Commission, 2022). A large part of the expenses under that heading are used for investment projects that support the economic structure of that region to provide economic safety and stability for such regions in the long run. In the budget it is called: "Solidarity between European regions" (European Commission, 2015, 2022).

The goal of this study is to identify to what extent academic spin-off companies contribute to regional economic development of (semi) peripheral economic regions, in terms of employment and growth (Rodeiro-Pazos, Fernández-López, Rodríguez-Gulías, & Dios-Vicente, 2021), and also about their migration patterns and to what extent there might be brain drain and brain circulation. Academic spin-offs are seen in the literature as one of the driving forces that could turn around the economic structure of regions and support the so-called regional innovation system, thereby contributing to economic stability (Bercovitz & Feldman, 2006; Clayman & Holbrook, 2003; Fernandes, Farinha, Ferreira, Asheim, & Rutten, 2021; Miranda, Chamorro, & Rubio, 2018).

In economical geography, countries and regions are often divided into core-regions and (semi)periphery-regions, terms coined by Raúl Prebisch in the 1950s. The idea behind these two terms is that core-regions are capital intensive and are able to attract new innovative businesses with the highest added values and that the lower added value activities are left for the periphery. Prebisch (1962) showed that Latin America was on the peripheral side of the economic spectrum and suffered from deteriorating international trade conditions. Another well-known theoretician in terms of these development questions is Emmanuel Wallerstein, who developed the so-called World System Theory, which explicitly makes the unequal economic exchange relations between core and (semi)periphery as the cornerstone of development issues (Wallerstein, 1974). The periphery is usually plagued by less development, poverty, a bad image, unemployment and outmigration of talent (Kühn, 2015; Leibert, 2013; Moldovan, 2019; Naumann & Reichert-Schick, 2013) as well as being poorly incorporated in the world economy (Mudambi & Santangelo, 2016). Such areas offer little chances for talent and are therefore also less attractive for the most innovative businesses. Semi-periphery takes a middle position between core and periphery regions.

The economic development of more peripheral regions of different EU countries is one of "the grand challenges of the 21st century", according to the British Royal Geographic Society (2015), in terms of keeping rural, old industrial cities and border regions liveable and economically alive. If left by themselves, and not interfering in their development path, such regions may further peripheralize (Caputo, Charles, & Fiorentino, 2022; Wallerstein, 1974), meaning that next to the poor economic circumstances for the inhabitants of such regions, also serious national security issues can develop. In the first place, more out-migration from such regions can destabilize such regions even further: leading to potential hazards such as a larger crime rate, more social problems and can lead to a vicious circle of problems (Bazen & Bijleveld, 2012; McDonald, 2014). In several countries, especially in weak states in the developing world even armed revolutionary movements have started in such regions (Smith, 2001).

The last couple of decades saw the development of many policies aimed at supporting new enterprises as one of the potential answers for the development of regions. The common policy until the 1990s was among others to offer companies premiums for investing in economically troubled regions and the relocation of state-owned companies and specific government services to other parts of the country, to act as "growth pole cores" of economic development (Bachtler & Yuill, 2001; de Smidt, 1985). As the years passed, criticism of this type of regional development policies grew: The investment premiums proved to be expensive and insufficient to attract enough companies to change the regional economic structure of most of the involved regions (Folmer & Nijkamp, 1987; Franz & Schalk, 1994; Morgan, 2007). Plus the companies that did move to peripheral regions were usually branches of "footloose" multinationals with just "shallow roots" in such regions (Dunning, 1997; Görg & Strobl, 2003). Therefore, it was hardly a surprise that regional policy measures underwent a paradigm shift in most countries, sometime during the 1990s, mainly driven by new neo-liberalist ideas on the relation between government and state. Regional policy changed from taking measures to overcome weaknesses of regions to measures aiming to use the existing strengths of regions (Bachtler & Yuill, 2001; Caputo et al., 2022). For the supported regions it meant among others that there was a shift in focus from larger scale projects aiming to attract large investments from outside, towards an approach in which more local initiatives are supported, not in the last place local entrepreneurship and addressing problems in the business climate (Fothergill, 2005).

Since the 2010s, the focus of regional policies in several European countries further shifts towards a more innovation-based approach instead of the previous sort of regional welfare-based approach (Morgan, 2017). There is a growing body of literature on the so-called "innovative periphery", stating that innovation is not just limited to economic core regions, but also happen in the periphery (see for a literature overview: Eder, 2019a). Therefore, several measures to support innovative start-ups and the local labour markets in developing human capital (so-called "smart specialization" of regions) are becoming more and more prominent in regional development programs (McCann & Ortega-Argilés,

2016). One of the consequences of these changes is that there is no more one-size-fits-all approach and therefore more actors in society are mobilized to participate, not in the last place higher education institutions (Bagchi-Sen, Baines, & Smith, 2020; Etzkowitz & Leydesdorff, 1995a; Mathisen & Rasmussen, 2019). The goal of this changed set of regional economic development policies is to enable such regions to innovate themselves out of a periphery situation by means of new spin-off businesses from those higher education institutions, much like the Baron Von Munchhausen in the famous story in which he pulls himself by his hairs from a swamp. It is no surprise that knowledge institutions have been playing an ever increasing role in the process of supporting innovative businesses and more and more attention has been given to those institutions as the cradle of new innovative enterprises (ie. university spin-off companies). This study aims to analyse the development and spatial pattern of such spin-off businesses as well as the regional economic impact that such businesses make. In this study, the spin-offs of two large higher education institutions from the Eastern part of the Netherlands are studied (one research university and one university of applied sciences), and where possible compared with other studies on spin-offs in different (semi) peripheral regions.

1. Research objective and research questions

1.1 Introduction

This chapter covers the research objective, research questions and the scientific and societal relevance of this study. The literature on the subject is very broad and diverse: one can encounter several schools of thought while studying the available literature. Therefore, the first part of this chapter (chapter 1.2), deals with definitions of the most important (policy) components of the study. This part introduces the way how entrepreneurship support policies are embedded in the broader regional economic development strategies. The next part of the chapter describes both the scientific and social relevance of this subject to explain the necessity of studying the topic (chapter 1.3). This part is followed by the research objective and the research questions (chapter 1.4), the conceptual model (chapter 1.5) and the research process scheme (chapter 1.6), that form the backbone and guideline of this study. Even though this introductory chapter contains many definitions, there is no definition of what a university spin-off actually is (ie. which companies do count as university spin-offs and which ones do not). It is a deliberate choice to leave this definition out of this chapter. The reason is that there is an extensive debate within the scientific community on the concept and definition of what a "university spin-off company" constitutes. Therefore, the discussion on and selection of the used definition of this term for this study, is not dealt with in this chapter, but instead part of the literature review and is the outcome of the literature study, to answer the first defining research question posed further on in this chapter.

1.2 Definitions of concepts used in the study

1.2.1 The role of Higher Education Institutions in supporting entrepreneurship

Regional development policy has experienced shifts in the last decades: One of the results – and the central topic of this study – was an increasing attention for innovative entrepreneurship. In many cases, innovative businesses are spin-offs from Higher Education Institutions (HEIs) and it is therefore no surprise that these institutions became more involved in the execution of these regional development policies. HEIs should function as entrepreneurial and innovation centers, by offering knowledge spillovers that would develop into new businesses (Florida, 2021; Sijgers, Hammer, ter Horst, Nieuwenhuis, & van der Sijde, 2006). An important new line of thought, underlining these shifts in regional policies, was the development of the so-called "third mission" of universities besides the already long existing two missions of "education" and "research". The "third mission" means that HEIs should actively try to valorise their new found knowledge. It means that HEIs should open up and partner up with other societal partners, for example the government and other businesses. HEIs should become more entrepreneurial and try to sell the results of their research activities. This could be done by stimulating more traditional activities such as knowledge transfer, but also and certainly not in the

last place by supporting staff members and/or students to start their own innovative business (Etzkowitz, 1999; Etzkowitz & Leydesdorff, 1995a, 2000; Stolze & Sailer, 2022). Collini (2003) argued that universities were open for this shift because they were faced with a strong growth in student numbers of HEIs and at the same time limited growth in governmental funding, often leading to situations of a per student net decrease in funding, so that alternative ways for acquiring university budget became necessary (Harding, Laske, & Scott, 2007). For this study, the most relevant development within the third mission was the ever increasing attention for academic entrepreneurship (Etzkowitz, 1998). In practice, it meant that there was heavy investment in the development of technology transfer programs as well as the strong development of entrepreneurship education for students and in several cases also staff (Katz, 2003; Klofsten & Jones-Evans, 2000; Stolze & Sailer, 2022). A side effect of this policy was that universities became more than ever economic change agents within the regions they are located in, offering innovative workplaces through their spin-offs. In this study, it is explored to what extent these innovative companies and workplaces are retained in the region of origin.

In the before mentioned study of Katz (2003), the development of entrepreneurship education in the USA is described during the second half of the 20th century. Given the ever more central place of entrepreneurship and entrepreneurial behaviour in regional policies, it can safely be assumed that the number of students that follow an entrepreneurship course has grown further strongly all around the world since then (Valerio, Parton, & Robb, 2014), even though reliable statistics about the exact number of participants are not available. What is clear however, is that even though the percentage of people actually engaged in entrepreneurship has remained more or less stable in the last decades, the interest in the subject among young people has soared, as has the research field of entrepreneurship education (Carpenter & Wilson, 2022; Rideout & Gray, 2013). In many (semi) peripheral regions, such programs are seen as an effective way to improve the regional economic structure (Benneworth & Charles, 2005).

Entrepreneurship study programs in universities are there in all sorts and forms. As is maybe unavoidable in a relatively young and complex academic discipline like the study of entrepreneurs and enterprises, definitions among different authors tend to be rather diverse. This is even more so for entrepreneurship education research, see for example the study of Fellnhofer (2019), who distinguishes no less than eight different clusters of research, based on different schools of thought. Nevertheless, the growth of educational programs and the number of recent studies into entrepreneurship is impressive. A very thorough in-depth discussion on entrepreneurship falls outside the scope of this study, however in the literature review chapter, several definitions are discussed, so that it will be clear for the reader which choices are made and which limitations apply related to entrepreneurship and entrepreneurship education within this study.

As already written, entrepreneurship education is very diverse in universities throughout the world. Some universities do not just offer entrepreneurship education as way to stimulate personal growth and

development of the participating students but take the support a step further and help students with the actual start of their business, by giving them practical support in setting up the business and/or help to let it grow faster. Such kind of support is often labelled as business incubation, or business acceleration. The details of the process of business incubation/acceleration itself falls largely outside the scope of this research, although it is important to mention that such incubators "produce" many knowledge intensive academic spin-offs (Soetanto & Van Geenhuizen, 2019). Therefore, some attention is being paid to the methods applied in such incubators, especially on issues that may relate to location decisions of spin-offs: There is evidence that a process of incubation, including the networking and brokerage which these incubators do, influence location decisions of spin-offs, especially for the most knowledge intensive ones (Bazen, 2018b; Van der Meer, Bijleveld, & Van der Meer, 2010).

1.2.2 Entrepreneurship as one of the tools for regional economic development

As written before, entrepreneurship is a core concept of nowadays regional development strategies: at the core is the idea that locally "grown" enterprises are more likely to stay in the region where they originated, than investments of large "footloose" multinationals coming from outside the region with only shallow roots in the region (Conway, 2022; Dunning, 1997; Görg & Strobl, 2003). Supporting start-up enterprises will provide new workplaces for local people and even though most of them would remain (fairly) small, they still do count in total together for a substantial amount of new jobs that are created (Caputo et al., 2022; Muller et al., 2017).

Entrepreneurship support policies are often combined with the support of already existing regional Small and Medium sized Enterprises (SMEs). Within the EU, the European Commission has adopted a plethora of funding and other support mechanisms for these types of businesses. When looking at the statistics, the SME sector of the economy is beyond any doubt very important: of all the workforce employed in the EU, on average around 67% of all workers are employed in SMEs, although there are considerable regional differences throughout the EU (Korcsmáros, 2017; Lazányi, 2015; Muller et al., 2017; OECD, 2019). Furthermore, the growth in employment in SMEs from 2010 to 2016 accounts for more than half the employment growth in most EU countries. Even though these statistics seem impressive, it has to be noted that on average these jobs tend to be less productive than jobs in large companies as well as usually offering lower wages (OECD, 2019). In total, slightly less than 99% of all companies in the EU are SMEs. It is therefore no surprise and probably correct, when the EU charter on Small Enterprises states that these businesses are the "backbone" of the European economy (European Commission, 2014). There is also strong evidence that even though so many people are employed in SMEs in Western Europe, they predominantly have a supporting role in the total economy. This applies for existing SMEs as well as for newly started university spin-off companies, the very large majority of those function as one of the suppliers in extensive global supply chain networks, usually dominated by large companies (Chong et al., 2018; Down, 2010). It is also assumed that academic spin-

offs are more mobile than ordinary SMEs, but since they tend to grow faster, the net-economic effect of having more academic spin-offs may be substantial, even for non-core regions that have a net outflow of talents and companies (Bazen & Bijleveld, 2012).

Just like the shifts in regional development policies, also shifts in interest among researchers can be observed. Within researchers dealing with entrepreneurship, a clear shift can be seen from a focus on the individual and his or her characteristics and entrepreneurial intention and so on, towards a situation in which there is more attention for the regional context, the so-called regional entrepreneurial ecosystem (Wurth, Stam, & Spigel, 2022). This means that there is more attention for the role that regional contexts play in stimulating or discouraging entrepreneurship. Since the relation is bi-directional, there is also a significant effect of entrepreneurship on regions, especially in the case of knowledge intensive university spin-offs. As often with relatively new study disciplines, the research field of entrepreneurship is not yet fully developed, and it appears "to be moving towards more theory-driven research" (Mathisen & Rasmussen, 2019; Rothaermel, Agung, & Jiang, 2007). Three directions of research related to regional influences on entrepreneurship are mentioned here: One direction of research is about the influence of (regional) culture and business/entrepreneurship education in influencing entrepreneurial intention, in order to increase the number of start-ups or at least the percentage of students/graduates interested in starting their own business (See for example: Carsrud & Brannback, 2011; Dajnoki, Szondi, & Filep, 2021; Krueger, Reilly, & Carsrud, 2000; Lazányi, 2014; Luthje & Franke, 2003; O'Shea, Allen, Chevalier, & Roche, 2005; Shinnar, Giacomin, & Janssen, 2012). The problem of this approach of entrepreneurship research is that it can only poorly predict the practical results of individuals actually starting their own business. Entrepreneurial intention proved to be a concept that needed much more theoretical development before it could be effectively used (Krueger, 2009). New ideas based on empirical studies among successful entrepreneurs sprung up, such as the idea of "effectuation" as an alternative (Sarasvathy, 2001; Sarasvathy & Venkataraman, 2011). Effectuation argues that entrepreneurs (including nascent entrepreneurs) are non-linear thinkers, people without a set plan in advance. Taking all of this into account, it comes as no surprise that university policies aimed to increase entrepreneurship among students or graduates by means of developing their entrepreneurial intention have often yielded disappointing results (Krueger, 2009), or otherwise said, the link between intention and action is not (yet) well understood (Bird & Schjoedt, 2009).

A second direction of research into the support of entrepreneurship aims at studying the institutional support context for (nascent) entrepreneurs. Typical aspects of studies in this direction are the results of measuring the effects of different facilities from either regional governments or universities in supporting entrepreneurship. There are many ways how actual entrepreneurship (not entrepreneurial intention) could by supported: for example the results of coaching/mentoring, or the effects on business development due to business incubation and the acceleration of growth because of financial support (See for example: Benneworth & Charles, 2005; Duma, 2014; Etzkowitz, Webster, Gebhardt, & Terra,

2000; Koopman, 2021; Koopman, 2013). Many of these policies can be related to the ideas of Etzkowitz and Leydesdorff (2000), with their concept of the "third mission" for universities. A successful application of the third mission means that entrepreneurship support must take a central place within the university (Arbo & Benneworth, 2007; Goddard & Chatterton, 2003; Parmentola & Ferretti, 2018; Stam & Van de Ven, 2021; Wurth et al., 2022). According to the institutional support literature, the business support systems of universities are of paramount importance for the development of academic spin-offs (Arbo & Benneworth, 2007; Benneworth & Charles, 2005; Stam & Van de Ven, 2021).

As a third direction of entrepreneurship research, several publications are dedicated to the effects of entrepreneurship on the regional economy, especially that of knowledge intensive spin-offs from universities and/or research institutes. In the last decade there has been a large number of publications on the regional entrepreneurial ecosystem and how the interaction between university spin-offs and the regional businesses and other institutions supports or hinders the development of spin-offs. Part of the business ecosystem is the institutional environment (the previously mentioned) second direction, but this direction takes a much broader view on the relation between spin-off and its environment. When the environment does not match with the needs of the spin-off, they may very well decide to move out. Armstrong (2001) for example, observed a strong tendency of clustering of knowledge intensive spin-offs in what he calls "totemic sites of the new economy", a relatively small number of places with a lot of attraction for these types of business. If the observations of Armstrong are correct, it will be difficult for universities in more peripheral regions without a well-developed support infrastructure for knowledge intensive enterprises to understand and measure what is exactly their real effect (Benneworth & Charles, 2005; Harrison & Leitch, 2010). Innovative spin-offs could move away from the region in which they originated, or (former) staff members, students and/or recent graduates from universities in such regions may decide to start their business in another region altogether. At the same time, university spin-offs are attracted to knowledge institutes, among others for obtaining state of the art knowledge. The more such knowledge institutes work on valorising their research results, the more attractive becomes such a region for knowledge intensive start-ups, the so-called knowledge spillover theory (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009). This study fits within this third category of entrepreneurship research and is about the pressing question whether these knowledge spillovers are strong enough to make non-core regions attractive enough for university spin-offs in the long run (cf. Eder, 2019a; Eder & Trippl, 2019; Rodeiro-Pazos et al., 2021).

Entrepreneurship support has its critics too. Several authors argue that – in any case for peripheral economic reasons – when looking at the costs and benefits of entrepreneurial support programs, one might very well come to the conclusion that the costs of entrepreneurship support programs outweigh the benefits (See for example Hughes, 2010), since many successful spin-offs will leave those regions anyway. Even though it is very difficult to measure the effect that such leaving spin-offs may still have on the region of origin, due to their personal/business networks, it is possible to measure how many

spin-offs are leaving and how much jobs disappear with those migrations. It may even be so that when enough new businesses are generated in a certain region, a percentage of those leaving the region may return in search for new business opportunities, the so called brain circulation.

1.2.3 Entrepreneurship and brain drain and/or brain circulation

Migration of both companies and university graduates is seen as a very important issue in regional development. There seem to be consensus among authors that high out-migration levels of young people and especially of university graduates limits peripheral regions in developing and convergence with more well developed and innovative core regions (Biscaia, Teixeira, Rocha, & Cardoso, 2017; Chen & Hiramatsu, 2022; Martin & Sunley, 1998; Neven & Gouymte, 1995; Smętkowski, 2015). In more severe cases, like for example in some regions in Spain, as studied by Rodriguez-Pose (2000), the lack of a qualified work force due to out migration from peripheral regions, severely limits general development possibilities of such regions. The consequence of many people leaving for better opportunities elsewhere is that enterprises, especially innovative start-ups are following in this trend, further limiting the development options of such regions (Moldovan, 2019; Rodriguez, 2023)

One of the things that could be said about actual internal migration patterns of countries during the last centuries is, that these are dynamic. From 1850 to approximately the 1960s there was predominantly rural – urban migration, due to expulsion of workers from agriculture, and the need for labourers in the cities (Antrop, 2004). From the 1960s until the 1990s there was predominantly migration to suburban communities (Florida, 2017; Vining & Pallone, 1982), and to a lesser extent counter-urbanization (Mitchell, 2004). Since the early 2000s, the direction of the migration again reversed and a process of re-urbanization started in which especially the higher educated and creative part of the workforce is attracted to urban areas, and often connected with the term gentrification (Butler, 2007; Florida, 2002b, 2017; López-Gay, 2014), often leaving behind decaying suburban and rural areas.

Internal migration patterns are important, but also international migration should be considered when talking about the issue of brain drain. Most brain drain literature is about international migration. According to Florida (2010) for example, developed countries should be wary of rules to limit immigration of highly skilled people. He argues that these talents are necessary to support internationally competitive clusters of innovative businesses and that such talents are always in short supply. There is consensus among authors on the benefits of immigration of highly skilled and educated workers for the developed destination countries, but on the effects for the countries of origin there is more debate. The classical line of thought is that it has mainly negative consequences for countries of origin, brain drain as a sort of curse (Chen & Hiramatsu, 2022; Gibson & McKenzie, 2012; Schiff, 2005). The report on the question “When brain drain hurts the economy?” (OECD, 2008), offers another perspective, that of “brain overflow”, which means that for some destination countries there could even be too many higher educated people (in a number of sectors, likely not including the highly sought after

technical and IT related specialists), leading to downgrading of the appreciation of the professional skills of incoming migrants. In many developed economies there are more or less strong restrictive policies on immigration from developing countries, especially for unskilled migrants, not to compete with the local workforce (Solimano, 2001).

Not everyone views "brain drain" as a curse: There is another line of thought related to brain drain of the "best and brightest" from peripheral regions and/or developing countries into the developed world. This of course includes the migration of highly skilled innovative entrepreneurs to offer their products or services somewhere else. Kapur and Hale (2005) conclude for example that the benefits of out-migration for the receiving countries as well as the migrating companies themselves, clearly outweigh the costs of migration in terms of a more limited development potential of the countries of origin. Schiff (2005) summarizes these perspectives, central to what he calls "new brain drain literature" as follows: Brain drain raises the potential return on investment in terms of pursuing an education, leading to more investment into education and entrepreneurship support in countries or regions affected by brain drain, so that the net result will actually be a so-called "brain gain", which in turn leads to increased welfare and growth (See for example Stark, 2004). The focus of this study is not about the differences in regional/national entrepreneurship support programs as response to brain drain, but it is a very interesting thought to keep in mind when thinking about a peripheral region as a sort of "incubator region" where new businesses are born and grow before leaving for somewhere else. According to this thought, the empty places left behind by leaving companies could be then filled by talented new local entrepreneurs.

Another aspect identified, related to this brain gain is the so called "brain circulation", in which migrants send money back to the countries origin in the form of remittances, a relatively stable flow of money that can be used for development projects (Solimano, 2003), as well as – and arguably more important – share their knowledge and experience (Gibson & McKenzie, 2012). Unfortunately there is no evidence that higher educated migrant workers remit more money than unskilled ones (Faini, 2007), leaving a strategy of reliance on remittances from well-paid higher educated migrant workers for further economic development of the country of origin, to be a strategy that will likely have just limited results. Nonetheless, the IT industry clusters in Taiwan and Bangalore have been built up by returning entrepreneurs, showing that there is a certain potential in this brain circulation based development idea (Saxeenian, 2001). An example of the potential for entrepreneurship support, using the idea of brain circulation among migrants is given by Papp, Bilan, and Dajnoki (2018) about the situation in Hungary, where it appears that a growing number of migrants plan to stay temporarily in the country and afterwards return. Crescenzi, Holman, and Orrù (2016) similarly study the careers, migration and return behaviour of highly skilled migrants from Sardinia. Other examples of influential studies on the extent and consequences of "brain circulation" are those of Saxeenian (2001) and Chacko (2007) who describe Silicon Valley entrepreneurs and high-qualified workers of Indian descent, moving back to Bangalore,

to start businesses there and bring new knowledge to India. A more recent study of Zagade and Desai (2017) confirms these findings and describes the importance of these professionals in sharing knowledge and using their personal networks in both the country of origin as well as the country where they migrated to, before returning. Empirically measuring the effects of brain circulation is difficult (Gibson & McKenzie, 2012) and studying it often leads to the conclusion that its effects are exaggerated (Schiff, 2005), which provides some evidence to the statement that the Chinese and Indian brain circulation of IT entrepreneurs as described by Saxeenian and Zagade and Desai are the exceptions and not the general rule. Especially in the case of African countries, the extractive governments and other complicated social and economic factors have led to less return migration or knowledge sharing projects as compared to several Asian countries (Acemoglu & Robinson, 2012; Campbell, 2015). More evidence of this can be found in the study on the Bosnian diaspora in Switzerland (Efendić, Babić, & Rebmann, 2014), which clearly shows the complicated relations and expectations between the country of origin and its "diaspora" abroad. A study from the OECD (2008) finds that no less than 40% of the highly skilled migrants arriving in OECD countries are actually transfers from other OECD countries, which gives some evidence that brain circulation within the group of OECD countries is likely to happen. It is however not possible from the given methodology to figure out how many of these migrants are exactly returning migrants. There is also no data on the number of migrants returning to developing countries, although it can be assumed from the study that this number will likely be higher in emerging markets (BRICS) than in developing countries. One of the arguments for this mentioned in the study is that in several developing countries (for example Egypt), university graduates have large problems to be absorbed into the labour market and resort to either working for the government, accept "underemployment" or choose to emigrate. It is not likely to assume that many of such migrants will return. Nonetheless, given the growth of many emerging markets, brain circulation is a potential force that must be reckoned with in terms of possibilities for economic development of regions (Bazen, 2020b, 2021).

1.3 Scientific and societal relevance

The objective of this study is to get a clearer picture on the level of economic impact that university spin-off companies have on non-core regions. Economic impact is about the question to what extent such university spin-offs generate local employment, or tend to move out towards other regions in search of better opportunities for growth. In this study the development of spin-offs, including their locations, – if applicable – their migration patterns, and development in terms of numbers of workplaces. The academic aim of this study is to contribute to the understanding of the development of spin-off companies. This study also aims to test available theories on the location decisions and migration patterns of university spin-off companies. The reason why this is academically relevant is that university spin-offs belong to the most innovative companies around. In very rare cases, such spin-offs can achieve so-called "unicorn" status, and those spin-offs can be found among the companies with

the highest growth rates. Upon studying the available literature, one can easily conclude that the subject of spatial distribution of spin-off companies is somewhat under researched. Furthermore, when looking at the development spin-offs throughout time, there is a clear lack of studies on this topic: Only very few empirical longitudinal studies are available to date. This study wants to tackle this by providing both an overview of the actual migration patterns as well as the consequences of management decisions to migrate or not to migrate, in development and growth of these companies. Therefore, better understanding of the actual migration pattern and the motives behind migration can provide more empirical evidence to core-periphery economic development models.

The societal aim of this study is to get better insight into what influence university spin-offs have on the regional economy: it will help policy makers with a better understanding of where university spin-offs are located and in which cases policy measures could make a significant difference in attracting spin-offs to a (semi-)peripheral region. It also helps to get insight into the policy options that are available for helping to retain more of the spin-offs that are already established in such a region. This study provides policy makers with a clear understanding of which types of spin-offs are likely to leave the region of origin, and will help them in formulating policy measures that have a more solid scientific substantiation. Policy makers will also get insight into the questions which types of spin-offs are most likely to stay in the region or most likely to move out of the region. Based on these insights, more targeted policy measures can be formulated to increase regional attractiveness for specific types of university spin-off companies. The consequence of this is that it will lead to a more developed regional economy.

1.4 Objective of the study

The objective of this study is to contribute to the understanding of the influence that university spin-off companies have on the regional economy in general and the regional innovation system in particular. As university spin-off companies are a highly heterogeneous group of companies, the group of spin-offs will be subdivided into different subtypes of spin-offs as well as the type of parent institution (research university or university of applied sciences).

The following main research question is formulated: *In what way and to what extent do different types of university spin-off companies influence the regional innovation system and to what extent could the differences in spin-off types explain the spatial behaviour of these spin-off companies?*

This research question can be divided into four subquestions:

1. In which way could university spin-offs be defined and what is their importance for the development of the regional economy in their region of origin?

2. What spatial pattern (including migration) can be identified for different types of university spin-off companies from higher education institutions in the eastern part of the Netherlands?

3. Which differences in innovativeness, company development and spatial pattern can be observed for spin-offs from research universities and universities of applied sciences in the eastern part of the Netherlands?

4. To what extent do knowledge and resource links play a role as location factor for different types of spin-off companies from a university in a peripheral region?

These four sub-questions above can be described in more detail as follows:

- In which way could university spin-offs be defined and what is their importance for the development of the regional economy in their region of origin?

The question which businesses can be / should be qualified as spin-offs is a much debated one. Based on the literature review, a specific definition is chosen which is on the one hand workable (in the sense of measurable) and on the other hand also providing enough meaning in order to be able to understand the specific role of educational interventions or other forms of non-formal entrepreneurship education by universities. The second part of the question deals with the importance of such spin-offs for the regional economy. Importance can be measured on many levels, in terms of jobs created, innovation, social impact or improvement of the general image of the regions. In this study, the choice was made to study the economic impact on the basis of the amount of workplaces, as this data is easily measurable and available in governmental databanks. In the research methodology chapter, more information can be found on the specifics of the measurements on this topic.

- What spatial pattern (including migration) can be identified for university spin-off companies from the eastern part of the Netherlands?

Discussions in the literature about spatial patterns of spin-offs often describe so-called knowledge spillovers as reasons for such companies to locate in certain places, usually close to the universities they originate from. This study will show the actual longitudinal location pattern of university spin-offs, based on empirical evidence. There are only very few studies that track university spin-offs throughout their lifetime. Some of these university spin-off companies are among the high-tech, high-growth category. It is therefore very interesting to understand how these companies behave spatially. According to the core-periphery theory, there should be a substantial flow of spin-offs from the periphery to more core regions. This research question will therefore contribute to general empirical knowledge of such migration patterns.

- Which differences in innovativeness, company development and spatial pattern can be observed for spin-offs from research universities and universities of applied sciences in the eastern part of the Netherlands?

In most of the literature on the subject, there is little attention for the differences within the group of spin-offs. One of the aspects of which spin-offs from higher education institution differ, is whether these spin-offs come from research universities or from universities of applied sciences. As is known

from different studies, universities of applied science usually have a more regional profile in terms of student population and industry relations than research universities (Rossano et al., 2023). Therefore, it is likely that the spin-offs that these institutions generate are also different and show a different development and spatial pattern, thus having also different levels of impact on the economy of the region of origin.

- To what extent do knowledge and resource links play a role as location factor for different types of university spin-off companies?

This research question deals with the importance of knowledge and resource links in relation to location factors of spin-off companies. Previous research among the general population of Dutch (and other West European) companies has pointed towards an ever increasing importance of so called "soft" location factors, of which the availability of specialized knowledge is part of (Pellenbarg, van Steen, & van Wissen, 2005; Pen, 2000; Rodriguez, 2023; Van Oort et al., 2008). Specific motives for university spin-off companies related to decisions whether to migrate or not are somewhat under researched. Some work on this subject has been done by Egeln, Gottschalk, and Rammer (2004) as well as Avnimelech and Feldman (2015), but an overview of migration motives, and especially the role of knowledge links as migration motive for university spin-offs and if there are significant differences with migration motives of the general population of businesses is missing. There are, to the knowledge of the author, no studies available on specific types of spin-offs and the role that knowledge links play in relation to the spatial pattern for more and less innovative university spin-offs.

1.5 Conceptual model

The relations mentioned in the research question and sub-questions can be visualized in a conceptual model (Figure 1-1) based on the influential model of an ideal-type regional innovation system of Cooke and Piccaluga (2004).

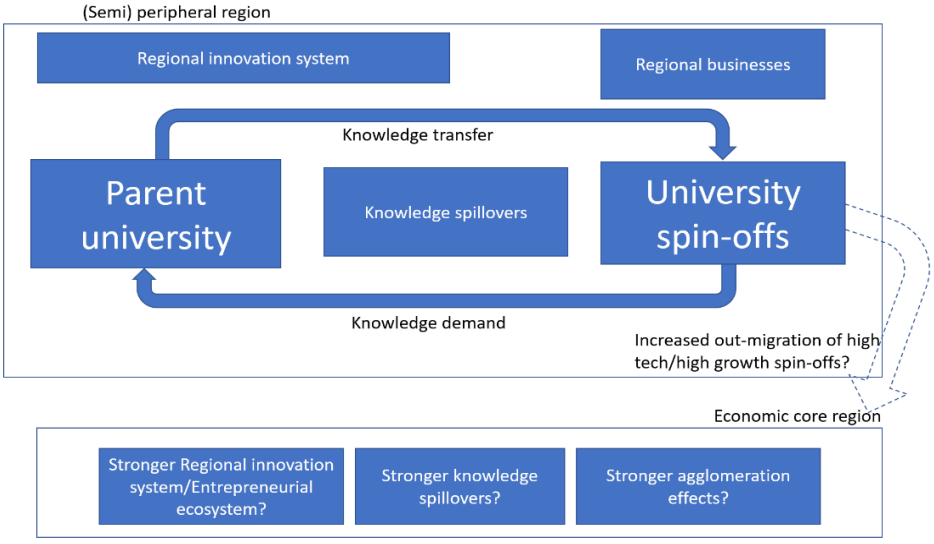


Figure 1.1: Conceptual model of migration of university spin-offs
Based the regional innovation system model of Cooke and Piccaluga (2004)

Since university spin-offs are by definition companies that work on the "translation" of university developed knowledge into actual business, this regional innovation system model is useful to show the knowledge relations between parent university and spin-off. The original model assumes that knowledge links between universities and businesses are key determinants of regional innovation systems, supported and/or enhanced by regional "assets" such as relevant business clusters. In the adapted conceptual model, the regional innovation ecosystem in a semi peripheral region, experiences influences from economic core regions. These influences pull on university spin-offs, especially the ones with ambitious entrepreneurs, aiming for company growth. It is expected that many high tech/high growth companies will leave the region of origin. The literature review chapter deals with the detailed aspects of all the factors mentioned in the conceptual model.

1.6 Research process scheme

The final part of this introductory chapter consists of the so-called research process scheme, which has been the guideline throughout the research process of this study. The schedule is shown in Figure 1.2 and consists of a number of steps that have been taken to execute this study and get to the conclusions, recommendations and the identification of several novel findings. The start of the research process was the identification of the research problem, the question whether university spin-off companies can function as game changers for (semi) peripheral economic regions, or that most of the spin-off companies originating from parent universities in such regions would move out from such regions in case of growth of such companies. In other words, do (semi) peripheral regions function as "nursery" for these kinds of businesses, but would they mostly leave when they "grow-up" and become larger, or would they mostly stay in the region and because of their – more than average – innovative nature, clearly contribute to the spread and development of new knowledge and therefore better economic prospects for the region.

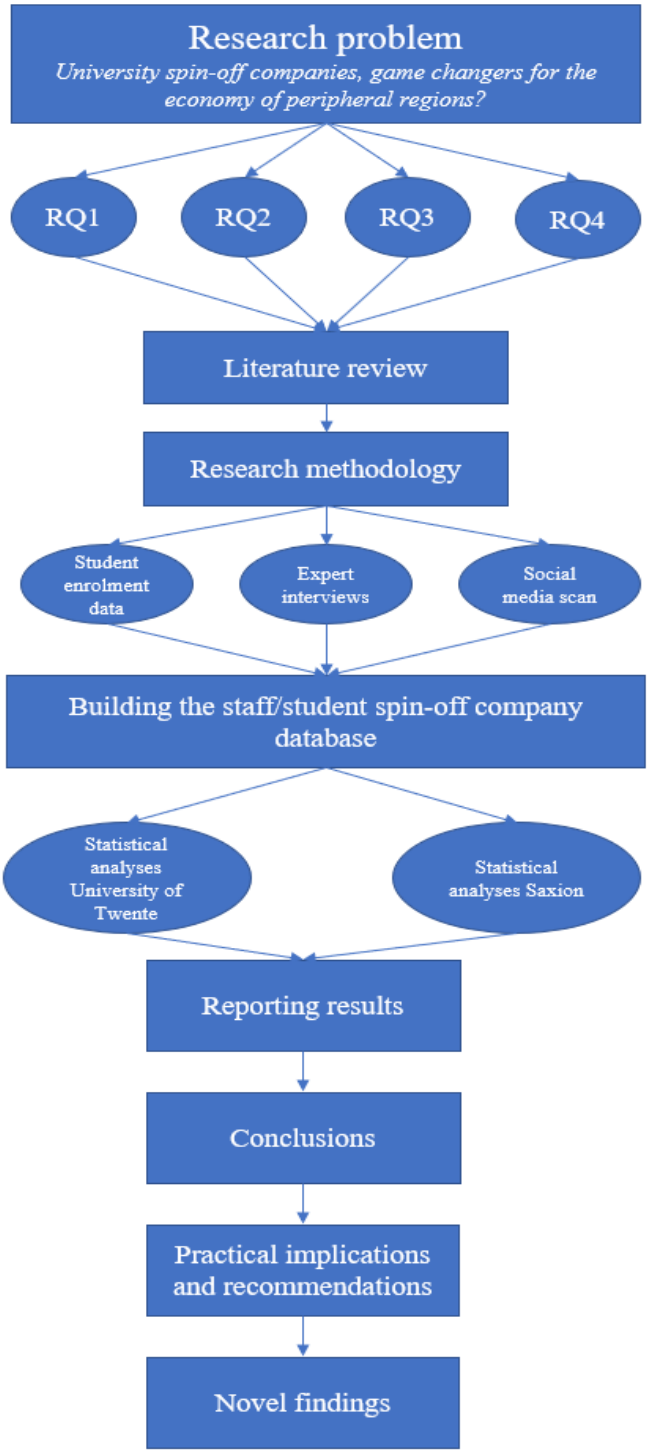


Figure 1.2: Research process scheme for this study

This research problem led to four research questions, discussed in more detail in chapter 1.4. To answer these research questions, first of all a literature study was performed to find the state of the art literature on this subject. The resulting summary of the literature review is written down in chapter 2. Chapter 3 deals with the next steps in the research process, namely the building of the university spin-off database, based on student enrolment data (in which students are asked if they have their own company), expert

interviews with business developers in the university business incubator and a social media scan (mainly on LinkedIn) to find graduates and staff members with their own business. Chapter 4 deals with the findings of the study, related to the research questions and shows the classification and distributions as well as several other statistical analyses. The 5th and final chapter deals with the conclusions and practical implications (i.e. the recommendations for the policy makers in the region) and concludes with a list of novel findings of the study.

2 Literature review

2.1 Introduction

In this chapter, the available literature on the subject of the regional economic effects of spin-off companies is being summarized and discussed. The first part of the literature review (chapter 2.2) deals with the importance of university spin-off companies for the regional economy. In this part, the available literature on the subject is described. The importance of spin-offs is a quite diverse subject, involving entrperneurship, business opportunities and the regional economic framwork conditions. This subchapter also shows an overview of several definitions of university spin-offs and provides based on these findings, a definition of what a university spin-off consists of. This is necessary because there is considerable debate in the literature about which companies to count as a spin-off company and which ones not. After the discussion on the importance of spin-offs for the regional economy follows chapter 2.3, with a discussion on agglomeration and deagglomeration effects in order to understand better the likely motives behind the migration patterns of university spin-off companies. The third part, chapter 2.4 consists of a literature review on the consequences of these agglomeration effects on innovation in more peripheral regions. In this subchapter there is considerable attention for the ongoing debate between the role and function of economic core and peripheral regions in the innovation landscape. The fourth part (chapter 2.5) deals with government policy implications for developing innovative businesses in non-core regions. The final section (chapter 2.6) deals with location and migration patterns of spin-off companies in the existing literature, providing a twofold function, namely the theoretical basis of the way that spin-offs behave spatially as well as offering comparative material for the findings of the empirical part of the study.

2.2 Importance of spin-offs for the regional economy

2.2.1 Introduction

The first subchapter of the literature review deals with some of the fundamental issues related to the regional economy and the somewhat enigmatic term “university spin-off company”. Many different authors have written about university entrepreneurship and spin-offs, and sometimes it seems there are as many definitions around as there are authors on the subject. Chapter 2.2.2 gives an overview and summary of the available literature on the subject and develops the framework for this study in terms of definitions of academic/university spin-off companies. Chapter 2.2.3 zooms in on the region and regional entrepreneurial ecosystem and the position that university spin-offs have in such a system. This is done on the one hand, because of the pressing question how relevant the region still is in an ever more globalizing world, and on the other hand, to understand the role that a region and its characteristics play in stimulating or discouraging entrepreneurship. Chapter 2.2.4 examines the observed regional impact

of spin-off companies as well as the regional conditions that university spin-off companies appear to be looking for.

2.2.2 The quest for a definition of spin-off companies

As already written in the previous paragraph and the previous chapter, there are many definitions for university spin-offs, a situation that Bathelt, Kogler, and Munro (2010) as well as Mathisen and Rasmussen (2019) call "surprising" for such an often studied phenomenon with such an impact in society. Syed, Singh, and Spicer (2023) conclude in their bibliometric analysis over the last 25 years that the research field is (still) fragmented, with several subareas that are underrepresented in the analysed studies. When looking at the available studies that do describe a definition of what a university spin-off is, some authors define spin-offs very widely, as any business that appears from (former) staff or students from a certain university (Roberts, 1991). Others use a very narrow definition, which limit university spin-offs to just these businesses that are started by (former) staff and are aimed at commercializing research results, and therefore have clearly defined intellectual property in their portfolio (Shane, 2004a). One of the reasons that there seems to be so much difficulty in reaching a common definition of what a university spin-off actually is, may be related to the heterogeneity of the types of businesses that appear out of university staff and students, as well as the different methods to study them (Bathelt et al., 2010). It is therefore not surprising that Pirnay, Surlemont, and Nlemvo (2003) in their study on academic spin-offs from MIT in the Boston area, found different numbers of spin-offs reported by different authors, just because the definitions used were different and not necessarily very clearly defined. The same study by Pirnay et al. (2003) attempted to construct a typology for university spin-offs. A later influential study of Mustar et al. (2006) focused more than Pirnay et al. on the heterogeneity of the university spin-offs and constructed their classification for spin-offs likewise. An attempt to summarize and classify the growing literature on academic spin-offs was done by Rothaermel et al. (2007). They however circumvented the issue of the different definitions of what counts as an actual university spin-off by stating that it is a research field in progress. Pirnay et al. (2003) call this *loose definition of a key element to be potentially harmful for further research*. Rothaermel et al. (2007) explain this lack of definitions and general theory on entrepreneurship by stating that *no powerful unifying paradigm yet exists*. Similar observations are made by other authors (See for example Busenitz et al., 2003). Therefore, before continuing with defining university spin-offs, it may be very useful to first delve a bit deeper into the actual topic of entrepreneurship itself. This is done to get a better understanding of the existing theoretical foundations of the theme of entrepreneurship as well as the academic context from which university spin-offs are coming forward.

Even though there might not be a generally accepted paradigm on entrepreneurship, there seems to be consensus in the literature that an entrepreneur is an actor that alone or with the help of others combines resources to initiate new business initiatives and acts therefore as an engine for societal change

(Leibenstein, 1968; Schumpeter, 2017). It is also broadly accepted, that in specific markets which are dynamic and experience fast technological development entrepreneurs are especially active, to search for a 'market niche' so that inefficiencies are mitigated (Hayek, 1945; Kirzner, 1997). There is also broad consensus that *the heart of entrepreneurship is an orientation toward seeing opportunities* (Krueger, 2003). In their highly cited research note on the "promise of entrepreneurship as a field of research", Shane and Venkataraman (2000) describe that most studies on entrepreneurship are on the performance of individual entrepreneurs, or firms, in the context of small or newly established businesses. This however is not necessarily always the way in which "resources are being combined to initiate new business activities". The conceptual difficulty in the field, as Venkataraman (2019) notices, is that there are in entrepreneurship research two different entities that play a role: *the entrepreneur* (and his/her team) and the *business opportunity*. The one cannot exist without (or is at least strongly dependent) on the other. Therefore it is difficult to clearly define in the first place what exactly is entrepreneurship and how to study it. Shane and Venkataraman (2000) propose as solution for this problem to see entrepreneurship as a process of value creation, where opportunities that objectively exists, need to be "translated" or "optimized" into a marketable product or service. This entrepreneurial process can take place within companies or can lead to the establishment of new companies (See also Amit, Glosten, & Muller, 1993; Bennett & Chatterji, 2023). Several studies indicate that when it is difficult to acquire financing, for example when markets need large investments, potential entrepreneurs tend to deploy their activities within existing firms or sell their idea to an existing firm, rather than starting a new company (Cohen & Levin, 1989; Graebner & Eisenhardt, 2004; Perlines, Ariza-Montes, & Blanco-González-Tejero, 2022). In this study however, since the focus will be on university spin-off companies, this so-called intrapreneurship will be largely left out of the picture, as it does not fall within the formulated research questions of this study. It should however be noted here, that the process of commercializing research results may indeed very well involve already existing companies.

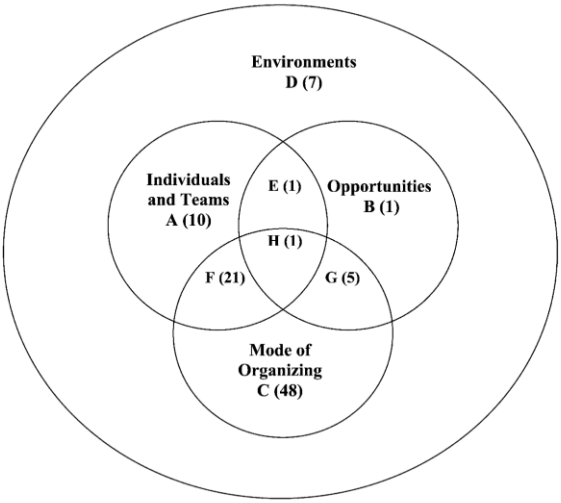
As written in the previous paragraph, Shane and Venkataraman (2000) describe in their research note that the conceptual framework of entrepreneurship in principle consists of two main variables: the entrepreneur (and his/her team) on the one hand, and the business opportunity on the other hand. Research on the entrepreneur and the team can take the form of research into questions whether entrepreneurs have different kind of psychological characteristics from the general population (McClelland, 1965) or have different cultural capital (See for example Kyle, Blais, Blatt, & Szonyi, 1990; Lazányi, Virglerová, Dvorský, & Dapkus, 2017). Research into business opportunities is about market and environment interactions that offer new means-ends relationships. In their literature overview, Busenitz et al. (2003) added a few more aspects of entrepreneurial research. As third aspect, or third circle they added the so-called *mode of organizing*. With this mode of organizing they mean the way the business is organized, such as management practice, acquisition of resources and followed strategies. All of these three aspects of entrepreneurship: the entrepreneur and the team, the business

opportunity and the mode of organizing are occurring within the context of the *environment* around the business. The environment can provide encouraging or discouraging stimuli for the development of businesses. Included in this aspect of entrepreneurship research are issues like the cultural, political/judicial, economic and market factors that help or do not help to create a favourable environment for businesses. Others, like for example Hobsbawm and Wrigley (1999) and Baumol (1990) have nuanced this point of view and argued that entrepreneurs are always active, regardless of the environment in which they are in, it is just a matter of whether the environment offers incentives for productive (innovative), unproductive (rent seeking) or destructive (criminal) types of entrepreneurship. Murphy, Shleifer, and Vishny (1991) provided evidence in their study that countries with higher percentages of engineering students are economically growing faster than countries with higher numbers of students in law programs, as such professionals are more wanted in rent seeking economies, thus contracting economic growth. Still, notwithstanding these nuances on the effects of the broader environment, it is in any case a factor to be reckoned with. In this study, it will be assumed that the environment will be in principle rewarding for innovative entrepreneurship and discouraging for rent seeking and destructive forms of entrepreneurship.

It is not surprising that Busenitz et al. as part of their literature review, found also studies that addressed overlapping issues between the circles of entrepreneurial aspects they identified. In fact, as they argued, these overlapping issues should be the core of entrepreneurial research. Objective business opportunities may very well exist, but without the entrepreneur, and the way how those opportunities can be tackled, no complete picture of entrepreneurship can be given, or as they write

> *...entrepreneurship is a multi-faceted phenomenon. Like the Kipling parable about the blind men and the elephant, simply touching one leg or the tail will not provide a synthetic view of the creature* (Busenitz et al., 2003).

Figure 2-1 shows the entrepreneurship research framework as developed by Busenitz et al. It shows between brackets the number of papers they found in their literature review on each of the given topics. There are as can be seen in the figure relatively few articles that deal with the overlapping themes, which is surprising to the authors, given that at these intersections would be the unique aspects of entrepreneurial research.



Conceptual domain of entrepreneurship as a field (n = 97 articles). Other articles, not included in specified categories (3). ( ) indicates number of study articles classified to this domain or intersection area.

Figure 2.1: Conceptual domain of entrepreneurship as a research area according to Busenitz et al. (2003)

Among the study of entrepreneurship, one of the phenomena that got quite a lot of attention is the university as place where because of research results, new ideas are generated and new business opportunities are so to say "born" (assuming here that Shane and Venkataraman are right with their assumption that business opportunities are real existing objective possibilities just "laying around" waiting to be discovered, developed and exploited). Schumpeter characterizes entrepreneurs in his famous work Capitalism, socialism and democracy (2010) as so-called "free spirits", who are driven by technological development and using that to initiate innovations, or as he calls it: creative destruction of existing business and/or societal structures (i.e. new things that replace old things). Throughout most of the 20th century however, it was common belief among economists that one has to be large and use economies of scale, to be able to innovate (Audretsch & Tamvada, 2022; Audretsch & Thurik, 2004), overlooking the creative destructive power that new technologies in the hands of entrepreneurs had. The university and/or its immediate surroundings with new knowledge in abundance seem to be one of the most likely places for (future) entrepreneurs to search for new market opportunities.

The first economist who described the importance of the "proximity of knowledge" for businesses was Alfred Marshall (1920) in his seminal work Principles of economics. He realized that businesses tended to cluster together, because it was advantageous that knowledge could informally flow from one business to the other. Later, in the twentieth century, several more ideas were added to Marshall's original idea. Arrow (1971) pointed towards the non-exclusive and non-rival nature of knowledge and considered it to be a sort of "unlimited" production factor. Later additions to Marshall's original idea were especially on how new innovative technologies are disseminated: Dense urban city environments where a lot of research and development takes place offer the best options for both the generation of new knowledge and it to spread quickly (*"knowledge is sticky")*, so that innovations can be adopted by the companies around and therefore cause higher economic growth for such cities (Glaeser, Kallal,

Scheinkman, & Shleifer, 1992; Porter, 1990; Romer, 1990; Von Hippel, 1994). Florida (2002b) suggested that human creativity is the factor that plays a crucial role in this process. Concentration of human creativity lead to more innovative ideas and therefore more development of business opportunities in the sense of Shane and Venkataraman. It is not meant to be said that all knowledge is non-rival and non-exclusive. Jane Jacobs (1970) makes a distinction between information and knowledge. Information is clear and concise, codified according to norms and interpreted in a standard way by everyone, for example stock prices, specific market information or patent documents. Knowledge is vaguer and can only be interpreted and is not written down somewhere, and often based on experience. It is this second form, which is also called tacit knowledge, that can and often will be used in many different occasions, as it is adaptable and usually non-rival in nature. These dissemination flows of new knowledge came to be known as knowledge spillovers (Nonnis, Bounfour, & Kim, 2023). Measuring the exact flows and nature of these is nigh impossible as "they leave no paper trail" (Krugman, 1991), although analysis show that proximity and interaction together are significant predictors for the adoption of new technologies among different startups (Roche, Oettl, & Catalini, 2022).

Universities are certainly among the most obvious places where concentration of such creativity and knowledge, as meant in the previous paragraphs can be found. Therefore, there is already a long tradition of scholarly research about the role of universities in supporting innovation and regional knowledge transfer. What is important in the context of this sub-chapter is the relation between universities and entrepreneurship, and the way that knowledge flows in the form of what Audretsch and Feldman (2004) and Acs et al. (2009) have called knowledge spillovers, are ultimately generating entrepreneurship. The so-called knowledge spillover theory of entrepreneurship explains why in some places more and in other places fewer companies are starting their operations (See for example Atkin, Chen, & Popov, 2022; Audretsch & Keilbach, 2007; Nonnis et al., 2023). Such knowledge spillovers are especially relevant, and useful for future entrepreneurs in and around universities that have strong entrepreneurship support policies (Markman, Phan, Balkin, & Gianiodis, 2005; Owen-Smith & Powell, 2004; Pugh, Lamine, Jack, & Hamilton, 2018). The idea of the knowledge spillover theory of entrepreneurship is that the role of the modes of organizing and especially the environment (letters C and D from figure 2.1) in the framework of entrepreneurship research as described by Busenitz et al. (2003) get a more prominent place. In other words, there is a bit of a shift in research from the individual entrepreneur and his or her motivations (e.g. risk taking vs. risk avoiding, need for independence, need for achievement etc.), towards the (social) environment in which they operate (Acs, Audretsch, & Lehmann, 2013; Gibb & Ritchie, 1982; Marzocchi, Kitagawa, & Sánchez-Barrioluengo, 2019).

The idea behind the knowledge spillover theory on entrepreneurship is as follows: when at universities or large businesses new ideas are generated, more often than not these new ideas are rejected as not fitting with the core business of the company, or in general no clear suggestions about the potential

applications of the new idea. Some individuals who do have a plan how to commercialize such new ideas, can use these to build their company around such ideas (Acs et al., 2013; Acs et al., 2009; Ghio, Guerini, Lehmann, & Rossi-Lamastra, 2015; Jaffe, 2022). The claim of Acs et al. (2013) is that the heart of the knowledge spillover theory of entrepreneurship is that the business opportunities, as described earlier according to the ideas of Shane and Venkataraman (2000) revolve around the availability of such knowledge spillovers. These spillovers originate because new knowledge is different from other production factors in the sense that these are characterized by greater uncertainty and therefore not for everyone the expected future value of new knowledge may be equal, and henceforth equally interesting to start a new firm (Acs et al., 2009). This implies that knowledge by itself is a necessary condition, but also not more than that, for the exercise of a successful enterprise (Acs et al., 2009), and the entrepreneur and his/her skills of discovering such opportunities are still also very important, as was already pointed out by Schumpeter (2017).

Universities have long before the development of the knowledge spillover theory of entrepreneurship realized the importance of commercialising research results as well as supporting the economy of the regions in which they are located by supporting students and graduates to start their own business. Rothaermel et al. (2007) suggest that in the USA the passing of the Bayh-Dole act in 1980 was one of the key events that helped universities to become more entrepreneurial. In Europe, the European Union played an important role in supporting programs for technology transfer from university to industry, thus making these universities also more entrepreneurial. The difficulty in Europe as compared to the USA was that in Europe, due to its many small states, the rules and regulations could be quite different and therefore, in most cases, “economies of scale” with regards to the project money invested were difficult to reach. In the Netherlands for example, the University of Twente was a pioneer in terms of being an entrepreneurial university (Bazen & Bijleveld, 2012; Benneworth & Charles, 2005), but the rules in neighbouring Germany for example were rather different, making cooperation in practice sometimes rather cumbersome (Meyers, personal communication, 2019).

Important to notice is that during the last decades, perhaps under the influence of the earlier mentioned knowledge spillover theory of entrepreneurship, a shift in the attention of researchers happened towards the context of entrepreneurship (Audretsch, Belitski, Guerrero, & Siegel, 2022; Marzocchi et al., 2019). In the before mentioned study of Rothaermel et al., this category scored just a mere 17% of all studies, but has become certainly more prominent (Mathisen & Rasmussen, 2019). This development went parallel with the increased attention of universities on constructing so-called entrepreneurial ecosystems (Alvedalen & Boschma, 2017; Stam & Van de Ven, 2021). One of the outcomes of most studies on university entrepreneurship was that the context matters, and new enterprises are actually helped a lot by not just delivering courses on entrepreneurship or just offering business incubation places, but instead offering a culture of entrepreneurship, where tacit knowledge and experience could freely flow as well as the availability of all necessary support services (Abramo, D’Angelo, & Di Costa, 2020;

Hwang & Horowitt, 2012; Stam, 2018). Hwang & Horowitt further suggest that it is in such places, where all the environment variables are in place that one can expect the most vibrant entrepreneurial culture and largest numbers of spin-offs. When a certain critical mass is created, a virtuous circle can develop, that can lead to strong regional economic development. At the same time, it should be noted that knowledge (as in knowledge spillovers), does not simply 'hang in the air', but is transferred via local networks and that also non-local linkages can play an important role in company performance (Audretsch et al., 2022; Boschma & ter Wal, 2007).

To finalize, it is necessary to look at the literature once again, this time specifically on the issue of the definition of a university spin-off company that captures the complexity of the issue of university entrepreneurship as discussed in this sub-chapter. At the same time, the definition should be limited at least somewhat, so that not every business that was started or acquired by a (former) student or employee that was ever once in their life associated with a certain university, automatically counts as a university spin-off: There should be a clear link with the university involved. Given the discussion in this sub-chapter on the knowledge spillover theory of entrepreneurship, it is wise to make the definition of what counts as a university spin-off not too narrow (cf. Abramo et al., 2020; Bathelt et al., 2010). As can be seen in the literature on the subject, business opportunities taken on by entrepreneurs are in many cases involving newly produced knowledge in the form of tacit knowledge (and not necessarily explicitly codified/patented knowledge). Sometimes this knowledge is used in different contexts as in which the new knowledge was originally developed, and interesting new crossovers can develop (the general idea of this has been discussed back in 1969 already by Jane Jacobs). Therefore Scott Shane's (2004a) and Nicolaou and Birley's (2003) narrow definition of a university spin-off as being a newly established company, to commercialize research results, with concrete intellectual property involved, seem to be too narrow to capture the entire phenomenon of university spin-offs. The British Higher Education Statistical Agency also counts the number of university spin-offs from UK universities, they use a likewise narrow definition as a spin-off being a newly established company involving any kind of intellectual property (patent, trademark, copyright). All other companies that are started by former employees or students from UK universities (within two years of graduation), without such explicit intellectual property, they classify as staff or graduate start-ups (Hesa, 2019). Although this definition is already broader than Shane's, the strong division between spin-offs and start-ups used in this definition, does not necessarily take the importance of any knowledge spillover effects on these companies into the picture. Furthermore, the time period of two years between graduation and the actual start of the business may be too short, because there is evidence that entrepreneurs often start their business a bit later after graduation. Müller (2010) found, in a study on exactly this topic, that around 50% of university spin-off companies were established no less than 4 years after leaving the university. Therefore, it seems a prudent idea for this study, to enlarge this period of two years from leaving the university to five years from leaving the university, to also catch a part of the group of former students

who have an idea to start a business, were indeed inspired by research results at the university and/or entrepreneurship courses there, but first prefer some work experience before they actually start, something common in the knowledge intensive businesses sector (Andersson & Hellerstedt, 2009; Hisrich, 1990). There can also be a significant time lag between a new idea, the formation of an entrepreneurial team and the actual commercial application of it (Knight, Greer, & De Jong, 2019; Müller, 2010).

There are of course different types of university spin-offs, even with a broader definition both to encompass codified intellectual property and tacit knowledge flows, characteristic of knowledge spillovers, as well as the larger time horizon than the often used two years. Earlier in this section, the study of Pirnay et al. (2003) was already mentioned, in the context of the consequences of the different definitions of university spin-offs that are around, for empirical findings. In the same study, Pirnay et al. have developed an interesting 2x2 table, that helps to identify different types of university spin-offs (see figure 2-2). The classification fits well with the knowledge spillover theory of entrepreneurship, as

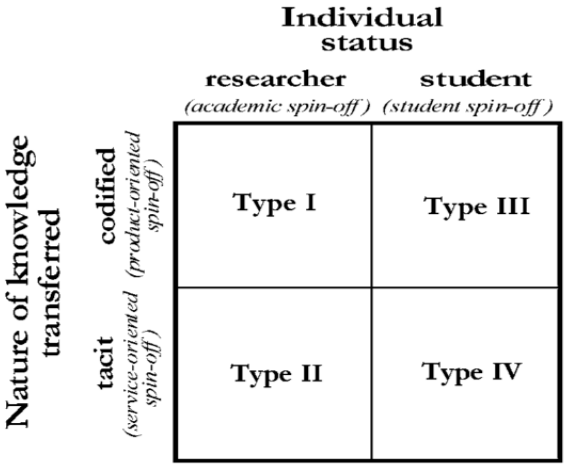


Figure 2-2: A typology of University Spin-offs by Pirnay et al. (2003)

it includes both codified and tacit types of knowledge transfer. It also includes the distinction between academic and student spin-offs, according to Pirnay et al. a useful distinction, as these different types of businesses behave quite different in practice, in terms of growth (potential) and technology involved. Another interesting literature review and typology of university spin-off companies is the one by Mustar et al. (2006). The authors of this study have identified three major perspectives from which spin-offs can be studied: A resource based view on spin-offs (spin-offs are vehicles for exploiting available resources: human, technical, financial and social resources), a business-model perspective (spin-offs exploiting new knowledge and new business models) and an institutional perspective (spin-offs are established to commercially exploit new scientific knowledge and intellectual property coming from it). These perspectives can be put into a matrix, in which Mustar et al. propose to categorize spin-offs, based on 1. their relationship with the parent university (institutional link), 2. their business model (among others which type of knowledge is commercialized), and 3. the types of resources involved

(human, technical, financial and social). Cocorullo (2017) suggests adding one more variable, namely the so-called technology level of spin-offs. High tech spin-offs often attract more investment capital and have higher survival rates. Even though added high-low tech as classification is a good suggestion in principle, the boundaries between the two are rather arbitrary, making it difficult to classify spin-offs in such categories in practice.

For this study, the classification of Pirnay et al. (2003) is probably the most useful, given the available data and since this classification will generally sufficiently answer the research questions from the first chapter. Some further detailed description of Pirnay et al.'s spin-off types, in the context of the Dutch region Twente is therefore useful. As can be seen in figure 2-2, the first spin-off type (Type I) that Pirnay et al. identify, closely resembles "traditional" definitions of a university spin-off (for example Shane's or HESA's) and consists of the commercialization of new research technology, usually protected by using patents or other forms of intellectual property. Type II spin-offs are based on commercialization of research results, but without patents. Most of these spin-offs are service based and profit from the available tacit knowledge (i.e. knowledge spillovers) from the university. The spin-off Types III and IV of Pirnay et al. are student spin-offs, of which type III are usually the more explicitly supported ones and type IV usually the more implicitly supported ones. Type III is often indicated with the term surrogate entrepreneurship (Franklin, Wright, & Lockett, 2001; Radosevich, 1995). In Type I and II, faculty members/the original inventors start the company, but in Type III and (sometimes) IV, universities allow others (usually students) the rights to commercialize research results, hence the term surrogate entrepreneurs (Djokovic & Souitaris, 2008; Nikiforou, Alkærsig, Voudouris, & Broeng, 2022). Still, there is quite some literature that indicates that especially spin-off Types I and II are more often higher tech spin-offs and Types III and IV are more often lower tech spin-offs. Some authors have called Type IV companies even "lifestyle companies" (Prokop, Huggins, & Bristow, 2019; Timmons & Spinelli, 2008) or "alternative to the paid labour market" (Harrison & Leitch, 2010) to distinguish them from the more research based companies. Most of the spin-offs of Type III and IV remain small, and as discussed before in this section, several authors therefore do not consider Type III and IV to be "real spin-offs". On the other hand, there is in the Dutch region Twente (the object of this study), and especially at the University of Twente already a long and well documented experience with entrepreneurship education and support for all of its students (Bazen, 2021; Bazen & Bijleveld, 2012; Van der Sijde & Van Tilburg, 2000; Van Tilburg & Van der Sijde, 1998), which is a good reason to still include Type III and IV spin-offs in this study, and to see if these companies behave very different in terms of growth, survival rate and especially their spatial pattern. Concluding, for this study the definition of a spin-off company is any company that has been started by (former) staff members, students or graduates from the parent university, during their stay/work in or within five years of leaving the parent university. The spin-offs that fall under this definition are further classified with the help of

the typology of Pirnay et al., which help to make the results of this study comparable to earlier studies with stricter spin-off definitions.

2.2.3 Spin-off companies and their embeddedness in regional "ecosystems"

This part of the literature review is particularly aimed at understanding the influence of spin-offs (and their entrepreneurs) on the regional entrepreneurial ecosystems and vice versa. In the last decade, the social environment of companies and especially that of start-ups has gotten a lot more attention in research in the last decade (Alvedalen & Boschma, 2017; Marzocchi et al., 2019; Stam & Van de Ven, 2021), compared with earlier literature reviews (See for example Busenitz et al., 2003). This section focuses on the environment for entrepreneurship and discusses different concepts from the literature on this subject in more detail. One of the concepts used for describing the possible benefits of the existing regional business environment for new start-ups/spin-offs is the "ecosystem" metaphor, in the sense of "business environment", first used by Moore (1993). Moore argues that just like in nature, businesses do not compete head on for market share, but develop partnerships (supply chains) with other companies or sometimes with the public at large, that cause true sustainable advantage for the ecosystem "leader", a company that is key to the continued existence of the system. The ecosystem metaphor has been used a lot in the decades afterwards, although a broadly shared definition of what such an ecosystem encompasses has so far not been developed (Stam, 2015; Wurth et al., 2022). There are some problematic issues with regional entrepreneurial ecosystems, that could easily lead to causal difficulties: in an area with a lot of start-ups, there must be a good entrepreneurial ecosystem. But what exactly causes what, is then still a question (Wurth et al., 2022). An in-depth discussion about the theoretical backgrounds of regional entrepreneurial ecosystems falls outside the scope of this study. In this study, the general definition and description of Stam (2015, 2018) is used, which defines

> *the entrepreneurial ecosystem as a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship.*

Productive entrepreneurship in the above definition is a term coined by Baumol and discussed in the previous section of this chapter. Stam describes two different aspects of the entrepreneurial ecosystem: interdependent actors and factors. As factors, Stam identifies two main groups of factors (and these are intertwined with actors) and calls them: systemic conditions and framework conditions. Framework conditions are the general enablers of productive entrepreneurship and economic growth, such as the policies of formal institutions (Alhendi, Tóth, Lengyel, & Balogh, 2021): rewarding productive entrepreneurship and discouraging rent-seeking and destructive forms of entrepreneurship (Stam, 2018; Stam & Van de Ven, 2021). On the European level, the quality of the instutions for supporting innovative entrepreneurship are still lower in Central and Eastern European countries as compared to Northwest Europe, possibly leading to worse innovative performance (Becsky-Nagy, 2013; Becsky-Nagy & Fazekas, 2023). Stam suggests further an influence of physical infrastructure as enabler, as well

as general demand levels among reachable customers, similar to what Porter (1990) calls "local demand" in his influential Diamond model. Perhaps the most difficult to measure framework condition Stam mentions is "culture of entrepreneurship". However important these framework conditions may be, the core of the entrepreneurial ecosystem is formed by the systemic conditions. These include: Networks, leadership, finance, talent, knowledge and support services/intermediary institutions. In the rest of this section, these systemic conditions are being discussed, in particular the ones that are most relevant for university spin-off companies.

Crucial to knowledge intensive spin-offs, is the component "knowledge" of the systemic conditions of entrepreneurial ecosystems (Feld, 2012; Messeni Petruzzelli & Murgia, 2022). Knowledge sharing within a regional entrepreneurial ecosystem is a key component of the evolutionary approach to economics, in which the inheritance of competences (i.e. learning capacity) between the parent company, institution or university determines to a great extent the success of such spin-offs (Atzema, Lambooy, Van Rietbergen, & Wever, 2015; Furlan & Grandinetti, 2014; Sapienza, Parhankangas, & Autio, 2004). Since this study focuses on university spin-offs, it is useful to understand the influence of "knowledge" better: Therefore it is good to investigate the development of the relation between universities and the wider business environment to understand the way of thinking that lead to the current well-established policies of universities for the transfer of knowledge, including but not limited to the transfer of knowledge to university spin-offs. The current system of universities actively collaborating and valorising knowledge did not come suddenly into being, instead it was a long process of development. In the Middle Ages and the Early modern period, universities were sort of detached worlds from society, internally oriented and with a curriculum of predominantly consisting of the so-called liberal arts. The industrial revolution and the subsequent changes in society however brought the need for larger scale applied science universities with more practical engineering courses to train the necessary specialists and middle management in the emerging industry, a development that was mainly pioneered in the USA. From US government policy perspective, especially innovations in agriculture were sought after, in order to stimulate food production (Mowery, Nelson, Sampat, & Ziedonis, 2004). Ehrlich, Cook, and Yin (2018) argue that the resulting land-grant university system of the Morrill act of 1862 was one of the important factors that brought the USA towards world scientific and economic hegemony, as it supported both agricultural and engineering innovations, combined with the increased human capital that resulted from greater access to higher education. In any case, USA universities became more practical and were moving away from the classical university model, often pejoratively described as "Ivory Tower", not just in agricultural sciences, but other technical subjects followed as well (Mowery et al., 2004). Universities did not just train more students in subjects that local communities needed, also in terms of research, they worked ever closer together with the local industry. There were large differences with Europe, where universities much longer stuck to the classical university model and remained attainable just for the elite (Graham & Diamond, 1997; Trow, 1999).

Throughout the twentieth century, and especially after the Second World War, more and more research became commercialized, for example through the patenting of new findings and licensing these out to existing companies, or by supporting students and alumni in starting their own business. One of the well-known pioneers in this field was Frederick Terman (one of the so-called fathers of Silicon Valley), who was already long before the Second World War, involved in entrepreneurship support activities (Bryson, 1984). The commercialization of research results, either through entrepreneurship/the founding of new ventures, or through licensing to existing business was a development that came with many critics in the academic world, who argued that academic freedom would be under threat due to increasing influence of business on universities (Seybold, 2008; Washburn, 2005) and argue that the effects of universities on the business environment and wider economy may even be detrimental, especially on breakthrough innovations, because of the secrecy and data hoarding connected to commercial interests (Washburn, 2005; Wysocki Jr, 2004). Others however, such as Thursby and Thursby (2011) have not found empirical evidence for this criticism.

The developments in university research patenting and licensing after the Second World War, were codified in 1980 in the so-called Bayh-Dole act, which can be seen as a formalization of these developments (Mowery et al., 2004; Popp Berman, 2008), and functioned as a sort of "formal start" of a new era in university research. It is argued that this law has been the single most important piece of legislation for universities related to the support of entrepreneurship in the USA (Economist, 2002; Shane, 2004b), although this is nuanced by Mowery et al. (2004) and placed in the longer term perspective, as described in the previous paragraph. Notwithstanding this, it can't be denied that the numbers of academic staff and graduates that started their own business have grown considerably in the last decades (Caputo et al., 2022; Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005). It has also been argued that government funding of such academic spin-off companies yields (with some uncertainties) rather positive returns (Vincett, 2010). It is however important to note that in Europe in contrast to the USA, access to venture capital has been lower for university spin-offs (Becsky-Nagy, 2013; Becsky-Nagy & Fazekas, 2023), leading to potentially lower innovative performance.

There are several ways that universities use to support start-ups, each with their own strengths and weaknesses, usually based on the local situation. Clarysse et al. (2005) identified three main support models and described their characteristics, based on several case studies of regions in Europe, with universities that generate a significant number of spin-offs. The first support model that they identify is the "low selective model", which is aimed at creating as many start-ups as possible. The second model they distinguish is the "supportive model", in which the university selects a more limited number of promising business cases based on the expected creation of economically viable companies that will stay in the region. The third model of start-up support is the so-called "business incubator model", which aims at supporting those business ideas that can (potentially) generate the largest financial returns for the university involved. It is understandably difficult to isolate and measure the exact consequences

of each support model for the number and success rate of spinoffs from any particular university. However, with the attention for new and innovative ideas and supporting spinoffs, universities became noted as one of the important actors in what became to be called the "learning region" (Florida, 1995; Morgan, 2007). Etzkowitz and Leydesdorff (1995a) coined the term "triple helix", which quickly became an often used metaphor in academia and among policy makers, to describe the relation between three important players in development of regions: universities, businesses and the government. The interesting part of the metaphor is that like the spiralling structure of DNA, in regional development there is also a cooperation between these three players and sometimes one of them is more profoundly visible, however, without the support of the other two, the structure would fall apart and cease to function. To summarize the literature on the subject: Many authors perceive a development of universities from isolated places of wisdom towards institutions involved in practical support of economic activities as well as valorising their own knowledge. Therefore, regional entrepreneurial ecosystems could be enhanced by the existence of a university that is actively working on knowledge valorisation policies.

Formal institutions are mentioned by Stam as another framework condition of entrepreneurial ecosystems. Agreeing with the view of Acemoglu, Johnson, and Robinson (2005) that formal institutions are of paramount importance for an entrepreneurial ecosystem that supports productive entrepreneurship (as meant by Baumol), it is also a condition that is in most countries rather uniform within a country. It often cannot explain differences between regions within a country. This is also the case of a small country like the Netherlands, the object of this study. The Netherlands is such a small and rather centralized country that differences between formal institutions in different regions can be assumed to be non-significant. More relevant for a regional entrepreneurial ecosystem may be one of the systemic conditions that Stam describes, namely the role of support services and intermediary institutions. To determine the influence of regional support services and intermediary institutions, first of all, some thoughts must be given to what is meant by the term "region". Obviously, an in depth discussion of what a region actually is, falls outside the scope of this study, but some important and work on definition of regions as well as regional identities has been done by Paasi (1986), Newman and Paasi (1998) and Terlouw (2012). Based on their work, for this study, a region is defined as a territorial entity with some administrative power, in between the national state and the local community. According to this definition, a region can set certain policy measures and spend funds on supporting the economic development within its territory. This means that regional governments have the power – to a certain extent – to improve (or not) conditions to support new start-ups. Sometimes entrepreneurship networks supported by local governments can be significant as well (see for example Gajzágó & Gajzágó, 2016), but this is not a specific object of this study.

In the last decades, there is a growing attention for innovation and entrepreneurship on regional levels, both among academics and policy makers. It appears that the way the economy works has

fundamentally changed due to a number of factors, such as the development of information and communication technology, globalization and the disappearance of the communist economic system (Baumol, Litan, & Schramm, 2007; Thurik, Stam, & Audretsch, 2013), leading to more competition between governments of different regions, in trying to attract outside investments (Bolea, Duarte, Hewings, Jiménez, & Sánchez-Chóliz, 2022; Geerdink, 2010; Geerdink & Stauvermann, 2009), but also to formulate policies with the aim to improve the innovation potential and specialization of the region itself (Bolea et al., 2022; Stam & Van de Ven, 2021). This last point has attracted quite some scholarly attention and according to De Bruijn and Lagendijk (2005) an entire school of thought has formed, researching what they call the Regional Innovation Systems (RIS). This term RIS was coined by Cooke, Gomez Uranga, and Etxebarria (1997) to stress regional variety within the earlier developed ideas around National Systems of Innovation. The concept of RIS has become the foundation of EU regional policies, aiming to support innovation on regional levels within the European Union member states, no longer are the member states supported, but instead the individual regions within the member states (Balland, Boschma, Crespo, & Rigby, 2019; De Bruijn & Lagendijk, 2005). The consequences of the way regional policy in Europe works at least at the moment, is that individual regions have some choices in which areas to allocate funding for support of entrepreneurship and/or innovation, so-called "smart specialization", or otherwise said: enhancing the strong points of a certain region (Balland et al., 2019; Barca, 2009). The rationale behind the RIS is that entrepreneurs will make use of the strong points of the region and build their business out of the resulting opportunities accordingly (Hervás-Oliver, Parrilli, Rodríguez-Pose, & Sempere-Ripoll, 2021). De Bruijn and Lagendijk (2005) argue that the main aim of the RIS policies of the EU is territorial cohesion and to provide a sort of self-help package for regions lagging behind in economic development (i.e. peripheral regions), all of this aimed at increasing economic stability. It is therefore relevant to see if such policies lead to an increase in the strength of the entrepreneurial ecosystem in the eastern Netherlands. The same authors also observe that the actual added value of RIS policies over national driven innovation policies is limited and should not be overemphasised. However, this might only just be true for highly advanced economies, and not for emerging economies as Cao and Shi (2020) note in their literature review on entrepreneurial ecosystems. Similar findings are reported for Hungary, one of Europe's emerging economies, where the national innovation policies do not provide extra synergy for the individual regions (Lengyel & Leydesdorff, 2011).

Perhaps more important for the regional entrepreneurial ecosystem than government policies (at least in the case of the EU member states), is the availability of talent (Feld, 2012; Stam, 2015). Talent can be defined as the percentage of people in a region with a higher education degree, meaning bachelor degree or higher (Florida, 2002a; Stam, 2018). Talent is not evenly divided within countries, but instead concentrated in economic core regions, especially in large diverse agglomerations (Florida, 2002b; Jacobs, 1970, 2016). This is not a coincidence, but one of the consequences of what Weber (1909) calls

"agglomeration effects". Florida (2017) argues that young people, especially university graduates (=talent) are attracted by diversity, that can be mainly found in large cities, giving such places an enormous competitive advantage over others. Due to the Weberian agglomeration effects, such advantages increase with the size of the city. Florida (2017) calls the largest most successful talent-magnet cities "superstar-cities" in this context. For regions that do not belong to the economic core, it means that it is more difficult to keep talent within the region, although also the most developed cities suffer from crippling economic inequality (Florida, 2021; MacKinnon et al., 2022). Since almost all highly developed countries face a demographic transition and ageing population, and fewer young people to replace them, it means that many policy makers see attracting talent as one of their key means in order to keep their region economically healthy in the long run (Buenstorf, Krabel, & Geissler, 2014). This competition for talent is in Europe by no means an issue that is limited to regions within countries, instead there is a flow of talent between different countries in Europe, especially within the EU. This migration flow is already apparent in student mobility flows between EU member states with Western European universities receiving more students from Eastern Europe than vice versa (Bazen & Duma, 2019). The migration pattern for graduates is similar. The outcomes of studies on alumni migration within Western Europe are mixed, Hamm, Jäger, Kopper, and Kreutzer (2013) found a clear brain drain effect for old industrial restructuring regions in Nordrhein-Westfalen in Germany, Nifo, Scalera, and Vecchione (2020) a similar effect for migration within Italy. Results for graduate migration from semi peripheral regions in Finland are mixed (Haapanen & Tervo, 2012). Venhorst, Van Dijk, and Van Wissen (2011) found also mixed results, but then between university and university of applied sciences graduates. The latter seem to be less mobile in terms of moving between different regions. Bazen (2020b) found similar effects for university of applied sciences graduates in the Eastern Netherlands. It is also clear that most moves are done in the first two years after graduation (Haapanen & Tervo, 2012; Venhorst et al., 2011), when graduates are looking for a job. For policymakers it means that this period right after graduation (and likely also a bit before), is the best time for any policy interventions. The conclusion on this subchapter is that there has been a shift in focus in entrepreneurship research away from the individual entrepreneur, more towards the supply chains and the regional embeddedness within existing structures (often labelled as ecosystems).

2.2.4 Impact of university spin-offs on the regional economy

University spin-offs are seen as key players in the regional innovation system (RIS, as discussed in the previous subchapter) in terms of drivers of innovation (Bercovitz & Feldman, 2006; Clayman & Holbrook, 2003; Hervás-Oliver et al., 2021), although this is not an automatic thing and may especially in less innovative regions require specific policy measures to be successful (Hayter, 2013). Different interests of university technology transfer offices may prevent clear information about the location of university spin-offs and their contribution to the regional economy: Such offices are busy with generating money from intellectual property and they normally spoken don't have a lot of interest in

which region or regions spin-offs deploy their activities (Tornatzky, 2001). Data about the contribution of spin-offs to the economy is sparse. Estimations (according to the narrow spin-off definition of Shane) for the USA are around 33.5 billion USD from 1980 to 1999, including indirect multiplier effects of such spin-offs (Hayter, 2013). Even though such numbers show an important contribution to the economy, it is however also important to look a bit further than just the figures related to turnover and job creation by such spin-offs. Spin-offs may very well offer new products and services that add to the technological variety of the region (Bagchi-Sen et al., 2020), improving the general attractiveness of regions. However, this is not as easy as it seems: as argued by Rutten and Boekema (2009), university staff at traditional research universities (at least in Europe) is usually more cosmopolitan in nature than regionally oriented. This means that there are large challenges to connect traditional universities to regional businesses (Vaessen, 2018). The role of supporting institutions and facilitating government policies are of paramount importance to achieve success (Neves, Costa, & Reis, 2021). In the empirical part of this study, spin-offs from the Eastern Netherlands are in focus, in particular from the University of Twente and Saxion University of Applied Sciences. It is therefore possible that these HEIs are better incorporated in the regional entrepreneurial ecosystem, given the more common linkages with the business community of these types of HEIs.

The role of the parent university is normally spoken larger in the starting phase of the spin-off than in later stages, Bathelt et al. (2010) as well as Bolzani, Rasmussen, and Fini (2020) found that relations with the parent university tend to dilute over time. Therefore, it is questionable if an analysis of the economic effects of spin-offs with the university as object of analysis in focus, will grant the most valid results. They also found that while many spin-offs start off by providing radical innovations, based on university research results, they in later stages change their business model into providing more incremental innovations. The long-term economic contribution to the regional economy of spin-off businesses could therefore be actually smaller than one might expect based on the – usually – more high-tech than average profile of spin-offs. Another piece of evidence that the impact of spin-offs on regional economies may be not as large as actually thought is the fact that most university technology transfer offices run at a loss or break-even at best (Gibb, 2012; Harrison & Leitch, 2010). Technology transfer offices usually get income from university participation in spin-offs, which means that the overall financial result of most spin-offs is not very positive. Consequently, in terms of finance and jobs, the direct impact of spin-off companies should not be overestimated, instead for regional economic impact, it is better to look at other issues such as new products, services or a better image of the region (Bagchi-Sen et al., 2020).

Another issue with university spin-offs in more peripheral regions is that they are attracted by what Armstrong (2001) calls “totemic sites of the new economy”, highly developed and diverse regions with a lot of human capital. Since university spin-offs have a rather high chance of moving out of the more peripheral region of origin, or are established in different region as where the university is located in

the first place, it is hard for universities from more peripheral regions to measure the real effect of their spin-offs on the regional economy (Benneworth & Charles, 2005; Harrison & Leitch, 2010). At the same time, there are also so-called pull factors towards the region in which the parent university is located, one of these is the knowledge spillover theory of entrepreneurship discussed in chapter 2.2.1. Concluding from the literature review on the direct economic impact of university spin-offs: This direct impact should not be overestimated, usually university spin-offs, with few exceptions, remain small. The real economic impact is mostly found in their indirect effects, such as the improved regional image and further development of the regional entrepreneurial ecosystem.

2.3 Influence of agglomeration and deagglomeration effects on the spatial pattern of spin-offs

This part of the literature review deals with the underlying motives of spin-off location and migration patterns. The underlying mechanism behind the uneven development of the economic core and periphery, are the spread and backwash effects from the economic core regions, described by Gunnar Myrdal (1957). These effects also leads to a strongly uneven pattern of spin-off migrations within a given space (for example The Netherlands). The root cause of these spread and backwash effects lies in the so called agglomeration and deagglomeration effects. Agglomeration effects have been theorized by Alfred Weber in his monumental work *"Standort der Industrien"* (1909), where he discusses these as a factor that makes larger cities grow disproportionally faster than smaller cities or the countryside. Around the same time, Alfred Marshall described the same mechanism of the large city attraction in the "Principles of economics":

> *In almost all countries there is a constant migration towards the towns. The large towns and especially London absorb the very best blood from all the rest of England; the most enterprising, the most highly gifted, those with the highest physique and the strongest characters go there to find scope for their abilities (Marshall, 1920, p. 199)*

What is more, not just the raw size of the city, but also the dominant type of economic activity matters. For example, cities in the USA specializing in traditional manufacturing tend to stagnate, and the ones specializing in innovative businesses tend to grow (Conway, 2022; Moretti, 2012). Glaeser (2011) calls cities in his book "The triumph of cities" to be the "greatest inventions of mankind", the places where everything new and innovative happens. Florida (2017) describes in his book "The new urban crisis" the attractiveness of urban areas and calls them "innovation machines"; and the largest among them "superstar" cities: the ones that are very successful in attracting the most qualified talents, thereby further reinforcing their status as "superstar" magnet. Florida speaks about the agglomeration effects as the "clustering force", something he feels is very difficult to turn around with policy measures aimed at deagglomeration, although some experiments related to using and subsidizing distance work are done (Glaeser, 2022; Oberhaus, 2019). It is important to mention that such agglomeration effects play a role

on different spatial levels – of course with different strengths – from one end of the scale, the level of a continent (as in the global North-South division) up to individual buildings in a neighbourhood (Rosenthal & Strange, 2019). In this study however, the focus will not be on the agglomeration effects for the general population/economy, but instead on the consequences of these effects for innovation and innovative businesses, the group which university spin-offs are – likely – part of (see the previous subchapter).

First however, some theoretical foundations of the concept of agglomeration. Weber's idea of agglomeration effects is that the concentration of businesses in a certain location causes a reduction in costs of production and/or a reduction in the sales costs. This reduction in costs is received because distances are smaller and therefore less effort is needed to operate the business. According to Weber (1909, pp. 125 - 129), the reduction of costs can be threefold:

1. *Production cost reduction*: Because of the concentration of businesses that need machinery and equipment, there are more possibilities to get it, because it will become feasible for suppliers to locate in such areas as well, given that they will know there will be sufficient demand for their services. This could mean among others less downtime of production for production businesses involved as well as less expensive machinery.
2. *Labour related cost reduction*: Since it is highly unlikely that a business, especially a large business, has every needed specialty always in-house and available, usually specialists from outside the company are hired to do certain highly specialized tasks. Because of the concentration of businesses, business support services and/or independent specialists are easier to find, because for such businesses and individuals, it is attractive to locate close to concentrations of businesses, because for them it means to be on a short distance from potential clients, and there will be enough clients around to keep the demand for their services up to acceptable levels. It means that because of lower search costs and faster operation, in business agglomerations the labour costs will be lower.
3. *Cost reduction through network effects*: If there is a concentration of businesses, inventory costs are likely to fall, because there are enough businesses around to support wholesalers in that place, so that materials don't have to be bought long in advance, leading to high inventory and therefore also opportunity costs. In an agglomeration develops a sort of new local market for materials, with all the competition and cost cutting that comes with it. Another effect in this category is the better market access, so that companies can sell in a more direct way to their customers, without all kind of middlemen involved. It also makes it easier to acquire funding for the company, because financiers would see companies within agglomerations, because of the lower production costs involved, as more reliable lenders. A further advantage can be achieved by so-called "*sichhineinhangen*" or otherwise said, connecting with existing supply chains in the agglomeration.

For Weber, agglomeration effects are just a mathematical function of businesses located closely together, within certain critical limits of transport cost and/or labour supply (*"isodapanen"* as he calls

them). Something that Weber doesn't deal with in his book is the question how such agglomeration effects actually come into being in places in the real world (just he acknowledges that agglomeration effects will become more prominent as transport costs fall and when population densities rise). His mathematical model is normative and does not deal with the question if it is possible to influence such agglomeration factors with policy measures, so that businesses in semi-peripheral regions can be helped in achieving such cost reductions as well. Hoover (1948) gives an explanation on the question why production is agglomerated in certain regions and not in others:

> *Thus a locality with an early start in some industry has thereby a competitive advantage that it may retain and increase, even though the early start was due to pure chance or whim. Economic history is full of examples* (Hoover, 1948, p. 4).

Alfred Marshall is the other classical theorist of agglomeration effects, and still often quoted today in many papers on the subject. In his already earlier mentioned book "Principles of Economics" (1920) he gives three reasons why agglomerations matter, reasons which partly overlap with Weber's definitions:
1. New ideas spread much faster (knowledge spillover effects occur). Mysteries of trade that hang in the air are informally discussed and no secret anymore for others around, thus stimulating innovation in such places where concentrations of businesses can be found:

> *If one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus, it becomes the source of further new ideas* (Marshall, 1920, p. 271).

Such knowledge spillover effects are in-depth discussed in chapter 2.2.2
2. Expensive and rapidly depreciating equipment can be shared by several firms, in other words, highly specialized and capital-intensive parts of the production process can be outsourced to partner companies, thus lowering the capital requirements and consequently the production costs. This is very similar to Weber's idea of production cost reduction.
3. Pooling of labour markets. It is easier for both employers and employees to find new staff/find a new job. This lowers the search costs, as well as offers more security for both sides:

> *The owner of an isolated factory, even if he has access to a plentiful supply of general labour, is often put to great shifts for want of some special skilled labour; and a skilled workman, when thrown out of employment in it, has no easy refuge* (Ibid., p. 272).

Another interesting observation of Marshall is that some industries are often found together. As he notes, some industries (steelworks, mining), require the labour of strong men. Often therefore, textile industry could be found in such regions to offer jobs for females, to compensate for the otherwise limited income possibilities for families:

> *But the remedy for this evil [industries with mainly jobs for men, JCB] is obvious, and is found in the growth in the same neighbourhood of industries of a supplementary character. Thus, textile industries are constantly found congregated in the neighbourhood of mining and engineering industries, in some cases having been attracted by almost imperceptible steps; in*

> *others, as for instance at Barrow, having been started deliberately on a large scale in order to give variety of employment in a place where previously there had been but little demand for the work of women and children* (Ibid., p. 272).

Others, such as Scitovsky (1954), have refined Marshall's agglomeration factors by stating that there are in principle two main agglomeration factors, the money driven factors as well as the technology driven factors. The first group consists of all the cost savings due to the economies of scale, and the second group is about the pooling of ideas and sharing of knowledge (such as the earlier discussed knowledge spillovers) (Conway, 2022). According to Jacobs (2016) and Florida (2002b), this second group "the urbanization economy" is nowadays the main driver for urban agglomeration economies. Jacobs assumes that the main innovative strength of cities lies in the facilitation of unplanned interactions. In order to have enough chances for such unplanned interactions, a sufficiently large dense urban area is needed, hence cities are the breeding ground of innovations (Jacobs, 1970). This also explains the attractiveness of such large dense urban areas for innovative university spin-offs.

One more influential classical theory on agglomeration advantages needs to be mentioned here, the so-called Hotelling's Law, named after Harold Hotelling. The idea behind this law is that companies that offer more or less similar products have the tendency to cluster together and be as similar to each other as possible (Hotelling, 1929). The analogy used is with two mobile ice-cream vendors on a beach, who would slowly but surely move towards the centre of the beach and stand next to each other, so that they have the largest potential customer reach (and similarly, they would also sell as much as possible similar products, as demanded by the majority of their customers, not to lose market share to each other). Hotelling's Law can be used to explain why retail stores are often so much concentrated in city centres or large shopping malls (and look alike so much). Although Hotelling's Law could be used to explain local concentrations/agglomerations of businesses, it is less useful in understanding wider core-periphery relations and the agglomeration effects caused by it.

Modern scholars still build on both Weber's and Marshall's theories of agglomeration effects. Krugman (1991) discusses the so-called positive feedback loops that help to understand how agglomerations keep growing once they reach a certain critical threshold. Other important aspects are that:

1. Enough people should be around in manufacturing areas to reach enough people to generate economies of scale (as compared to rural areas, where population is usually limited to the amount of people that local farms can sustain and/or the necessary labour needs for agriculture).
2. Transport costs should be low enough. High transport costs would encourage production in nearby small towns, leading to a spatial economic model like that of Von Thünen (1842) or in a static hierarchic one, like from Christaller (1933). Such conditions of high transport costs would likely be met in pre-industrial societies and would effectively block further agglomeration effects. As Krugman summarizes it:

> *Let the factory system and eventually mass production emerge, and with them economies of large-scale production; and let canals, railroads, and finally automobiles lower transportation costs. Then the tie of production to the distribution of land will be broken* (Krugman, 1991).

Agglomeration effects are further fuelled by "division of labour" effects (Fujita & Thisse, 1996), first theorized by Adam Smith (1776, p. 2, Book I). This division of labour (or specialization) is a powerful mechanism to increase productivity, there is however a limit to it: too much specialization requires too much coordination efforts, so that the added value of specialization is lost (Becker & Murphy, 1992), although this seems to be mainly an issue inside companies (Foss & Foss, 2022). On the scale of regions, economists have already argued from the outset of European Cooperation that it would lead to the development of a core-periphery structure between and within European countries (Fujita & Thisse, 1996; Giersch, 1949), because manufacturing would be attracted to the most developed regions, based on already existing economies of scale advantages. German economist Herbert Giersch on the effects of the proposed European integration as early as 1949:

> *…the long-run effects of creating a large area of free trade and free movement of factors will – other things being equal – enforce the agglomeration of industry and population in the industrial centre of the union* (Giersch, 1949).

Once an agglomeration of businesses with the accompanying scale advantages is established, it tends to stick around, as businesses would not want to give up such local scale advantages and become a first-mover out from it, with results that are going to be uncertain at best (Venables, 2020). Therefore, it is highly unlikely that peripheral areas when just left to the market forces ("the first mover problem") will be able to turn themselves around and develop more core characteristics, unless they are able to build new business agglomerations in innovative technologies (Moretti, 2012), and even then this likely happens in just a few "lucky cities", such as Seattle, USA. Seattle turned its entire economy around when Microsoft arrived there, and an entire software cluster sprang up around this "first mover". The fact that Microsoft's headquarters moved to Seattle was most likely not because of specific advantages of the city, but was highly influenced (hence the term "lucky city") by the fact that both Bill Gates and Paul Allen grew up in Seattle (Venables, 2020). The element of chance is also present in the influential "diamond framework" of Michael Porter (1990), which offers several factors that are important for regional (or national) competitive advantages, one of which is the factor "Related and supporting industries", which is a direct consequence of agglomeration of businesses and is quite influential for the opportunities that new market entrants have (Porter, 1996). Crucial for Porter's theory is that firms which are operating in business clusters (a form of agglomeration economies) experience a strong internal rivalry, so that in more or less the same general circumstances, competition takes place on actual firm excellence, giving incentives for innovation. Also:

> *The competitive pressure in a cluster is amplified by peer pressure, even among indirect or noncompeting firms. Pride and the desire to look good in the local community motivate firms to attempt to outdo each other* (Porter, 2000).

Both Frenken, van Oort, and Verburg (2007) as well as Santoalha, Consoli, and Castellacci (2021) nuance the importance of undifferentiated agglomeration effects for regional economic growth somewhat, as they found that agglomeration effects are a crucial factor for the development of businesses/economic sectors in regions, but these effects only really matters if such a region has a substantial amount of complementary sectors (regardless whether cluster relations exist or not). This finding appears to be a sort of synthesis between the work of Jacobs and Porter. Duranton and Puga (2001) also add another dimension, that of the product life cycle. They found in their study that highly innovative companies in the beginning stages of the product life cycle are usually found in large urban areas (as they call: the nursery) and as soon as their innovative product enters the stage of mass production, such companies are prone to relocate to more peripheral areas, in search for as low as possible production costs. Innovations in this stage are usually incremental and aimed at lowering the production costs. This is an interesting finding: it appears to be the exact opposite of what both Marshall and Weber have theorized. Therefore, only taking agglomeration effects into account is most likely not enough: Weber also discusses the opposing forces of agglomeration effects, something he calls the "deglomeration effects", because no agglomeration could grow infinitively in reality. So far, the discussion in this subchapter has been on the centripetal forces that let economic (mainly manufacturing & service) activities agglomerate to core areas. There are of course also opposite centrifugal forces at play in the economy, the "deagglomeration effects". Weber notes that the net agglomeration effects are a collection of plusses and minuses, consisting of the balance of the actual agglomeration effects minus the deagglomeration effects (Weber, 1909, p. 128). As deagglomeration effects Weber describes the following:

1. Rising land prices. Since production has to take place somewhere, land will be in higher demand in agglomeration areas, leading to increases in land prices, probably made worse by land speculators. The higher cost of the land rent would diminish the economies of scale enjoyed, as compared to more rural areas.
2. Rising general costs. There may be higher costs involved in storing materials for production, this is connected to the higher land prices. Businesses may also be forced to pay higher wages (even when labour as a production factor would be completely mobile), as labour unions will probably be stronger in agglomeration areas and would be able to enforce businesses to pay higher wages. The extra costs in this group would grow proportionally with the growth in the size of the agglomeration.
3. In general: Lower savings after a certain threshold is reached. The per unit cost savings are "degressive-progressive". This means that in very large agglomerations the additional per unit cost savings barely increase anymore, and the agglomeration advantages are already approaching the maximum possible cost savings. One of the reasons for this degressive-progressive behaviour of the per unit cost savings is the problem of congestion that occurs in very large agglomerations, which is negatively impacting the per unit costs of production and transport.

When looking at the product life-cycle approach of Duranton and Puga, combined with the deagglomeration factors of Weber, it appears that for products in a mass-production stage in the life cycle, deagglomeration effects become stronger. This could very well have to do with the amount of (expensive) space needed during mass-production, which so to say pushes out companies from dense urban agglomerations (Koster & Pellenbarg, 2019; Van Dijk & Pellenbarg, 2000).

Wrapping up the theory on agglomeration effects on the possible locations of spin-off companies, two things could be noticed:

1. If a spin-off company is established, due to agglomeration forces it will be either established in a region with agglomeration advantages (assuming that the net agglomeration advantages are positive), or

2. It will be attracted to move to such regions, especially during a phase of growth, when highly specialized personnel are required for further growth, given the better availability of human capital there.

2.4 The innovative periphery: implications for university spin-offs

Even though there is an abundance of literature that points to agglomeration effects being strongest in core regions, and to cities "being the birthplaces of innovations" as well as "magnets for talent and businesses", also a growing number of authors have pointed to this view as oversimplifying reality, or even that there could be a discourse present with an "urban bias", more than objective science (Martinus, Suzuki, & Bossaghzadeh, 2020; Mayer, 2020; Petrov, 2007; Shearmur, 2012). In this subchapter, the periphery takes a central place, and the debate in the literature about innovation in peripheral regions (in North West Europe) in particular. It is important to discuss here a bit the ideas related to innovation in the periphery, since the goal of this study is to understand the migration patterns of spin-offs originating from a parent university in a non-core region. First of all, with peripheral regions, in general all regions outside of main metropolitan areas are meant, not so much economically marginal regions alone. Peripheral regions in most European countries (especially in Northern and Western Europe) are also wealthy regions with low unemployment levels and healthy business communities. When reading the literature on peripheral regions, most authors mean "less urbanized regions on national level", although in the original sense of the term, as meant by Prebisch (1962), core-periphery is a phenomenon on continental scale. Some authors also speak about core-periphery even on a regional level, for example in the study of Doloreux (2003) on innovation in suburban areas in Quebec in Canada. In this study, following most studies, periphery is – unless specifically noted differently – looked at from a national scale, and is about regions within that country.

Even though there is consensus in the literature that a division between core regions and non-core (periphery and semi-periphery) regions exists, there is no agreed upon definition or even a set of criteria on when a region within a country would classify as a (semi) peripheral region. Often, the classification is based on the amount of FDI entering a region, relative to the national average or the level of

innovativeness relative to the national average (Calignano, 2022; Hall, Harrison, Weaver, & Wall, 2013). Still, that is just a narrow angle to look at the peripherality of a place (Mihály, 2022). Given that not all the problems of peripheral regions can be attributed to "international embeddedness", it is useful to look for a bit more categories to define peripherality. Jauhiainen and Moilanen (2012) argue that periphery can be seen from an institutional point of view as well as from a geographical point of view. The functional point of view related to periphery has the following aspects:

> *Weak human and social capital and civic society, thin institutional structures, narrow business networks, limited local embeddedness, poor quality of local information and communication technology infrastructure, and scarce links to the European and global markets and knowledge providers* (Jauhiainen & Moilanen, 2012).

The geographical perspective on peripherality is about long distances and poor access, as Jauhainen and Moilanen describe:

> *Such areas are characterized by remote locations, with poor access to economic core regions; long internal distances, leading to expensive transport, travel, and service provision costs; few relevant development actors, resulting in weak agglomerative advantages; and low innovation capabilities and entrepreneurship resulting from poorly developed research and development sectors* (Jauhiainen & Moilanen, 2012).

Others have argued that terms such as "weak", "less dynamic" and so on should be used with care when talking about peripheral regions (Bolea et al., 2022; Calignano, 2022; Graffenberger & Vonnahme, 2019), because there is a growing number of studies that show – as is pointed out below – that there is quite some innovation going on in businesses in peripheral regions, albeit of a different character than in large urban agglomerations. Even though Jauhiainen and Moilanen's list of aspects of peripheral regions is rather extensive, there are probably more aspects of peripherality which are not covered. One important additional aspect is about migration patterns, both from (higher educated) people and (innovative) businesses out of such regions (which are often also border regions) towards core regions (Marlet, Oumer, Ponds, & Van Woerkens, 2014). It is all the more surprising, given the lack of a broadly shared definition on peripherality, that Eder (2019a) observes in his literature study about innovation in the periphery, that around 20% of the studies he analysed do not mention any definition of what the author(s) exactly means with the term. It is also apparent that peripheral regions can be very different from each other, making general definitions even more difficult.

Nonetheless, there is a growing number of studies about examples of innovation in peripheral regions. To name a couple of examples: Anderson (2000) describes in his paper "the paradox of the periphery" that in the Scottish Highlands innovative entrepreneurs make work from tradition and environmentalism to build new key assets for this region. In their study of the marine biotechnology cluster in Tromsø – one of Norway's peripheral regions – Karlsen, Isaksen, and Spilling (2011) found that policies to promote the development of such a sector, including the establishment of university spin-offs, might

work, if such regions would be well embedded in international knowledge networks (although this would be very difficult, given the geographic location of the region). Grabher (2018) studied the architectural sector in peripheral Vorarlberg in Austria as an example of a successful innovative cluster in a peripheral region, Cooke (2012) found that innovation in organic food tourism took place almost completely outside of cities and Petrov (2012) demonstrated that even very peripheral arctic communities in Canada can be breeding grounds for innovations.

It would however not be wise to downplay the challenges of peripheral regions, even though these and other examples of successful peripheral regions exist. One crucial challenge of most peripheral regions is the difficulty that businesses and institutions have in attracting the necessary specialists (Karlsen et al., 2011). Rodríguez-Pose and Fitjar (2013) show that successful peripheral regions have the tendency to construct what they call "pipelines" to the rest of the world, in order to get the necessary external information. There seems to be consensus about the issue that the differences in specific regional factor-endowments in non-core regions are of limited importance, and that for innovating firms in such regions the internal efficiency of operations is of crucial importance in order to become or stay innovative (Eder, 2019a). The periphery is not necessarily passive when it is about innovation, but innovation is normally spoken – at least – less visible than in core regions. Another point that is often mentioned is that there is a concentration of marketing and decision-making power in major cities. This leads to the consequence that it appears that innovations originate from there, but it is a question whether that is really the case (Shearmur, 2012). Among others, Boschma (2005) observed that proximity between firms may be necessary for stimulating innovation, but proximity does not necessarily (always) mean geographic proximity. It can also mean organizational, cultural, social and cognitive proximity. These other forms of proximity can very well occur on longer geographical distances as well. Too much proximity can be however too much of a good thing, as a situation of lock-in can occur, where there is no openness anymore for new ideas (Presutti, Boari, Majocchi, & Molina-Morales, 2019).

Innovation is often measured by the number of patents per capita. It is clear from many studies on the subject, that most radical patented innovations are registered in the largest cities (Bettencourt, Lobo, & Strumsky, 2007). It is however questionable whether this is a good measure for the real innovativeness of firms (Eder, 2019a; Glückler, Shearmur, & Martinus, 2023; Shearmur, 2012). As stated before, even though patents could be registered in large diverse urban centres, it does not mean that those innovations really originated there. Shearmur and Doloreux (2016) make a distinction between slow innovation in the periphery and fast innovation in the cities to describe the differences. Slow innovation in the periphery means that companies are more shielded from market pressure (Mayer, 2020). As already stated in the previous section, according to Jacobs (1970) diversity ("unplanned interactions") in urban areas leads to creativity and innovation. Even though the majority of authors agree with this, some, such as Bathelt (2010) do not deny the importance of diversity, but argue that large cities are not enclosed spaces, instead they are full of links with the outside world, among others the peripheral regions around

them. It is therefore not unthinkable that at least some innovations are generated outside of the city limits, and are just brought to the attention of the world in cities (Shearmur, 2012). What is more, there may even be a limit to the "useful" amount of diversity for innovation, higher diversity does not always lead to higher innovative performance of firms (Fujita, 2009; Mors, 2010). The implication of these two arguments is that also in a less diverse environment, creativity and innovation can flourish. Firms may also solve the challenge of a less diverse environment by more intensely cooperation with each other, as well as apply other so called compensation strategies (Eder & Trippl, 2019; Grillitsch & Nilsson, 2015). McCann (2007), as well as Shearmur (2011) found evidence that businesses work with different types of innovation, and the amount of face-to-face contact they require is also different: only for innovative businesses requiring a high amount of face-to-face contacts, a location in a large urban area seems to be almost imperative. For other types of innovative companies, the optimum minimum cost location would most likely be in less central locations: their success may very well rely on other activities, such as doing experiments or observations (Glückler et al., 2023). There is evidence that firms pursuing radical innovations are best located in large urban centres, whereas firms that do more small incremental innovations could also very well be located outside cities (Shearmur, 2011, 2012). On the other hand, the necessity of face-to-face contacts do not by definition mean that a firm must be located in a certain geographical space. "Mobility" (not always migration) has been a crucial solution to overcome information shortages due to a lack of face-to-face contacts: in particular in the form of trade fairs or conferences (Boschma, 2005; Lagendijk & Lorentzen, 2007; Shearmur, 2015). This leads to the situation that several mid-size "not-so-well-known-to-the-general-public" companies (so-called "hidden champions") in peripheral regions are very innovative and world class players in their specific niche markets. Empirical research shows that in Germany no less than 20% of these "hidden champions" are located in non-core regions (Tuitjer & Küpper, 2020).

Lagendijk and Lorentzen (2007) argue that the main cause of problems of the periphery is the "lack of power", as decision making is concentrated in core urban areas. They explain the core-periphery embedded power relations as follows:

> *Key mechanisms of power and control, e.g. of granting access to places and resources, remain heavily founded upon territory-based practices. Indeed, especially for those living in less privileged areas, it is clear that access to good education, jobs, social security, health service, decent housing, competitively priced products, or even the possibility to travel abroad, very much depends on places of birth and residence* (Lagendijk & Lorentzen, 2007).

This means that for peripheral regions, resources are limited as well as having less diversity, which would severely impair the possibilities of peripheral regions to develop powerful innovation systems. As Eder in his literature review on innovation in peripheral regions concludes:

> *With the absence of a vibrant environment and fewer possibilities to discover new ideas, scientific research, and possibilities for cooperation by chance, firms rely more on their own*

initiatives. Accordingly, it is unlikely that a peripheral region could provide all inputs necessary for a firm's innovation process (Eder, 2019a).

All in all, when reading the literature on the innovative periphery, it becomes clear that for certain types of innovative behaviour of firms, the geographic location is probably less relevant than strong advocates of innovation in large urban agglomerations led to believe (Shearmur, 2012). On the other hand, it is very clear from different empirical studies that distance does matter, or at least one or more forms of proximity (not always geographical proximity though) for having successful and thriving innovative businesses (Boschma, 2005; Eder, 2019a). On the other hand, existing case studies of successful (semi)peripheral regions are just what they are: examples of individual regions. There should be some care being taken in generalizing such studies to all peripheral regions, that would be a form of cherry-picking (Eder, 2019a). Still, the whole debate on innovation related to core and periphery makes clear that also in more peripheral regions there are possibilities for innovative companies. For this study, the question is, if that would lead to the decision of more university spin-offs to stay in (or even move towards) the region of the parent university. One more aspect needs to be discussed in this context, namely the role of regional development policies and their influence.

2.5 Policy measures related to supporting economic development in non-core regions

In the previous subchapter, the relation between periphery and innovation is discussed. Even though core and periphery systems are rather stable (cf. Wallerstein, 1974), they are not static. It is possible for previously peripheral regions to become part of the economic core and also vice versa (Eder, 2019b). Switzerland is a good example of a peripheral country in Europe around 1800 – where the only way to earn a decent income was to hire oneself out as mercenary soldier abroad – which developed into a country that is part of the world economic core nowadays (Atzema et al., 2015, p. 15). Vice versa also happens, well known examples are old industrial regions that lost their leading position due to economic restructuring (for example the Walloon region in Belgium or the Ruhr area in Germany). It is evident that changing the position of a region or even a country from periphery into core takes a long time, possibly generations long. The most effective policy measures therefore must aim at improving the economic structure in the long term. Traditionally, governments in command economies, with quite a lot of instruments for directive economic development at their disposal, have tried to spread employment over their territory by planning and establishing new businesses in previously less developed regions or moving already established ones there. In market economies, governments have obviously less possibilities to relocate businesses, although in many market economy countries, parts of governmental services and state owned businesses were deliberately moved to growth poles (Darwent, 1969; Perroux, 1955). However sympathetic the growth pole theory is, it failed to deliver on its promise, since it was expensive and the initiatives were not powerful enough to change the economic

structure of the target regions (Atzema et al., 2015, p. 19; Parr, 1999). It falls outside the scope of this study to provide an extensive historical overview of the regional development measures that have been tried throughout the last decades, suffice to say here that in the context of The Netherlands, there is no regional development policy anymore on national level, just a sectoral policy to support strong internationally competitive business sectors, also known as "Topsectors" (MinEzk, 2016; Planbureau voor de Leefomgeving, 2012). This means that regional economic development policies have been left to the European Union on the one hand (with its smart specialization programs) and to the regional level, the Dutch provinces, on the other hand (Balland et al., 2019; Benner, 2022). Foray, David, and Hall (2011) argue that smart specialization is the best way forward for (semi) peripheral regions, as smart specialization helps regions to choose a strong regional economic sector and then subsequently invest in research and development in that specific sector. Pursuing this policy of smart specialization (with different sectors in different regions and not copying of successful examples of clusters from elsewhere) is likely the most successful way to develop peripheral regions and provide economic stability, according to these authors. Smart specialization has been quickly adopted by policy makers after its inception, although one could really ask if the smart specialization development strategy is an evidence based policy (Benner, 2022; Morgan, 2015).

In the literature, several other competing or complementary suggestions for general regional development policies are made. Here now follows a non-exhaustive list of measures that could be taken to help improve the economic situation in (semi) peripheral regions in the long term, all with the goal in mind to strengthen regional economic stability.

- Castells-Quintana and Royuela (2014) show that in developed economies income inequality is a limiting force for economic growth, especially for the periphery. Better income distribution would help to help develop peripheral regions. Among others this would lead to a more balanced urban system, helping smaller cities, providing better economic options for citizens there.
- Kohoutek, Pinheiro, Čábelková, and Šmídová (2017) argue that higher education institutions are key in changing the economic structure, with a focus on Life Long Learning programs that can help with improving the skills of the existing workforce in (semi) peripheral regions that go through industrial restructuring.
- Shearmur (2011) argues that investments in infrastructure in the broadest sense of the word would help. The key to development is proximity (not necessarily geographical proximity), but without good infrastructure the necessary level of proximity is hard to achieve. He proposes investment in physical infrastructure, but also in basic services such as air transport, highway maintenance, hotels and others.

- Venables (2020) argues among others that a focus on facilitating innovation would be a good option for development, although there are usually just a few innovation hotspots available in a country.
- Rodríguez-Pose and Fitjar (2013) argue that building connections outside the region, which they call "pipelines", would help to overcome the geographical distance to the core regions, and instead help to build organizational, cognitive and cultural proximity. These forms of proximity help to encourage new business development in such regions.
- Nuur and Laestadius (2010) argue that governments should facilitate cluster development in peripheral regions, in order to support the development of local/regional knowledge spillovers that would help to form innovative cores in such regions, that have at least a chance of competing with the rest of the world.
- Eder and Trippl (2019) found that innovative companies in the periphery do not only use compensation strategies for the negative aspects of being located in a peripheral region, but also actively exploit the strengths of these places. Policy measures should therefore not be exclusively aimed at trying to fix deficits in peripheral regions, but instead facilitate businesses with options to exploit the available strengths of those regions.

All the measures above have in common that they attempt to structurally change the economy of regions (by investing in infrastructure, education or even a mere focus on available regional strengths), to build a more inclusive economy that offers economic opportunities for everyone. Such economic opportunities are key to providing economic safety and reaching sustainable income sources for the population, while avoiding vicious circles of decay (McDonald, 2014).

2.6 Location theories and firm migration patterns

2.6.1 Introduction

This subchapter deals with firm migration. In the subchapters before, the framework conditions for entrepreneurship and business development in peripheral regions have been laid out. This subchapter focuses on actual migration studies and investigates to what extent there is a "brain drain" or backwash effects from the economic core on businesses located in semi peripheral regions. It is important to note beforehand that the studies specifically dealing with the migration of university spin-off companies are very sparse. Three of the sparse studies with some longitudinal approach, including migration of university spin-offs are those of Vincett (2010) and Clayman and Holbrook (2003) with an investigation of spin-offs from Ontario, Canada and Vaessen (2018) who studied university spin-offs from the Radboud University in Nijmegen. Since the number of longitudinal studies is so limited, the focus of this part of the literature review is on the general population of Dutch companies. This means that there is likely going to be a difference in the migration patterns of university spin-offs, but this subchapter provides at least an opportunity to find some comparison with the migration patterns of the general

population of companies (which of course includes the university spin-offs). In The Netherlands, around 18.000 companies relocate yearly, which is around 4% of the total amount of companies (Van Oort et al., 2008). To understand the background of this phenomenon better, this chapter provides a theoretical overview on the migration patterns of companies in general and of spin-offs in particular. First, location determinants and location advantages are discussed. Such locational advantages are at the heart of any future migration decision any company, including these of (high tech) spin-offs. The second part of this chapter is about different reasons for migration, as found in the literature on the subject are discussed, to find out about the most common and most pressing reasons for businesses to move from one place to another. The chapter concludes with the consequences for both core regions and peripheral regions.

2.6.2 Mechanisms behind the spatial location patterns of companies

Companies are no isolated entities, instead they relate to the world around them because of their supply chain, partners, customers, and employees. This means that companies usually have certain requirements about the place in which they are located. This is of course a two-way relation: Not just do companies require some things from their surroundings, but also when companies are located in a certain region, it may lead to for example the construction of (extra) roads or railway links (Pellenbarg et al., 2005). Not all desired locations can be used by every company, so the search for a location for a company is also an economic question in which costs and benefits of certain locations are being weighed. Several so-called location theories have been formulated by both economists and geographers, to try to understand the locational preferences of businesses. Atzema et al. (2015) identify four different approaches to locational theories, all of which stressing a different aspect of company operations.

The first group of theories Atzema et al. identify are the (neo)classical locational theories, where the optimal location for a business is the location with the lowest possible production costs. The first known theory on location is from Von Thünen (1842), already mentioned in the previous chapter. Von Thünen argues that transportation costs towards the market is the main reason why certain types of businesses are located in certain regions. On the level of an individual city today the model of Von Thünen still has some explanatory power, as it shows the stratification of businesses in relation to the central business district. The closer to the centre, the higher the land prices, and therefore only businesses who feel the need “to be seen” or are dependent on large flows of visitors are located there. Another well-known classical theoretician is Alfred Weber (1909), who formulated in his seminal work “Standort der Industriën” his vision on a location theory for businesses. Just like Von Thünen, he stressed the importance of transportation costs of the final product to the market, but added the transportation costs of raw materials, as well as labour costs. He also added cost price advantages due to external factors: the agglomeration effects (discussed in-depth before). One of the aspects of Weber’s location theory is factor substitution, when production processes mechanize and/or computerize, labour is substituted for capital and the optimal cost location will most likely change (i.e. it would become again more profitable

to produce in Europe instead of in low-income countries). To a certain extent, this development is visible in practice and is called reshoring (Bauman, 2020; de Snoo, 2016; Tate, 2014). Neoclassical location theories state that companies are not just looking for the location with the lowest production costs, but also to the market as to where they sell their products. This means that they will not just look at the production costs of a certain location, but also to the revenues they can get there. Famous neoclassical location theorists are Walter Christaller (1933) with his hierarchical honeycomb style settlement patterns and Harold Hotelling (1929), who argued that competing firms would be most likely located close to each other, in central locations, in order to catch as much of the market as possible.

The second group of locational theories is the behavioural approach to location choice. These theories have the characteristic that they are inductive and aimed at the micro level of the individual enterprise, and to generalize from that perspective. A famous representative of this group is Herbert Simon (1960), who developed the concept of bounded rationality, which means in this context that entrepreneurs make decisions based on incomplete information. Therefore, they are not "objective" optimizers of the location of their business (as neoclassical theorists suggest), but rather "subjective" satisfiers. The behavioural matrix of Allan Pred (1967) is an example of how businesses work in a world with imperfect information. Pred argues that there is no single optimal point that entrepreneurs are searching, but rather a range of options that they have that are profitable and possibly narrowing down towards the optimal lowest cost point, as soon as they acquire more information on the specific characteristics of the region. Important to mention is that people in general, and entrepreneurs are no exception, tend to rationalize their choices afterwards. Therefore Meester (1999) argues that it is necessary to do in depth interviews with entrepreneurs about their motives behind the choice for a certain location, otherwise they will give socially acceptable answers and/or rationalize their choice in retrospect.

The third group of locational theories are the theories that have an institutional approach as guiding principle. These theories are focusing on the rules of the game and pay a lot of attention on the transaction costs of any economic transaction. In both the (neo) classical approach as well as the behavioural approach, companies act in a sort of "static" external environment. In the institutional approach, the environment is key to understanding the role of companies. All activities that companies are involved in, lead to transaction costs. Companies do as much as they can to lower transaction costs, by trying to develop as much as possible routine behaviour. In uncertain situations, transaction costs for companies tend to get up, because of the extra risk and/or extra work that companies have. They would need in such cases third parties such as brokers and/or translators to help reduce transaction costs (Nooteboom, 2004). Poor quality of governments (see for example Acemoglu & Robinson, 2012; Fukuyama, 2014) and differences in culture (see for example Hampden-Turner & Trompenaars, 2011) can lead to higher transaction costs for businesses as well. Therefore, when looking for a business location, entrepreneurs tend to choose well-known locations or at least locations about which a lot of

information is available, because that will reduce the amount of uncertainty and consequently lower the transaction costs (Falaster & Ferreira, 2020).

The fourth group is the evolutionary locational approach, in which path dependency, inheritance and coincidence play key roles in the development of businesses and the location decisions of entrepreneurs (Boschma & Frenken, 2018). That a certain innovation is generated somewhere may be coincidence, but once something like that happens, due to path dependency, clusters of businesses may develop over time, which make use of this innovation and develop it further (Porter, 1990). When at a certain place an innovation is developed, a so-called window of locational opportunity opens (Boschma, 1997), in which it is possible that in that place, such a cluster/network may come into being, before there is a so called industry shake-out and subsequent path dependency kicks in and the possibility to build new business clusters around this innovation in new locations becomes very unlikely (Boschma & Frenken, 2003; Diemer, Iammarino, Rodríguez-Pose, & Storper, 2022; Willard & Cooper, 1985).

This study borrows from all four groups of theories, to understand the mechanisms behind the migration patterns better and to find explanations for the migration patterns and migration decisions. Since the study is inductive in nature and aimed at the individual businesses, the largely deductive (neo)classical theories are often less suitable in the analysis.

2.6.3 Given reasons for firm migration: finding a better location.

Even though on average 4% of the companies in the Netherlands migrate (Van Oort et al., 2008), a migration decision is not taken lightly: it is a costly affair and it potentially disrupts participation in different networks, whether those be social or professional ones (Dajnoki, Balázs-Földi, & Móré, 2021). This is true for both individuals and their families as well as companies who consider moving. This section of the study focuses on the motives for companies to move, as found in the literature on the subject. Firm migration is an important issue for any society: the location of firms leads to the growth of settlements, influences the decisions between which places infrastructure is built or upgraded, as well as generally contributing to the production and income of the places where firms are located (Koster & Pellenbarg, 2019; Musolino, Mariotti, & Brouwer, 2020; Pellenbarg et al., 2005). Therefore, studying the migration of firms could provide insight into the (perceived) attractiveness of a certain location as well as shed some light on the push factors that companies experience that drive them away from a certain location. As mentioned in the previous paragraph, migration motives for companies according to (neo) classical location theory are connected to production cost reasons and/or to reasons of market accessibility. Such motives can and probably do play a role in the new location decision, but such motives likely apply mainly to larger spatial scales (such as countries or regions within a country). When looking at decision for an exact location within a region or city, (neo) classical location theories are not very accurate in predicting the locational choice of entrepreneurs when they are looking for a new company location (cf. van Winden et al., 2020 for their study into migration to and from

Amsterdam). The behavioural, institutional, and evolutionary approaches are more useful here. Pellenbarg et al. (2005) as well as Van Dijk and Pellenbarg (2000) have identified in their study several motives for the migration of companies. Before going in depth into the motives, it is good to note here that the vast majority of company migrations is on short distances, more than 90% of the migrations is within the region (Pellenbarg et al., 2005; Van Oort et al., 2008).

Largely based on the research results of Pellenbarg and his colleagues, de Bok (2004) formulated a conceptual model on company migration (figure 2-3). In this model, de Bok identifies three main concepts that influence the decision to migrate or not. The first concept is that of the pull factors, which means the (perceived) positive factors or attractiveness of the possible alternative company location(s). Pull factors could be issues such as a shorter distance to a larger target market, better accessibility, or easier rules and regulations at the alternative location. The second concept is that of the push factors, these are the perceived negative aspects of the current location, such as lack of space to expand, lack of access to the target market or dissatisfaction with the current company building, to name a few examples. The third concept is that of the keep factors, also known as industrial inertia (Dicken & Lloyd, 1990). De Bok calls these the "relative satisfaction with the current location" in his model. As written before, a migration decision is not taken lightly, as it involves a lot of costs and investment and

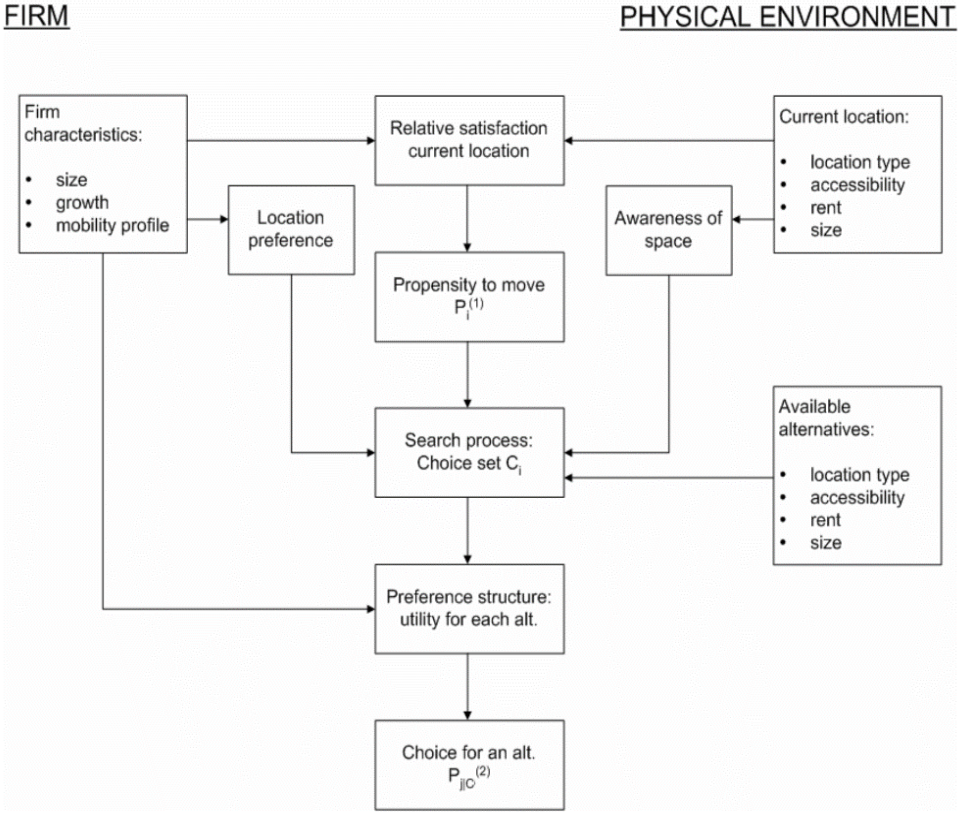


Figure 2-3: Conceptual model of firm migration

Source: De Bok, 2004

especially on longer distance migrations it has considerable influence on the existing workforce of the company. For many companies, at least in The Netherlands, the existing workforce and the fear of losing it, is one of the strongest reasons for staying in a certain location (Pellenbarg et al., 2005; Van Oort et al., 2008). It seems plausible that for university spin-offs, at least for a significant part of them, the knowledge relation with the parent university is also one of the keep factors, as a geographical location close by would likely facilitate knowledge transfer. At the same time, due to the limited number of staff in spin-offs (at least in the starting years), it can be expected that the keep factor of the workforce won't be that important. Instead, in terms of workforce, a location in a semi-peripheral location may be more of a push factor for such companies, as the pool of available talent to choose from is likely to be rather limited.

Another conceptual model on company migration (figure 2-4) is that of Portnov and Schwartz (2008), which offers a different insight into the process and consequences of company migrations. According to Portnov and Schwartz, a company chooses an initial location to start operations, represented by the letters A, B and C. Each of these locations offer enough possibilities for the company to operate sufficiently, but as time goes it shows that especially location A has a lot of advantages. Therefore, Portnov and Schwartz expect that companies would likely move from B and C locations, to the A location. Such moves would be attractive, because additional revenues because of the favourable location could be invested in improving locational advantages in such a place even more. These locational advantages in location A refer to Weberian agglomeration advantages. Portnov and Schwartz do observe that due to innovation, the locational advantages may change, where in the 19th century a fertile agricultural hinterland might have been an important locational advantage, in the 21st century with its high tech industry, this is probably not be the case anymore (Balbontin & Hensher, 2019, 2021; Portnov & Schwartz, 2008). It is this constant process of adjustment of companies that help them to survive and grow further, in the best suited location for that moment. The difference between the models is on the point of action, in de Bok's model, the entrepreneur with its "bounded rational" behaviour, selects a place that fits best to his needs, regardless whether there are actually strong scientific arguments for the location choice. Portnov and Schwartz point to the environment as the main driver for the locational adjustment of the company. Therefore, de Bok's model fits better with the behavioural approach to company locations and Portnov and Schwartz more with the evolutionary approach. In the model of de Bok, migration is depicted as a thorough process with different steps, with weighing several alternatives before a final decision is made. A similar phase by phase approach can be seen in the work of Pen (2000) who identified up to seven different phases through which companies go during the relocation process. Pen calls a relocation decision to be one of the most strategic decisions that a company can make. Especially in larger companies, such relocation decisions can take multiple years of thorough searching.

An often-heard critique on firm migration studies is that they are mainly descriptive and repetitive without much theoretical development (Pen, 2000). Another aspect that is criticized is that many geographers who study company migration, see the company as a "black box" and have little attention for the processes that take place within the companies, including the perception of decision makers in company about different regions (Meester, 1999). What is more, as Louw (1996) notes, one should be careful in looking at company relocations as some sort of event in itself, instead it should be treated as an integral part of the general strategic management decisions which a company has to do to adapt to changing societal and/or market circumstances. It means in practice that relocation is just one of the options for a company to adapt to changing market circumstances. Nonetheless, migration is a relatively often chosen option, Van Oort et al. (2008) found that yearly on average in The Netherlands, 4% of the companies migrate, involving around 3% of the workforce. When looking at the migration patterns in the country, Meester (1999) measured the perceived attractiveness of different regions in The Netherlands and Germany among entrepreneurs. Two aspects stood out, entrepreneurs liked their own region usually rather well, and at the same time, the factor "distance to customers" led to most of the entrepreneurs having a high appreciation for the Western and Central part of the Netherlands. Consequently, most entrepreneurs showed a low appreciation for peripheral locations. Musolino, Meester, and Pellenbarg (2020) draw similar conclusions in a comparative study in several EU countries, on the mental maps of entrepreneurs, related to preferred locations for their business.

International company migration is not a focus of this study, even though there are a lot of companies

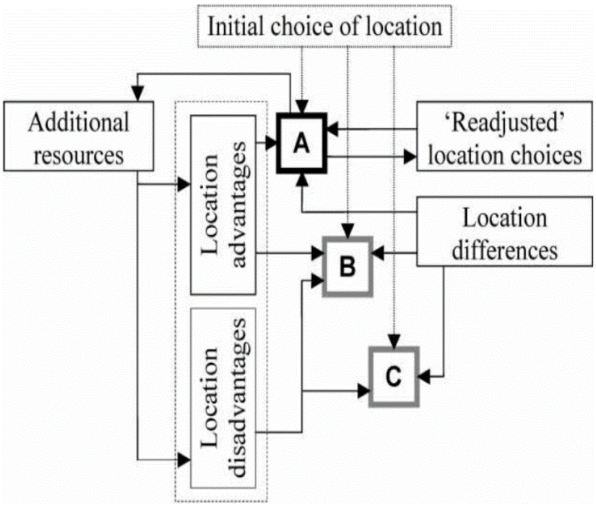


Figure 2-4: Conceptual model of company migration

Source: Portnov & Schwartz, 2008

in The Netherlands, especially in the industrial sector, that relocate or outsource their production to different countries in Europe or the rest of the world (Mariotti, 2005; Wolters, 2013). However, in most cases only a part of the company migrates and at least a substantial part of the company remains in the Netherlands. Full cross-border migration of SMEs is (still) a rather limited phenomenon (Knippenberg, 2004; Mariotti, 2005; Terpstra, 2009), due to political, cultural and language differences (Molema,

2018; Van Houtum, 1999) and probably not in the last case also because of bureaucratic and legislative hurdles, even between countries within the European Union (See for example Rammeloo, 2018). Erken and Gilsing (2005) studied the international relocation behaviour of R&D companies in The Netherlands and have not found evidence for large scale relocation of R&D activities abroad, instead they observe that Dutch companies increasingly set-up small scale R&D activities in different countries as sort of what they call "listening posts", to be well connected to international knowledge networks. Therefore, international spin-off migration is not included in the empirical part of this study, not in the last place given these observations of Erken and Gilsing on the limited importance of international R&D relocation, which would also apply to the generally more knowledge intensive spin-off companies.

On a local scale level, van't Verlaat (1997) studied the differences in popularity of industrial zones within the city of Rotterdam and concluded that the observed differences in popularity of new industrial zones could not be explained by classical locational factors such as enough space, accessibility, parking opportunities etc. Instead, he argues that some locations have characteristics of a so-called "psychological product", something in the location that brings added "emotional" value to entrepreneurs, on top of the rational locational factors that one would expect to be dominant from classical location theories. It is of course interesting to know whether such principles from the study of van't Verlaat would not just be applicable on the local scale level, but also on a regional or even national level, in the sense that certain cities or even regions are attractive for university spin-off entrepreneurs, more than could be expected from rational arguments. As discussed before, locational preferences among entrepreneurs seem to have shifted away from "hard" locational factors towards more "soft" locational factors, also for entrepreneurs of spin-offs the importance of "emotional values" such as being located at a representative location (i.e., a large city or being around a cluster of similar companies) may have grown in importance. In other words, would it be possible that certain core regions or cities become such kind of "psychological products"? There are some methodological issues with this type of research: Measuring the reasons in hindsight, why a certain location is preferred and chosen by entrepreneurs is a practice that is criticized by several authors (see for example Atzema et al., 2015). The criticism mainly evolves around the often-observed phenomenon of "rationalizing" decisions afterwards and would therefore lead to an incomplete and in the worst case completely incorrect picture of the process of the location decision.

Several authors have studied migrated companies, to find out about their motives to migrate. In the Netherlands Pellenbarg did himself or supervised several studies that measured the development of migration motives over time. Perhaps surprisingly, when looking at the development of the motives of entrepreneurs to relocate their business, no large changes have occurred within the approximately 30 years that these motives were measured (see table 2-1). This applies both to push and pull-factors of the migration decisions. Looking at the push-factors first: Lack of space to expand is in every decade the most important push factor to move out from a certain location. It is followed by organizational issues

as push factor. “Organizational issues” is a group of reasons that have to do with internal company issues, for example a move to a different location after a merger or acquisition or because a company would like to introduce a new way of working and prefer to have another environment for implementing it. Bad quality of the company building(s) has become less important over the decades and has been replaced by optimistic outlook for the future. This means that such companies, for whom this was a push factor, already well in advance looked at the consequences of growth for their company, in terms of enough available work/production space for example or related to potentially necessary new human capital for the company, which might become a problem in the current location. Also, the push-factor of not having a representative building appears to have grown in importance. It appears as if the physical quality of the building(s) has become a less important problem, to be replaced by the representativity of the building. In terms of pull factors, the factor “possibility to expand” has become somewhat less important, at the expense of “good infrastructure accessibility”. For most companies this meant either a location close to a major railway station or to an exit of the motorway. Another change in pull-factors is again, just like with the push-factors, the aspect of the representativity of the new building or location. Pellenbarg et al. (2005) argue that there is a shift in locational preferences among entrepreneurs, with “soft” factors such as the architecture of the building as well the image of the place, as example of things that become ever more important. This shift is not surprising, given the ever-increasing density of infrastructure and lower transport costs, which makes many locations roughly equal in terms of locational attractiveness based on transport costs, making many (Western) European countries function as a so called “Urban Field” (Atzema & Wever, 1994, p. 158). From the data in table 2-1 and 2-2, it becomes clear that important motives for migration are in many cases internal company issues.

Table 2-1: Comparison of the five most important push-factors of migrated companies (1977 – 2008) in The Netherlands

1977	**1988**	**1999**	**2008**
Lack of space to expand	Lack of space to expand	Lack of space to expand	Lack of space to expand
Organizational issues	Organizational issues	Organizational issues	Organizational issues
Bad quality of the current space	Difficult local traffic situation	Optimistic expectations about the future	Optimistic expectations about the future
Threat of expropriation/cancellation of rental agreement	Bad quality of the current space	No representative building	No representative building
No representative environment	No representative building	Bad quality of the current space	Bad quality of the current space

Source: Pellenbarg et al. (2005, p. 117), Boelens (2008)

The institutional location theory (cf. Atzema et al., 2015) argues that these internal issues are a core aspect of the migration decision, and it is in the first place necessary to look at the company and its requirements first, instead of at the location itself. In other words, there is not an objective optimal location for any company, instead it is dependent on the context, on the specific needs and wishes of

the individual company. On a local level, at the development of new industrial zones in a city the need to involve future users of the plots in those zones can also be felt, a non-demand driven approach may lead to problems in finding enough companies that would like to settle there (van't Verlaat, 1997).

Table 2-2: Comparison of the five most important pull-factors of migrated companies (1977-2008) in The Netherlands

1977	1988	1999	2008
Possibility to expand	Good infrastructural accessibility	Good infrastructural accessibility	Good infrastructural accessibility
Organizational issues	Possibility to expand	Representative building	Representative building
Ample available property	Favourable local traffic situation	Possibility to expand	Ample available property
Good infrastructural accessibility	Low price for land and buildings	Ample available property	Low price of land and buildings
Favourable local traffic situation	Closer to the target market	Better parking possibilities	Representative environment

Source: Pellenbarg et al. (2005, p. 117), Boelens (2008)

As concluding remark for this part of the literature review: The studies referred to in this subchapter, are about the general population of companies and their motives to migrate. It becomes clear that throughout the last several decades the importance of so called "soft" location factors (such as representativeness of the building and the environment) have become more important as compared to the more "hard" location factors (such as accessibility, parking and building size/quality). However, since this part of the literature review focuses on the general population of the businesses and their migration motives, it is not known if these factors also one on one translate to university spin-offs.

2.6.4 Migration pattern of university spin-offs and their knowledge relations with the parent university

As described in the introduction of this sub-chapter there are very few studies available that focus on the development of university spin-offs and their migration patterns through space and time. There are however some aspects of the university spin-off location patterns that are well studied. These are discussed in this part of the literature review and mostly revolve around the idea of knowledge relations with the parent university as important location factor: Given the – on average – relatively strong knowledge relations with the parent university, as well as the knowledge spillover effects from a location close to the university, there may very well be different migration motives for university spin-off companies, as compared to the general population of companies. University spin-offs usually decide to migrate when they outgrow the space in their first location (Bazen, 2018b; Bazen, 2021; Bazen & Flooren, 2020). When they are looking for a new company location, what factors play a role in decisions to move out from or stay in the region where they are founded (usually spatially close to the university)?

And when spin-off companies move to another region, what is it that drives these companies to that specific other region?

University spin-offs are by nature rather "sticky", meaning that they tend to stay in close geographical proximity to the parent institution, provided that business clusters in the region can absorb and exploit the knowledge generated by the university (Avnimelech & Feldman, 2015). This is a very important finding because the general goal of university spin-off companies is to translate university knowledge into practical business products/services. If there are not enough other companies around which would have a need for these innovative products and services (ie. the absorbtive capacity), this would be a very important motive to move out from such a region. Soetanto and Van Geenhuizen (2019) make next to the "stickiness" some additional observations: Firstly, often the overall performance of academic spin-offs after leaving an incubated environment drops significantly. Secondly, they also observe that spin-offs tend to locate close to the parent university, to retain as much as possible social ties/networks with researchers from that university, especially in the cases where there are in the team of founders one or more individuals who keep a parttime position as lecturer/researcher at the university. Thirdly, spin-off companies with – what they call – "a highly entrepreneurial orientation" are likely to move away to places which better suits their needs in terms of venture capital availability, staff availability and/or be closer to the target market. Similar findings to this third observation come from Van der Meer et al. (2010), who found a significant relation between "entrepreneurial ambition" and the likelihood of spin-offs physically moving away from the parent university. Moving away from the parent university however does not automatically mean that existing networks with this university are cut, there is often still interaction and cooperation (Soetanto & Van Geenhuizen, 2019), something that was also already observed by Boschma and Frenken (2003). This is probably not very surprising in the age of internet and its opportunities of working together on distance. When the proximity to the parent university is very close, meaning that the company relies heavily on university incubator support, actual performance of such companies after "graduation" from an incubator is on average worse than comparable non-incubated businesses with the same age (Lasrado, Sivo, Ford, O'Neal, & Garibay, 2016), and especially such type of businesses tend to remain in close spatial proximity to universities (Soetanto & Van Geenhuizen, 2019). These findings correspond with earlier studies on the issue: An extensive study on Canadian university spin-offs (with a rather narrow spin-off definition) by Clayman and Holbrook (2003) showed that from the 301 companies identified, 219 were still active and from those, 172 (or 79%) were located in the same region as the parent university. Bagchi-Sen et al. (2020) found in a study about spin-offs (with a similar rather narrow definition) in the UK even higher retention levels, on average 83% of the spin-offs stayed in the region of the parent university. Studies by Bhansing (2013) and Bazen (2018b) show that there is a notable difference among University of Twente spin-offs, in terms of employment growth: spin-offs located outside the region grew faster than the ones within the region, suggesting that the spin-offs with a higher entrepreneurial orientation are indeed more likely to

leave the region. Still, the subject of the influence of the region on the growth and development of spin-offs is a somewhat under researched subject (Prencipe, Corsi, Rodríguez-Gulías, Fernández-López, & Rodeiro-Pazos, 2020).

A final question still remaining on the subject of this subchapter is about the development of the knowledge relation between the parent university and the spin-off, if knowledge relations between the spin-off and the parent university decrease faster over larger distances than they tend to decrease on average on shorter distances. To answer this question, first of all, it is important to note that in general, over time, knowledge relations between parent business or university tend to wither away (Bagchi-Sen et al., 2020; Bathelt, 2010; Perez & Sánchez, 2003; Sapienza et al., 2004). The issue is whether this process is accelerated by the spin-off not being located in the geographical proximity of the parent. This subject is however under researched. Taheri and van Geenhuizen (2019) have studied the international knowledge relations of spin-off companies and found that a large majority (74%) was actively involved in developing international knowledge relations from the early beginnings of the company. Unfortunately, they did not specifically study the specific knowledge relation of the spin-off with the parent institution, however they did find that "domestic" networks, which may or may not include the parent university, played a very important role in the development of the company. Furlan and Grandinetti (2014) identified for corporate spin-offs that the variety of knowledge relations (not just with the parent company) was beneficial to boost the performance of such spin-offs. It is likely that these findings on variety of relations are also valid for university spin-offs, but they also did not study the geographical location of the spin-offs related to their parent university. In a case study of spin-off companies in Flanders, Clarysse, Wright, and Van de Velde (2011) found out that support of an experienced university technology transfer office made an important difference in the growth of a university spin-off company. Zahra, Van de Velde, and Larraneta (2007) came to similar conclusions, they found out that when comparing university spin-offs and company spin-offs, there is a clear difference in the way that knowledge was used: universities have on average less experience than companies when talking about knowledge of commercialization of technology, as well as that it is likely that university spin-off founders have less competences in commercializing knowledge. Also, in this study, geographical proximity to the parent is not considered. Tödtling and Trippl (2005) observe that universities in non-core regions, especially these in regions that go through industrial restructuring are often still predominantly occupied with traditional industries and/or technologies. It is very well imaginable that this could lead to the situation that innovative university spin-offs would feel sort of left alone and would be looking for other places/clusters where they would be able to get the right type of support. Autio (1997) argues that the value of science parks would be the building and support of R&D networks, and by giving shelter to university spin-offs, to build up a system of support and inspiring environment for such companies, instead of just focusing support on a few, as he calls, "atomistic companies" in a passive environment. Specific attention to the geography and the role of

university spin-offs in the regional entrepreneurial ecosystem close to the university is paid in the study of Benneworth and Charles (2004) who identify important factors in the regional entrepreneurial ecosystem that support the development of university spin-off companies and are mentioning examples of spin-off companies that help others with networking and venture capital acquisition. Benneworth and Charles have doubts whether such supportive environments exist or are at least strong enough outside strongly developed regions. These also argue that the role of the university as knowledge provider for spin-offs could be viewed in three different ways: 1. spin-offs cause universities to be more open to the world, or otherwise said: "universities as communities of practice", 2. Improving the local innovation environment and 3. Partnerships and clustering of spin-offs within the regional innovation system. Benneworth and Charles seem to suggest that geographical proximity to the parent university is required to have a meaningful knowledge relation. Johansson, Jacob, and Hellström (2005) conclude in their study on relations between parent university and spin-off that the role of trust between parent and spin-off needs not to be underestimated and that geographical proximity plays a role in the maintenance of knowledge relation linkages as well. Bolzani et al. (2020) conclude that geographical proximity in combination with strong scientific/technical linkages with the parent university are often detrimental for the business performance of university spin-offs: such businesses could be sort of "external research labs" with a limited business focus. They also found a strong link between university equity ownership, geographical proximity, and business performance: formal involvement of the parent institution combined with the physical access to university resources leads to better spin-off performance. As a conclusion evolving from this chapter, most studies see a positive relation between geographical proximity and the strength of knowledge relations between spin-offs and parent institutions. These stronger knowledge relations may lead to stronger spin-off performance: there is strong evidence that knowledge relations help in boosting the economic performance of spin-offs, but also that too intense knowledge relations may hurt the business focus and therefore the economic performance of spin-offs (this is a risk that is mainly present among the spin-offs found in close geographical proximity of the parent).

3 Research area and methods

3.1 Introduction

This chapter consists of the research methodology for the empirical part of this study. In the previous chapters was already every now and then mentioned that the geographical scope of the study consists of the universities located in the region Twente in the eastern part of The Netherlands. This chapter starts with a description of the region Twente, with a spatial application of the core-periphery concepts from chapters two and three. Chapter 4.3 continues with a description of the two largest universities in Twente, the University of Twente (UT) and Saxion University of Applied Sciences (Saxion), as the two parent institutions of the university spin-offs included in this study. The second part of this chapter consists of the research methodology of this study in terms of the research design and information sources used.

3.2 Description of the region Twente

The region Twente is located in the eastern part of The Netherlands, bordering Germany from two sides (see figure 3-1). Some authors trace the name of the region back to the Tuihanti, a Germanic tribe that supposedly lived in this area during Roman times (Kokhuis, 1982), others point to the similarity of Twente with the nearby province of Drenthe. This name supposedly comes from the division of this province into three subregions (Drente, “three entities”).

Figure 3.1: Location of Twente in The Netherlands

The name Twente would, according to this logic, have meant to be “a region divided into two subregions” (Rentenaar, 1990). It is known that Twente during the most of the middle ages has been a sort of self-governing body. The most likely reason for this can be found in the geography of the region, the northern and western part of the region consisted of bogs and quagmires, which made

communication, trade and integration of this region into larger territorial units not very easy (Bazen & Bijleveld, 2012).

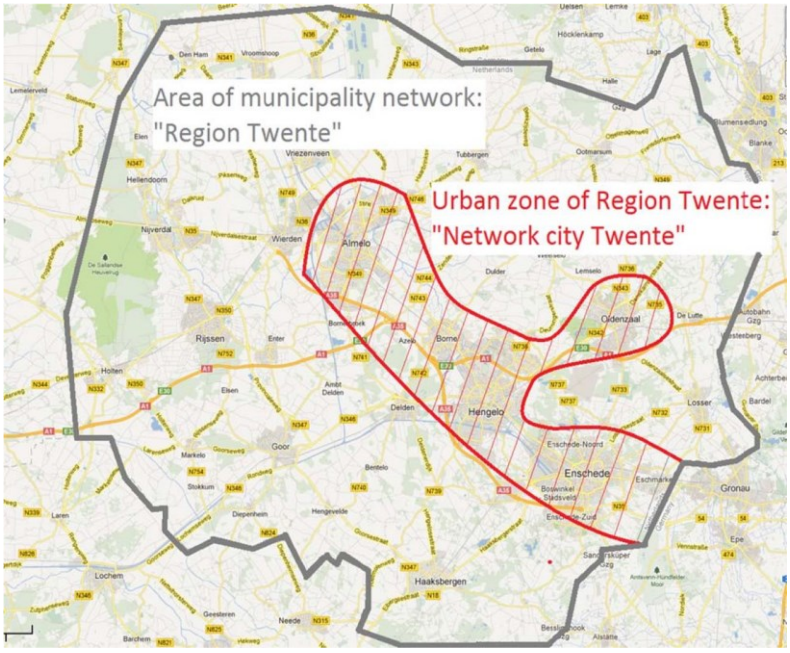


Figure 3.2: The two parts of the region Twente: The industrialized urban zone and the largely non-industrialized rural area. Source: Google Maps

During most of the early modern period, Twente remained a thoroughly peripheral region, even though it was politically integrated in the Republic of the Seven United Netherlands. Strong incentives for the economic development of the region were given not long after 1830 by the Dutch government. During this time the Kingdom of the United Netherlands (formed during the Treaty of Vienna in 1815) fell apart into The Netherlands, Belgium and (slightly later) Luxembourg. In 1830, Belgium was more industrialized than the Netherlands, and had a lot of textile industry. During and after the Belgian revolution, the Dutch government closed off the Scheldt estuary, to limit the export possibilities of the Belgian textile industry. At the same time, the Dutch government strived to establish its own textile industry, to compensate for the loss of this industry in what is now Belgium. Twente was an ideal candidate as a region for developing this industry, far enough away from the Belgian border not to be under risk of an eventual surprise attack, with experience in textile production and with low average wages, due to poor economic development. The experience with the textile industry was because of the infertile soil in the region, which made it necessary for many farmers in the region, during the early modern period, to earn some additional money with spinning and weaving cloth at home, from regionally produced flax or wool (Kokhuis, 1982). The industrialization of Twente therefore, is a clear example of how government intervention at the right time and place can very significantly speed up regional economic development. It has to be noted here that the industrialization of the region concentrated itself in only a few urban cores (Almelo, Oldenzaal & Enschede for textile industry and Hengelo for machine building industry), and that large parts of Twente remained rural (including five

of the historical cities in the region: Delden, Diepenheim, Goor, Ootmarsum and Rijssen) (see also figure 3-2). In its heyday the textile industry in Twente was the world's second largest concentration of textile industry, after the Manchester region (Benneworth & Hospers, 2007). The textile industry remained the most important driving factor of the regional economy until the early 1960s. After this period the sector rapidly collapsed within just ten to fifteen years, due to increasing competition from lower wage countries, the loss of the Dutch colonies as export market and as some argue, the loss of entrepreneurial alertness and innovation (Atzema & Wever, 1994; Bazen & Bijleveld, 2012; Kokhuis, 1982). The decline of the textile sector was a direct major reason for the Dutch government in establishing a technical university in Twente in 1961, in order to create new conditions for regional economic development (Boer & Drukker, 2011).

The regional economy in the region Twente has become undoubtedly more diversified since the collapse of the textile industry. Nonetheless, this diversification has not been able to completely overturn the economic position of the region. Especially Enschede still has a high unemployment rate, in 2014 it was the highest of the 50 largest municipalities in the Netherlands, with Almelo not far behind (Burema, Marlet, Middeldorp, Muilwijk-Vriend, & Van Woerkens, 2014). Statistics from the last couple of years show some improvement, however Enschede is still in the top-10 municipalities with the highest unemployment rates in The Netherlands. Table 2-1 shows some important economic development indicators for the region Twente and its three largest municipalities in comparison with the Netherlands as a whole. The three cities of Twente score above the national average for unemployment and below average on the percentage of the population between 15-75 with paid work. Twente as a whole scores slightly below the national average on unemployment, leading to the conclusion that unemployment in the more rural areas of Twente must be lower than average. It is also clear that the percentage of the population with a higher education degree is significantly lower than the Dutch average. Employment in the service sector is on average lower than in the Netherlands and employment in industry higher. The non-commercial service sector is larger than average, in Enschede mainly due to the largest regional hospital as well as the two universities UT and Saxion. In Almelo the non-commercial sector is larger than average due to employment in the second regional hospital, the regional courthouse and prison.

Table 3-1: Economic development of the region Twente compared to the Netherlands in 2020

	The Netherlands	Twente	Almelo	Enschede	Hengelo
GDP/GRP per capita (Euro)	46 714	37 569	.	.	.
Labour productivity (in Euro per hour)	52.3	45.8	.	.	.
% of the workforce unemployed	3,8	3,7	4,4	4,9	4,3
% of the population between 15-75 years with paid employment	68,4	67,1	64,1	63,1	66,4
Employment in:					
Primary sector (Agriculture, Fishery & Forestry) (%)	1.2	0.6	0.2	0.1	0.2
Secondary sector (Industry and Construction) (%)	13.8	19.9	21.3	11.8	21.9
Tertiary sector (Commercial services) (%)	52.6	47.3	43.5	46.9	47.3
Quaternary sector (Non-commercial services) (%)	32.4	32.1	35.0	41.2	30.8
Percentage of the population (15-75) with a university degree	26.7	22.7	19.4	24.0	27.8

Source: Centraal Bureau voor de Statistiek,2021

The lower labour productivity in Twente as compared to the Netherlands can be explained by the lower average education level combined with the more than average employment in industry and therefore less employment in the commercial service sector, which includes the so-called knowledge intensive creative sector (Florida, 2002b). Consequently, the value of the total economic production in Twente per capita (Gross Regional Product) is significantly lower than the Dutch average. The economic indicators of the region show therefore that Twente can be classified as an economic non-core region.

Another aspect of peripherality is demography. Peripheral regions in Europe are usually characterized by net out-migration and a declining population in general. Table 3-2 shows the demographic development of Twente. As can be seen in this table, the death rate in Twente is higher than the birth rate, a consequence of an ageing population, for the Netherlands in general the birth and death rates are nearly equal. The population in Twente is still very slightly increasing, due to a net in-migration. The countryside in Twente is growing faster than the cities in the region, providing evidence that there is suburbanization going on, since the relative share of the number of people living in urban areas is decreasing. As conclusion, also from the demographic perspective, Twente can be seen as a non-core region, although it appears to be not very peripheral. Even though there is no net migration deficit, the net migration rate is lower than the Netherlands on average, causing the share of the population of

Twente in the Netherlands to fall, a clear indication of a process of peripheralization of the region (see also table 2-3 for the development of the population of the region in relation to the Netherlands as a whole).

Table 3-2: Demographic development of Twente compared to the Netherlands in 2020

	The Netherlands	Twente	Almelo	Enschede	Hengelo
Population 1 January	17 407 585	631 064	73 107	159 640	81 140
Number of births	168 066	5 494	666	1 289	695
Number of deaths	168 537	6 674	796	1 629	868
Birth rate (‰)	9.65	8.71	9.11	8.07	8.57
Death rate (‰)	9.68	10.58	10.89	10.20	10.70
Birth surplus (‰)	-0.03	-1.87	-1.78	-2.13	-2.13
Migration into the area	1 013 860	26 925	3 084	8 927	3 802
Migration out of the area	946 281	25 109	2 921	8 524	3 712
Net migration rate (‰)	3.88	2.88	2.23	2.52	1.11
Population growth	67 108	636	33	63	-83
Population growth (%)	0.39	0.1	0.05	0.04	-0.1
Population 31 December	17 474 693	631 700	73 140	159 703	81 057

Source: Centraal Bureau voor de Statistiek, 2021

As written before, Twente is a historical region, and it has a strong cultural identity as well, fitting all categories of regional shapes as described by Paasi (1986). Twente is however not a separate administrative unit, but part of the province of Overijssel. This means that the possibilities for specific regional development policies are rather limited. The region Twente does have a voluntary cooperation organization named “Regio Twente”, formed by the 14 municipalities that make up the region. This regional cooperation organization has among others the aim to coordinate regional development policies, as these are usually more effective on a regional scale. This “Regio Twente” organisation, as well as the Province of Overijssel, are also two of the main partners in the Novel-T organization, the accelerator network for university spin-offs.

Table 3-3: Long term development of the population of the region Twente

	1795	1849	1889	1950	2000	2012	2017	2020
Twente region (total population)	55 580	83 871	120 963	377 286	611 797	626 591	627 209	631 700
The Netherlands (total population)	1.9 mln	3.1 mln	4.5 mln	10.0 mln	15.7 mln	16.7 mln	17.1 mln	17.4 mln
Twente region (population share)	2.96%	2.74%	2.68%	3.76%	3.86%	3.76%	3.67%	3.62%

Source: Centraal Bureau voor de Statistiek, 2021

An important decision of the municipality of Enschede was to support the development of a 120 hectares large area next to the UT, to develop there the so called "Kennispark" (Business and Science park) from around 2005 onwards. Kennispark quickly became a focal point for innovative businesses among them many UT spin-off companies (Bazen & Bijleveld, 2012; Benneworth & Hospers, 2007). The Kennispark area was so successful that it won less than ten years after its inception the prestigious price "Best business park of the Netherlands" (RTV Oost, 2013). It can be concluded that the cooperation of the university with the regional and local governments as well as the regional industry, including the university spin-offs, has been successful in improving the regional innovation system of Twente. In 2021 new plans were released to combine the UT campus area with the Kennispark business area into one mixed area where work, living and studying is combined. This new layout of the area should be beneficial for the development of new ideas:

> *A transformation to an innovation district where scientists, students and entrepreneurs meet each other casually and from these meetings new ideas will appear* (Vreeman, 2021).

The development strategy of the Enschede municipality in cooperation with the UT with the Kennispark area is, as can be seen from this quote, aimed at further developing the so-called Jane Jacobs externalities. For a country like the Netherlands, with strict zoning laws and usually strict separation of functions, this plan is quite revolutionary.

3.3 Description of the universities in the study

3.3.1 University of Twente

The University of Twente (UT), is a technical research university in Enschede, founded in 1961. As is described earlier, the most important reason to establish this university in Enschede was that there was concern about the decline of the textile industry in the region already then (Boer & Drukker, 2011), even though probably nobody could have imagined back then that this collapse would be so fast and radical. The university was perceived as a regional stimulus for innovation that could increase the competitiveness of the companies in the city and improve the human capital position of Enschede in general (Bazen & Bijleveld, 2012). The city of Enschede offered the estate Drienerlo northwest of the city to the new UT for free. The decision was made to build a typical Anglo-Saxon style campus

university on this estate, so that students could concentrate all their efforts on studying without having all the distractions of city life (Boer & Drukker, 2011). Even though this may have worked in terms of faster studying, it also shielded students more or less from getting involved in the cultural life of Enschede, so that there was just little attachment to the city and the region. A large percentage of UT graduates left Enschede soon after graduation, which did not help too much in improving the regional economy. Slowly but surely, the university got more integrated into the city and the obligation for students to live on the university campus was abolished. This integration probably helped to keep at least a part of the human capital inside the region.

The UT has as its slogan "The entrepreneurial university". Even though this slogan was introduced by rector Van den Kroonenberg in the early 1980s, already at the start of the new university in the 1960s, many of the new professors were recruited from commercial research labs, leading to a more entrepreneurial culture from the beginning, than in other universities (Universiteit Twente, 2020). Van den Kroonenberg formalized this entrepreneurial mindset into the concept of the entrepreneurial university, to give the at that time fledgling university a new positioning. He developed several policy measures to support students and staff members to commercialize their research results (Boer & Drukker, 2011; Sijgers et al., 2006), with programs like the technology transfer point (in 1979) and the BTC Twente (short for "BedrijfsTechnologisch Centrum", Commercial Technology Center, in 1982). A study among UT graduates by Van der Meer and Van Tilburg (1984) showed that at least 40 former staff members and students had started a business and that there were many more who had serious plans to start their own business upon graduation. The study also showed that there was not a lot of attention and support from the university for these entrepreneurs. The direct consequence of this report was that Van den Kroonenberg initiated the so-called TOP-program (short for "Tijdelijke Ondernemers Plaatsen", Temporary Entrepreneurship Places) for starting academic entrepreneurs in 1985 (Boer & Drukker, 2011; Universiteit Twente, 2020). The TOP program has functioned since its beginning as an important tool for supporting university spin-offs of the UT. Benneworth and Charles (2005) describe the TOP program as a broad support program, which they classify in the group of "low selective university policies to support entrepreneurship" among universities throughout Europe. Characteristic for this type of entrepreneurship support is that the university supports a lot of different business ideas of staff/students, without having a specific technological spearhead (such as biotechnology, chemical technology or Information and Communication Technology). The advantages of this system, as the authors describe, is that a lot of university spin-offs are founded, but that the consequence of it is quantity over quality.

Benneworth and Hospers (2007) describe the policies of rector Van den Kroonenberg as the first steps to "regionally engage" the university, even though there was very considerable opposition from the rest of the Dutch academic community at the time. The authors describe that from the early 1980s, innovation in the regional industrial sector was increasing and that Van den Kroonenberg saw

opportunities to connect the knowledge questions of the larger industrial firms in the region with the knowledge generating capacity of the UT. The result of this regional cooperation of the UT with the municipality of Enschede, the regional government and businesses was the development of the Kennispark Twente (Business and Science park Twente), as before discussed before. Besides the area of the business park itself, Kennispark also included business support services, including a business incubator and seed capital funding to support knowledge intensive university spin-offs to commercialize research results. The earlier mentioned TOP program was also incorporated within the Kennispark organization. Specialized programs such as VentureLab were developed to mentor and coach nascent entrepreneurs with necessary knowledge and skills in entrepreneurship (Koopman, 2021; Koopman, 2013).

Being a relatively small university (within the context of The Netherlands) with around 11 000 students and around 3 100 staff members in 2020, the university has focused on just a few areas for its research programs, bundled into three research institutes, MESA+ (Nanotechnology), the TECHMED Centre (Health care technology) and the Digital Society Institute, aimed at methods and techniques to integrate digital technology into society (Bazen, 2021; Boer & Drukker, 2011; Universiteit Twente, 2015). Benneworth and Hospers (2007) describe that the attempts of the UT to develop with its policies to become a world player in research in these areas and stimulate innovative entrepreneurship to commercialize the research results were met with a lot of scepticism ("Silicon valley on the Dinkel river"), but that gradually the result was that the outside perception of the region changed from problematic region towards a region with a lot of high-tech development. The award of Kennispark as best business park in the Netherlands is exemplary for this change. The development process of science parks require coordination of the role of the universities and its spin-off companies, to form a mutually reinforcing regional cluster of innovation that could institutionalize over time into a full-fledged science park (Benneworth, Hospers, & Timmerman, 2009; Kooij, 2015).

3.3.2 Saxion University of Applied Sciences

Saxion University of Applied Sciences is the result of a merger in 1998 between the "Hogeschool Enschede" (Enschede University of Applied Sciences) and the "Rijkshogeschool IJsselland" (Ysselland State University of Applied Sciences) in Deventer (not located in the region Twente). "Hogeschool Enschede" has its roots in the industrial revolution of the mid-19th century, with the rise of the textile industry. In 1864, the "Twentse Industrie en Handelsschool" (Twente School of Industry and Commerce) was established and subsidized by factory owners and textile traders, in order to have sufficient regional human capital to drive the ongoing industrialization of the textile industry further. "Hogeschool IJsselland" was formed after a merger in 1986, which brought different schools for higher education in the city together. The history of higher education in Deventer goes back to the Latin school of the Middle Ages, with famous students such as Erasmus of Rotterdam.

Saxion is a University of Applied Sciences, which means that it is a higher professional education institution, offering more practical and profession-oriented education than the UT, specifically designed for entering a particular profession upon graduation. Even though Saxion does offer both professional bachelor and master courses, the overwhelming majority of students (around 95%) follow a professional bachelor course. Saxion is as university of applied sciences not allowed to award PhD degrees. Research in Saxion is therefore normally spoken more practically oriented than at research universities such as the UT. Saxion is in terms of students much larger than the UT and one of the largest higher education institutions of The Netherlands with over 27.000 students and around 2800 staff in 2020 (Hogeschool Saxion, 2020). When comparing the number of staff members of Saxion and the UT, it becomes clear that the staff/student ratio at the UT is much lower, indicating a much stronger focus on research at the UT. Research at Saxion focuses on three areas: Smart Industry, Health & Wellbeing and Areas & Living.

Entrepreneurship support policies for students/graduates and staff members at Saxion are from a later date than that of the UT. Formalized entrepreneurship support came into being with the development of the Small Business & Retail Management study program combined with the establishment of SKIO ("Saxion Kenniscentrum voor Innovatief Ondernemerschap", Saxion Knowledge Centre for Innovative Entrepreneurship) shortly afterwards (Van der Velde, personal communication, 2021). Here, research projects related to entrepreneurship were housed, next to entrepreneurship support programs for students and recent graduates. One of the conclusions of an extensive study into the effectiveness of entrepreneurship education at universities of applied sciences commissioned by SKIO was that entrepreneurship education did not have significant effects on the students in terms of perceived acquisition of entrepreneurial skills as well as entrepreneurial intention (de Krosse, 2017; de Krosse, van Geert, van der Werf, & van der Meer, 2012). The results of the study show that entrepreneurship education in universities of applied sciences is still "work in progress" (if one has the opinion that entrepreneurship can be learned).

In 2017 SKIO was renamed into CvO ("Centrum voor Ondernemerschap", Centre for Entrepreneurship), with a new support program with the name TOR ("Top Ondernemers Regeling", Top Entrepreneurs Directive), where student-entrepreneurs could apply to be able to run their business while studying. The study program is then organized in such a form, that it is possible for these entrepreneurs to combine their work with studying (Saxion Centrum voor Ondernemerschap, 2017).

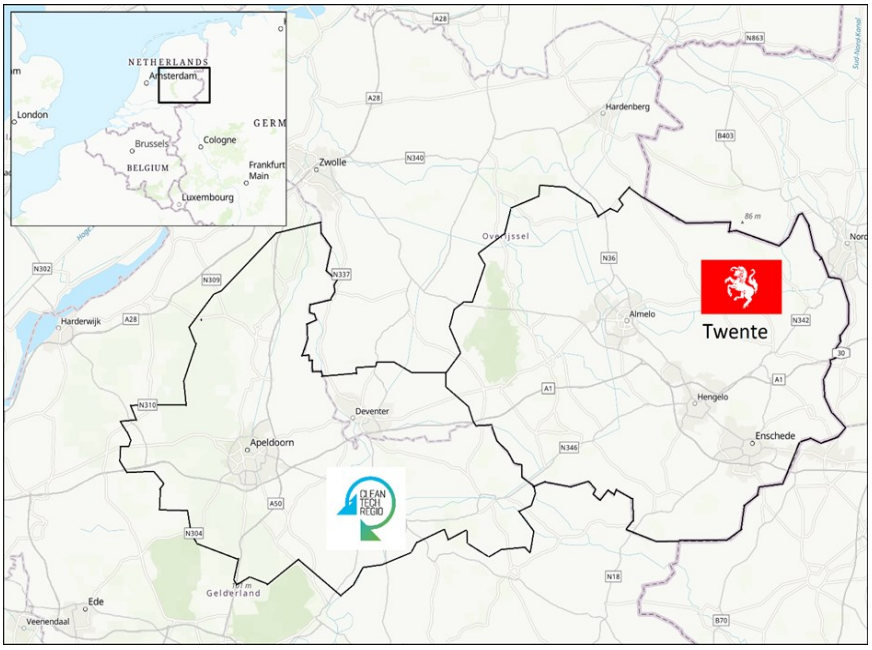


Figure 3.3: Map of Twente and the Cleantech Region

Source: Own compilation

In this study, the two regions where Saxion campuses are located are as much as possible separately analysed, even though the focus is on the region Twente because of the by far larger number of spin-offs there. The largest part of Saxion is located in Enschede in the region Twente, and two smaller campuses are in Deventer and Apeldoorn, in the Cleantech Region. Figure 3.3 shows a map of a part of the eastern Netherlands, with these two regions. The cities Apeldoorn, Deventer and Enschede where Saxion campuses are located are also visible on this map. Any analysis that deals with either Twente or the Cleantech Region in this study, uses the boundaries shown in Figure 3.3 for these regions.

3.3.3 Kennispark Twente/Novel-T

The local and regional governments, respectively Enschede and the region Twente as well as the province of Overijssel joined forces with the UT and soon afterwards also with Saxion, to bring support for spin-off companies to a new level. A 120 hectare area next to the UT was designated by the Enschede municipality to be developed as a science park specifically for university spin-offs and other highly innovative businesses that would profit from a location close to the university. Besides a physical area, Kennispark Twente also consists of an organization that supports and develops this area. This is done by organizing events, trainings, business incubation as well as participation in promising spin-offs by means of a seed-capital fund. In 2017 the organizational part of Kennispark was renamed into Novel-T, whereas the actual business and science park area kept the original Kennispark name. Novel-T calls itself “Ecosystem accelerator”, figure 3-4 shows a visual representation from the Kennispark

organization about the regional entrepreneurial ecosystem in Twente, and their place in it. Novel-T organizes many activities for both nascent entrepreneurs as well as already started businesses

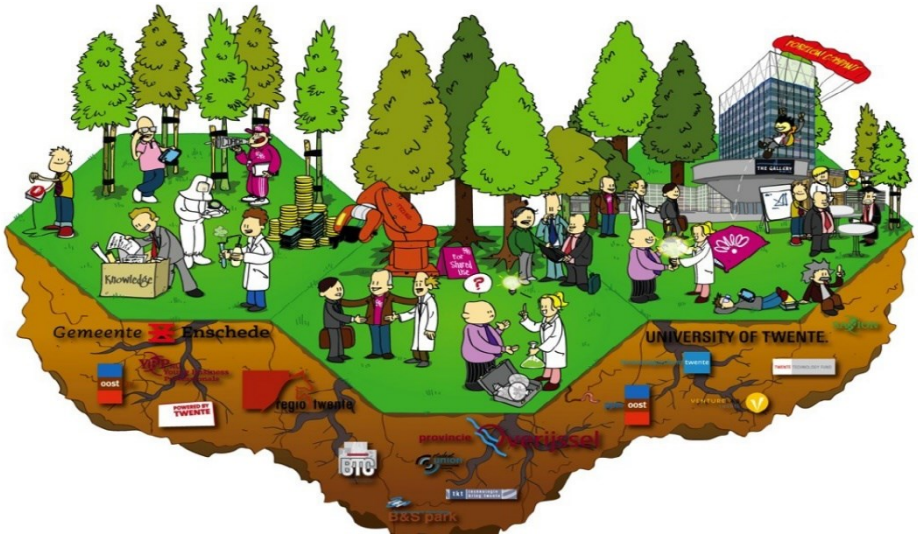


Figure 3.4: Visual representation of the Kennispark/Novel-T entrepreneurial ecosystem
Source: Novel-T (2020)

The support of Novel-T can be summarized in four directions:

1. Capital: Financing in the form of the TOP program and the High-Tech fund (www.hightechfund.nl) organized by Novel-T itself, as well as giving advice to apply for external funding such as the Take-off fund and/or other government subsidies, loans or grants (Novel-T, 2020).
2. Talent: Novel-T offers challenges to students and/or the wider public, to solve technological issues that companies within the ecosystem of Novel-T come across. In this way Novel-T helps to connect talent with innovative regional (start-up) companies. Such challenges can be in the form of traditional internships, but also in the form of shorter challenges such as Create Tomorrow (Novel-T, 2021), NovelT SMART, hackathons (called Creathons within Novel-T) (Bazen, 2018a) and the inGenious projects (Boertien, Bosch-Chapel, ten Dam, & Loohuis, 2020).
3. Knowledge and facilities: Novel-T is involved in no less than four innovation campuses within Twente, each specialized in certain economic sectors. The most well-known of these is the Kennispark area itself. The others are the Technology base, at the former Twente airport, the High Tech systems park in Hengelo and the XL Business park (with a focus on logistics) in Almelo. Other facilities of Novel-T include the student start-up incubator Incubase and a number of different business cluster initiatives (Novel-T, 2020).
4. Networking: Novel-T is part of many regional business networks which help facilitate the growth of spin-offs. These networks offer spin-offs access to scientific knowledge, venture funding, export connections as well as different customer groups.

This study deals with university spin-offs from both Saxion as well as the UT. Within this group of spin-offs, a substantial amount has had, in one form or the other, received support from Novel-T. To distinguish between the spin-offs that have had support and those that did not, different codes have been given to the different types of spin-offs. More about this can be found in the next part of this chapter, where the specific research methodology is described.

3.4 Research methodology

3.4.1 Introduction

The empirical part of this study consists of the construction of a database in which all qualifying university spin-off companies that have been identified are included. The database consists of an entry for every year that the company exists, up to 2021 or until the year the company is dissolved for whatever reason. This approach leads to a database in which not just the development of companies in terms of workplaces can be seen, but also gives insight into the spatial development of the spin-offs, in the sense of whether these companies migrate or not and about their development in terms of number of employees before and after migrating.

Finding as many qualifying spin-offs as possible is a challenging task, not in the last place because Saxion and the UT are both large HEIs with around 27.000 students/2800 staff and 11.000 students/3100 staff respectively. Since spin-offs appear from different origins, from staff members or students, with a lot or very little influence from the parent university, it is therefore necessary to use different ways to acquire data. The data collection methods for this study are rather straightforward, but very labour intensive. Spin-offs in this study have been found with the help of three main data collection methods:

1. The UT/Saxion student entrepreneurship monitor
2. Social media (LinkedIn) searches
3. Interviews with business developers/other experts

When a university spin-off has been identified by any of these three above methods, the Dutch trade register is consulted, to see whether this specific company is legally registered. The REACH database of Bureau Van Dijk is used for this, as it offers a complete overview of all registered businesses in The Netherlands (Bureau Van Dijk, 2017). Since Novel-T also offers trainings to nascent entrepreneurs, usually there is a delay in having followed a training and the actual legal registration of a business. The names of these legally soon-to-appear spin-offs are saved in a special list of “prospect companies”, to be checked again in the next round of updates. In the REACH database also ownership of the spin-off can be found, so it is possible to confirm the link between entrepreneur and company.

3.4.2 Data from the Saxion/UT on student entrepreneurship

Both Saxion and the UT ask all students during the yearly (re) enrolment procedure in any of their academic programs whether they are interested in starting their own business, or if they already have their own business. The question is asked via the central Dutch enrolment platform "studielink.nl", where individual universities have the option to adjust the questions asked slightly. Both HEIs have added the question "Do you consider starting your own business?" to the enrolment platform. Answers given can be: Not at all, maybe, likely, very likely or "I already have my own business".

The "studielink" question delivers the names of the students who answered "I already have my own business". A subsequent social media search is done to find out the company name of this student and possible further details. The third step is to find out from the Bureau Van Dijk REACH database whether the business has been legally registered. In case the company is officially registered, it is included in the study. If it is not registered, it is added to the list of "prospect companies", which is re-checked in the next round of updating the database.

This data collection method has the advantage that all students of both HEIs are asked about their own status as entrepreneur. Even though several additional steps need to be taken (social media search and REACH database check), this method yields a lot of qualifying start-ups. Of course not all student entrepreneurs choose to continue their company after graduation, but a significant amount of them does. Likewise, not all recent graduates already start their business while being a student. According to the definition used in this study (see chapter 2.2.2), all start-ups that are established less than five years after the entrepreneur leaves the UT/Saxion qualify as a spin-off. Therefore, this method alone will not find all qualifying spin-offs and needs to be complemented by other data collection methods.

3.4.3 Data from Social Media (LinkedIn)

Besides data from the UT/Saxion on student entrepreneurship, data on spin-offs is also collected by doing a wider social media scan. In the Netherlands, LinkedIn is the most popular professional public platform to publish one's curriculum vitae, and has around 7.8 million users in the Netherlands (Marketingfacts, 2020), about 40% of the total population. Given the fact that LinkedIn is so often used, especially within the target group of entrepreneurs/business owners, even if it is just for publishing a public C.V., it is the most likely place to find qualifying spin-off entrepreneurs.

On LinkedIn, the search terms in the job description: "entrepreneur", "founder" and "owner" as well as their Dutch equivalents "ondernemer", "oprichter" and "eigenaar" are used in combination with having had an education at the UT/Saxion. The search results are then manually filtered to exclude those who started a business more than 5 years after leaving the university. Just like with the data from the "student entrepreneurship" re-enrolment question, the collected data is fed into the REACH Bureau Van Dijk

database to find out whether this business has been officially registered. If not, the data is added to the list of "prospect companies", which is re-checked in the next round of updating the database.

The strength of this method is that it is possible to find with a rather large degree of reliability (because of such a high percentage of users) many qualifying spin-offs. The disadvantage is that the results are dependent on the entrepreneur having his/her own profile in LinkedIn and the willingness to share this information to the wider public. In several cases, incomplete LinkedIn profiles (e.g. without graduation year/years of employment and/or year of establishment of their own business) can lead to exclusion of potential qualifying spin-offs. To minimize the risk of excluding companies that actually qualify, one more data collection method is used to find additional spin-offs, namely interviewing business developers/other experts.

3.4.4 Data from interviews with business developers/other experts

To complement the data from the "Studielink" student entrepreneurship question and the Social Media (LinkedIn) scan, also several UT/Saxion business developers are interviewed, and shown the list of newly found enterprises, to understand whether they know of some additional businesses started either by staff or students that they worked with, and have not been included in the results so far.

Also here, the data collected via this method is fed into the Bureau Van Dijk REACH database, to check whether the company is legally registered. Information of business developers leads relatively often to the identification of entrepreneurs who are in the preparation phase of starting their business. Such nascent entrepreneurs are then added to the "prospect companies" list, to be re-checked in the next update of the database.

3.4.5 Longitudinal approach

The resulting database with UT/Saxion spin-off companies is updated on a yearly basis. Every year new companies are added and for the already existing companies a new entry is added with information from the Bureau Van Dijk REACH database. The following aspects of any company are available and added to the database every year:

- Chamber of Commerce identification number (serving as a unique identifier for any company in the database)
- Name of the firm
- The main sector of activity (according to the Dutch SBI2008 classification system, based on the international NACE/ISIC systems)
- Number of employees
- Location of the company (Dutch postal code)
- Year of establishing the company
- Name of the entrepreneur (not always available)

- Gender of the entrepreneur (not always available)
- (If applicable) year of dissolution of the company
- (If applicable) reason of dissolution of the company
- (If applicable) merger/acquisition

Financial data is only sparsely available within the REACH database, therefore indicators such as turnover, investments and profit are not included in the research database, since only a limited number of spin-offs have the obligation to report such data. Number of employees is much more widely available and serves in this study as a proxy for company size. Since the database is longitudinal by nature, development of each of the company aspects can be monitored over time. The name of the company and the main sector of activity only seldom change. Number of employees is reported yearly and can therefore be used accordingly. The location of companies is updated on almost real-time basis, and can also be used in yearly reporting, as it is unlikely that companies move multiple times per year.

Therefore, the yearly collected data of these spin-off companies forms a longitudinal study into their development in mostly two areas: the company size in number of employees and their location. Based on the variables stated above, including combinations of these, many different analyses can be done.

When spin-off companies are dissolved, no extra entries are added and data collection for that company stops. In case of the original entrepreneur selling the company, data collection will continue, but a special flag variable will be activated, that this company is no longer under control of an entrepreneur who meets the criteria for having a spin-off.

4 Research results and evaluations

4.1 Introduction

As the UT and Saxion, the two HEIs in focus of this study, have different profiles, respectively research university and university of applied sciences, large differences in the types of spin-offs as well as their development and spatial pattern can be expected. Chapter 4.2 describes the spin-offs of the University of Twente. Since the UT is a technical university with a research profile, its spin-offs have been classified into four groups (based on the typology of Pirnay et al.), as discussed in the literature review. Chapter 4.3 deals with the development of spin-offs from Saxion, and these spin-offs have not been classified into different groups, as virtually all of them are lower tech than those of the UT. It means that almost all of them would fall in category IV in the classification of Pirnay et al.

Spin-offs from the UT and Saxion are dealt with in separate subchapters, because they are quite different from each other. An independent (one-tailed) T-test on the economic impact of spin-offs in terms of the size of the spin-off companies in terms of number of workplaces from both institutions shows that UT spin-offs have a significantly larger size (Mean: 35.54 workplaces, St.dev: 563.3) and therefore impact than Saxion spin-offs (Mean: 5.95 workplaces, St. dev: 56.6), t(2382)=2.08, p=.019.

Group Statistics

	Parentorganization	N	Mean	Std. Deviation	Std. Error Mean
SpinOffSize	University of Twente	793	35.54	563.305	20.004
	Saxion UAS	1591	5.95	56.640	1.420

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance			
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference
SpinOffSize	Equal variances assumed	13.010	<.001	2.075	2382	.019	.038	29.593	14.262
	Equal variances not assumed			1.476	799.992	.070	.140	29.593	20.054

Independent Samples Effect Sizes

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
SpinOffSize	Cohen's d	328.094	.090	.005	.175
	Hedges' correction	328.198	.090	.005	.175
	Glass's delta	56.640	.522	.435	.610

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

Figure 4.1: Independent samples T-Test output table on company size per parent organization

Source: Own compilation

Figure 4.1 shows the detailed description of the above mentioned independent T-test. Given the significantly different average sizes and therefore economic impact of the spin-off companies from

Saxion and the UT as outcome of this test, means that doing analyses on the combined spin-offs would yield less useful results than when doing all these analyses per parent institution separately.

4.2 University of Twente spin-offs: characteristics and development

The UT was established in 1962, but strong attention for entrepreneurship only started in the 1980s, within the university policy. Given this situation, as well as the fact that the results of the university policy to support entrepreneurship took some time to be actualized, there are only few spin-offs from before 1990. At the time of writing, there are 1286 spin-off companies identified, of which 722 are still commercially active (see table 4-1). It took the university 44 years to reach 505 spin-offs, bringing it to an average number of 11 spin-offs generated per year. Table 2-1 also shows that from 2006 to 2020, the average rate of spin-off generation was around 55 spin-offs per year (1276 spin-offs in 2020 minus 505 spin-offs equals 771 spin-offs established in these 14 years). These numbers provide some evidence for the entrepreneurial ecosystem theory, which argues that the development of entrepreneurship and the good examples of leadership in itself leads to stronger growth of entrepreneurship (Feld, 2012; Stam, 2018; Wurth et al., 2022)

Table 4-1: Number of UT spin-offs established per year

Year of establishment	Cumulative number of established spin-offs	Cumulative number of commercially active spin-offs
Pre-2006	505	283
2006	548	310
2007	599	338
2008	665	371
2009	739	411
2010	816	446
2011	908	488
2012	982	522
2013	1051	559
2014	1115	599
2015	1171	639
2016	1199	662
2017	1219	680
2018	1237	696
2019	1258	716
2020	1276	734
2021	1286	744

Source: Own compilation

The spin-offs of the UT have been classified according to the typology of Pirnay et al., among them are 53 spin-offs of Type I, the spin-offs with codified intellectual property. This is just a small number of the total amount of spin-offs, as could be expected because of the narrow definition. Type II, the

research based spin-offs (with more tacit knowledge transfer), consists of 167 spin-offs. The group Type III, the entrepreneurial ecosystem supported spin-offs, consists of 525 spin-offs and the remaining Type IV, the student start-ups, consist of 541 spin-offs. Adding the numbers of the four types, gives 1286 as the total number of identified spin-offs. Table 4-2 shows an overview of the different types of spin-offs, including the currently commercial active ones.

Table 4-2: Number of UT spin-offs per spin-off type

Type of spin-off	**Total number identified**	**Currently commercially active**
Type I	53 (4%)	38 (5%)
Type II	167 (13%)	95 (13%)
Type III	525 (41%)	296 (40%)
Type IV	541 (42%)	315 (42%)
Total	1286 (100%)	744 (100%)

Source: Own compilation

When comparing the percentages from Table 4-2 of the total number of spin-offs per spin-off type with the number of commercially active ones, there is barely any difference visible between the different types in terms of the percentages per group. When looking at the first five year survival rate of spin-offs per different spin-off type, the differences between the groups are a bit larger (Table 4-3). The spin-off survival rate is an important statistic: If a lot of spin-offs are established is one thing, but if only few of them survive, it does probably do just little for the development of the regional innovation system.

Table 4-3: First five year survival rate per spin-off type and average

Type of the spin-off	**Average 1st 5-year survival rate** (for spin-offs established between 2010 – 2015)
Type I	74.3%
Type II	62.6%
Type III	70.6%
Type IV	77.0%
Average UT spin-offs	72.2%
Dutch average start-up survival rate	57%

Source: Own compilation & Eurostat, 2021

The higher survival rate of the type IV spin-offs can be explained because a relatively high percentage of these spin-offs consist of what Harrison and Leitch (2010) call “less innovative lifestyle companies”. Such companies are usually service based and require less investment (Pirnay et al., 2003), so that the majority of companies in this group stay very small. When the entrepreneur is just a sole-proprietor, there are usually not a lot of fixed costs that have to be paid (especially no salaries). Such situation is therefore likely to increase the longevity of such spin-offs. The spin-offs of type III, which have gotten support from the ecosystem in terms of financing, training, brokerage and/or business incubation score

second in terms of survival rate. This can be explained by the more product oriented focus in comparison with the type II spin-offs, which also received ecosystem support, but are usually more service oriented (Clarysse et al., 2005; Mustar et al., 2006). It must be said however that in practice the difference between product and service oriented spin-offs is rather blurry. Many of them of both products and services. Spin-offs of type II, with their profile of research based high-tech service provider, have the lowest survival rate of all groups. But even this group has a significantly higher survival rate than the average of all Dutch start-ups, which is around 57% for the first five years (Eurostat, Business Demographics, 2021). Type I Spin-offs have the second highest survival rate, these companies are almost always product based and have codified intellectual property and therefore very often rather intensive support from the entrepreneurial ecosystem/parent university. Knowledge links between the spin-offs of this type and the parent university are – on average – the strongest, given that there is often still a lot of research and development needed to commercialize the new technology.

Since this study is about the Eastern part of the Netherlands, it is logical to compare the spin-off survival rate of UT spin-offs with the Dutch average survival rate for start-ups, as well as with reported spin-off survival rate from literature. Clayman and Holbrook (2003) report an overall survival rate of 73% for spin-offs of Canadian universities. Van der Sijde and Van Tilburg (2000) come to the conclusion in an earlier study on UT spin-offs, that the survival rate of the spin-offs that have received TOP support (in this study this is largely comparable with the Type III spin-offs), have an average five year survival rate of about 89%. In this study, the average five year survival rate UT spin-offs is 72%, which is significantly higher than the national average, but also considerably lower than the 89% reported by Van der Sijde and Van Tilburg. Since these authors have just looked at the "ecosystem" supported UT spin-offs, it is good to isolate these (the Type III spin-offs from this study) from the rest of the UT spin-offs. As can be seen in Table 4-3, the five year survival rate of the type III ecosystem supported spin-offs are with 71% nowhere near as high as Van der Sijde and Van Tilburg found in their study of the same group in 2000. The reason for this large difference in survival rates over time is interesting and is difficult to explain. One reason might be that in 2000, the year of the Van der Sijde and Van Tilburg study, the TOP support program was still rather new, as well as the concept of academic entrepreneurship itself. It could be the case that in these days only very motivated graduates and researchers would take the step to start their own company and that later, when academic entrepreneurship at the UT became much more mainstream, more people wanted to "give entrepreneurship a try", leading to more spin-offs, but also relatively more business closures.

In terms of the development of workplaces in spin-offs, the UT spin-offs count for about 28000 workplaces in the Netherlands (Figure 4.2). It is however important to add a few notes to these results. In the first place, the Dutch trade register is not very accurate, especially for micro sized companies (less than 10 employees). Secondly, around three quarters of all workplaces in spin-offs are formed by two outliers, namely Booking.com (around 15000 employees registered in The Netherlands) and Just

eat/Takaway.com (around 3000 employees registered in The Netherlands). The large jump in employment in spin-offs in 2019 is caused by a large administrative transfer of jobs to the Netherlands by Booking.com. The third issue is connected with the second one, in the sense that only jobs registered within The Netherlands are counted, leading to an underestimation of the total amount of workplaces generated worldwide. Nonetheless, for the question of the development of the regional innovation system in the Eastern Netherlands, these three issues related to employment do not strongly influence the results and conclusions.

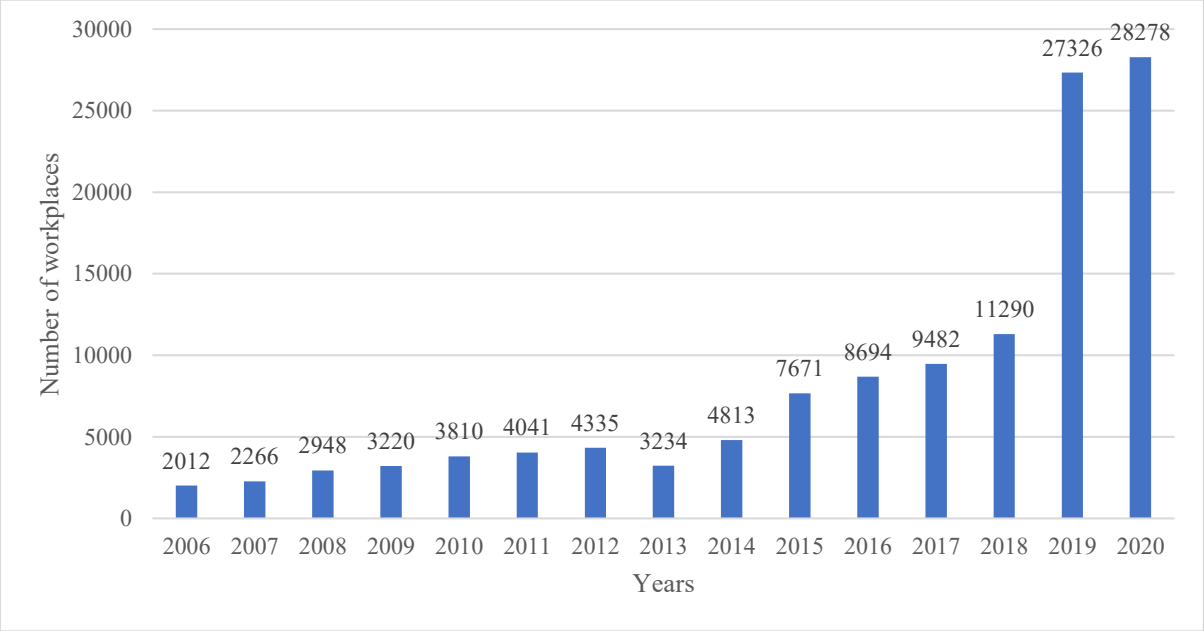


Figure 4.2: Development of the number of workplaces in UT spin-offs

The number of jobs per spin-off type shows that the type I spin-offs account for the lowest number of workplaces and type IV for the most (see table 4-4). As predicted by Bolzani et al. (2020), type I spin-offs with their usually very close links to the parent institution, being the most high tech spin-offs around, such intense knowledge links could actually hinder the commercial development (i.e. company growth) of such spin-offs.

Table 4-4: Number of workplaces per spin-off type

Spin-off type	Total number of workplaces in 2020
Type I	294
Type II	1286
Type III	3201
Type IV	23497

Source: Own compilation

Type IV spin-offs offer by far the largest amount of workplaces, and are spin-offs that have not received a lot of formal support from the entrepreneurial ecosystem around the UT. It is however good to note again that the large number of the type IV spin-offs is caused by a few very large companies that fall

into this category. The majority of the type IV companies stay very small, and are only sole proprietor firms. None of the other spin-off types have such a high percentage of sole proprietors. So, paradoxically type IV spin-offs are the largest when looking at the arithmetic mean, as well as the smallest, having the largest percentage of sole proprietors (see table 4-5). This finding partially confirms the observations of Harrison and Leitch (2010) that many of these student start-ups are likely "lifestyle companies", more than firms aimed at growth and scaling-up.

Table 4-5: Percentage of sole proprietor entrepreneurs per spin-off type

Spin-off type	Percentage of sole proprietors
Type I	47%
Type II	39%
Type III	46%
Type IV	55%

Source: Own compilation

Figure 4-3 gives a better understanding of the extreme skewedness of the size distribution of the different spin-offs, per spin-off type. It can clearly be seen that only very few spin-offs do not fall in the category of SME business (1-250 employees, according to the EU definition). Still, these five companies offer in total more than 20 000 workplaces, showing that in rare cases (the so-called unicorn cases), spin-offs can indeed become very large companies which could have a large impact on employment within a region, providing that such spin-offs will stay in the region of the parent university.

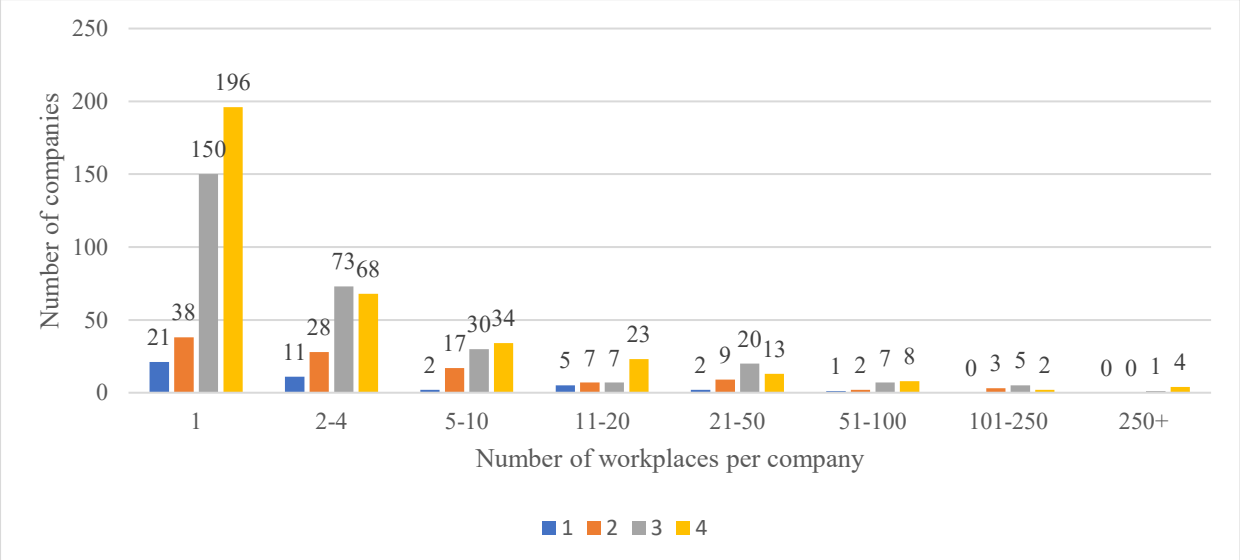


Figure 4.3: Number of UT spin-offs per size class (in number of workplaces)

To provide a complete overview of the UT spin-offs, also the economic sectors in which they are active should be mentioned. As discussed in the literature, most academic spin-offs concentrate in a small number of economic sectors, namely biotech, information and communication technology and

nanotechnology (Bagchi-Sen et al., 2020). From the Dutch trade register, the SBI2008/NACE codes provide insight into the different sectors in which UT spin-offs are active. Figure 4.4 shows the division of UT and spin-offs over the economic sectors, compared to the Dutch national average.

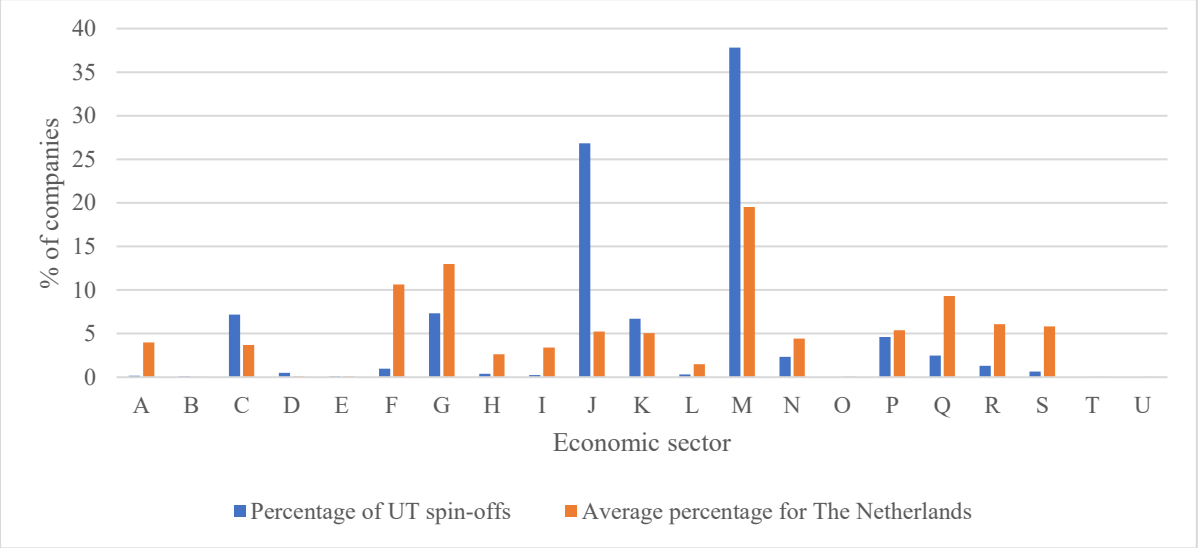


Figure 4.4: Comparison of the division of UT spin-offs with the Dutch average over the different economic sectors

The description of the economic sectors can be found in table 4-6. From Figure 4.4 it becomes clear that as predicted from the literature, a lot of spin-offs are active in sector J (Information and communication technology). Also sector C (Industry) and sector M (Professional business services) have significantly more than average representation.

Table 4-6: Description of the economic sectors

SBI2008 Main groups (letters)	SBI2008 Main groups (description)
A	Agriculture and related service activities
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management
F	Construction
G	Wholesale and retail trade
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication services
K	Financial institutions
L	Renting, buying and selling of real estate
M	Consultancy, research and other specialised business services
N	Renting and leasing of tangible goods and other business support services
O	Public administration, public services and compulsory social security
P	Education
Q	Human health and social work activities
R	Culture, sports and recreation
S	Other service activities
T	Households as employer
U	Extraterritorial organisations and bodies

Source: (CBS, 2019)

Information and communication technology is clearly a focus area for UT spin-offs (Figure 4.4). Other common areas for spin-offs, biotech and nanotechnology, are a bit obscured from view from the main economic sectors, according to the SBI2008/NACE classification. To identify these specific groups, it is necessary to look into the so-called "topsector" policy of the Dutch government. This study is not the place to give an extensive review of the Dutch "topsector" policy, but suffice to say that the Dutch government has identified nine economic sectors which are internationally strongly competitive and supports these sectors to become even more competitive. The nine "topsectors" are: Agriculture and food, Chemistry, Creative Industry, Energy, High Tech Systems and Materials, Horticulture and starting materials, Life sciences & Health, Logistics and Water. Biotech and Nanotechnology companies are in both the High Tech Systems and Materials and the Life sciences & Health topsectors. Figure 4.5 shows

the comparison of the percentage of all UT spin-offs in the nine topsectors with the Dutch average amount of companies in the topsectors.

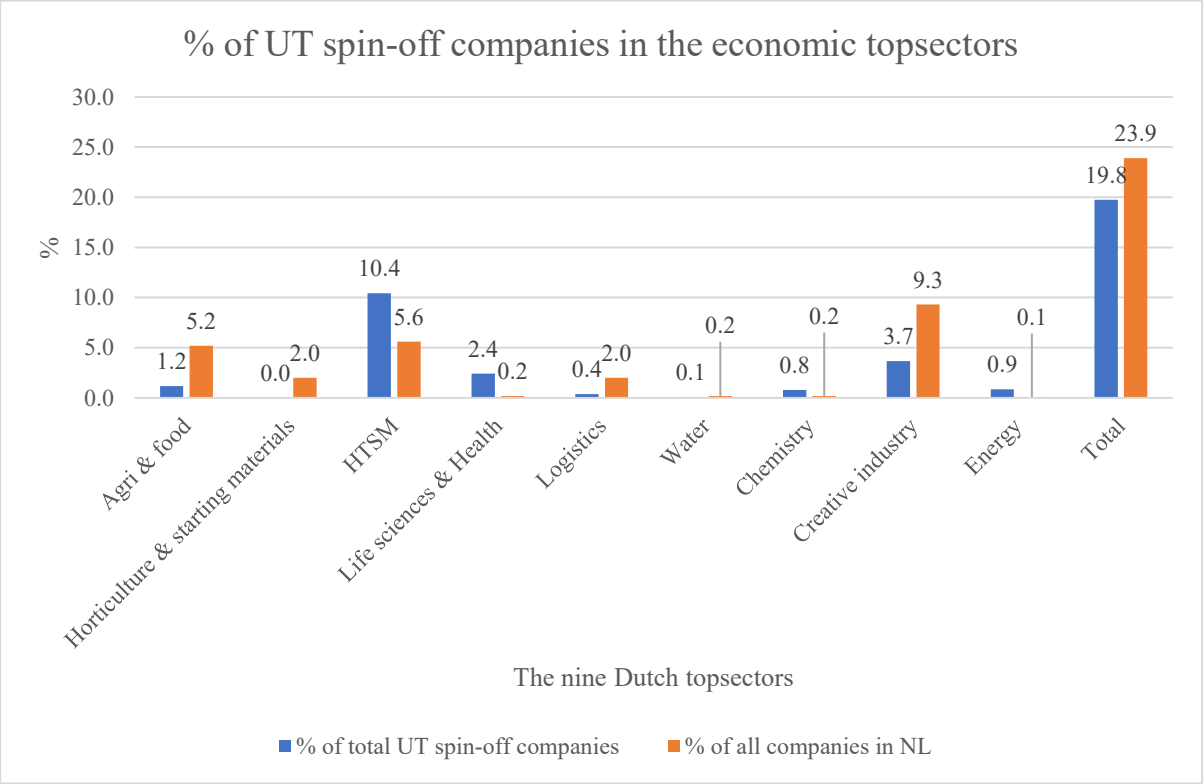


Figure 4.5: Percentage of UT spin-offs compared to national average in the nine Dutch topsectors.

From Figure 4.5 it becomes clear that UT spin-offs are more often than the national average can be found in the topsectors High Tech Systems & Materials, as well as Life Sciences & Health, consistent with the literature, which states that spin-offs can be more often found in biotech and nanotechnology (Bagchi-Sen et al., 2020). Apart from that, the percentages for chemistry and energy are also higher than the national average, but as can be extrapolated from the percentages, these are just a handful of UT spin-offs. It is interesting to see that both the Agro & Food and Creative industry sectors among the UT spin-offs, are percentage wise much smaller than the national average. It is likely that this difference is caused by the strong technical profile of the UT. Likewise, it is possible that the higher percentages in HTSM and Life sciences and health are equally in the first place caused by the technical profile of the UT, more than that spin-offs generally are formed in these categories, as Bagchi-Sen et al. argue. A comparison with the spin-offs from Saxion, which has a much broader profile, is therefore useful. More about the Saxion spin-offs in the next subchapter.

4.3 Saxion University of Applied Sciences spin-offs: characteristics and development

Saxion has an almost similar database available of its start-ups, like the UT. The two most important differences between the databases is that in the case of Saxion, no further subdivision among the spin-offs is made and that detailed spin-off information is only collected since 2016. Spin-offs of the UT are categorized in four subtypes, but the spin-offs from Saxion not. This is because Saxion is a university of applied sciences with more practical study programs and also spin-offs from Saxion tend to be lower tech than the ones from the UT. This means that there are only few spin-offs in type I and II, and most would be in type III and IV. There is however a lack of data within Saxion about spin-offs that have gotten ecosystem support, therefore the division into spin-off types cannot be made.

Saxion exists already longer than the UT, and its origins can be traced back to at least the 19th century, however, entrepreneurship support policy at Saxion only took off in the second half of the 1990s, with the establishment of the Small Business & Retail Management study program and shortly after that the Saxion Kenniscentrum voor Innovatief Ondernemerschap (SKIO), later renamed to Saxion Centre for Entrepreneurship (Van der Velde, personal communication, 2021). The number of Saxion spin-offs in 2006 starts of lower than those of the UT due to this later starting point, but given the much larger size of Saxion in numbers of students, the number of spin-offs grows faster than those of the UT (see table 4-1 and 4-7).

Table 4-7: Number of Saxion spin-offs established per year

Year of establishment	Cumulative number of established spin-offs	Cumulative number of commercially active spin-offs
Pre-2006	282	211
2006	340	248
2007	414	293
2008	503	339
2009	614	396
2010	759	463
2011	873	528
2012	1006	605
2013	1148	697
2014	1263	761
2015	1346	821
2016	1392	851
2017	1437	893
2018	1524	973
2019	1589	1037

Source: Own compilation

Since there is no subdivision of Saxion spin-offs, only the general survival rate of these types of spin-offs can be calculated. The average 5 year survival rate over the spin-offs established from 2010 to 2014 is 63.6%, slightly higher than the Dutch national average of 57% (see previous subchapter). The five year survival rate is however significantly lower than for the UT spin-offs, at least when looking at the comparable Type III and IV of the UT spin-offs. These have survival rates of 70.6% and 77.0% respectively (See Table 4-3). The reason for the lower five year survival rates of Saxion spin-offs is unknown.

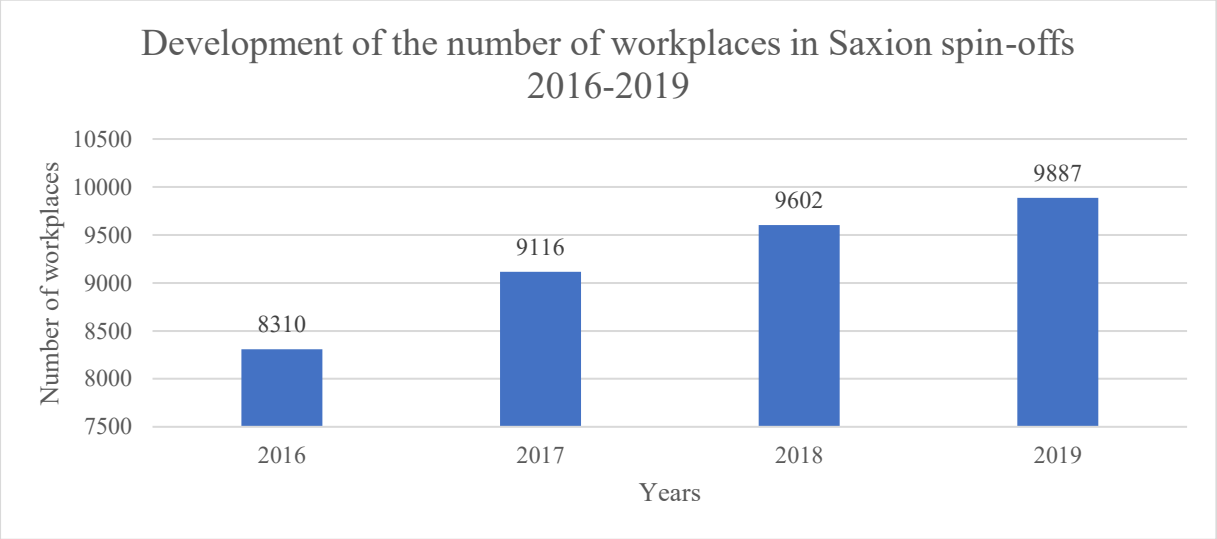


Figure 4.6: Development of the total number of workplaces in Saxion spin-offs

Figure 4.6 shows that the number of workplaces in Saxion spin-offs counts to 9887 in the Netherlands in 2019. Just like with UT spin-offs, this is an underestimation of the total number of workplaces in Saxion spin-offs, because no spin-offs located outside of the Netherlands are taken into account. But as with the UT spin-offs: important for this study is the influence of these spin-offs on the innovation ecosystem in the Eastern part of The Netherlands. Therefore, missing out on the international effects of the universities is an acceptable shortcoming. As written before, the Saxion spin-offs cannot be divided into different subtypes, but in general the development of the employment can be measured and is visible in Figure 4.6. An important notice here is that there are no reliable specific employment data from before 2016 available, therefore this graph covers only the time period 2016-2019.

Just like the employment in spin-offs in the UT, the division of workplaces over the Saxion spin-offs is very skewed. A large percentage them consists of sole proprietors (63.5%), a considerably larger number than at the UT spin-offs. Many more spin-offs are only micro-sized: Only a handful of spin-offs offer more than 250 workplaces, which means that more than 99% of them are SMEs. Figure 4.7 shows an overview of the size classes of Saxion spin-offs. The independent sample T-test as described at the start of this chapter shows that the difference in size between Saxion and UT spin-offs is significant. This means that Saxion spin-offs are significantly smaller, giving some evidence that many

university spin-offs are “simple” lifestyle companies or even barely active ones, so-called zombie companies (Caputo et al., 2022; Harrison & Leitch, 2010).

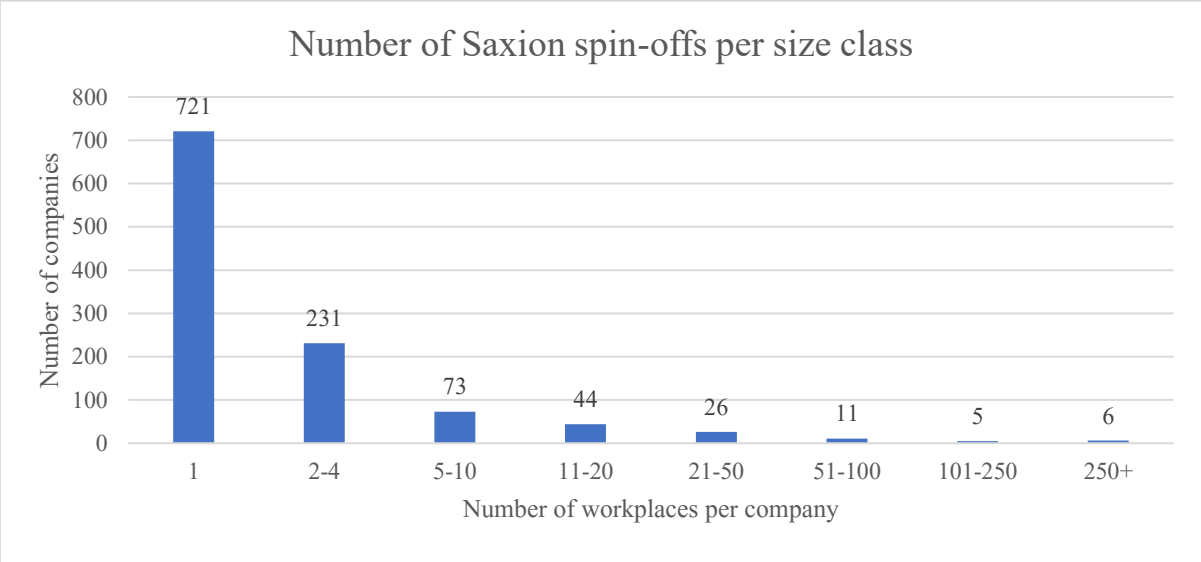


Figure 4.7: Number of Saxion spin-offs per size class (in number of workplaces)

In terms of the different sectors in which the Saxion spin-offs are active (see Figure 4.8), several differences with the sectors of the UT spin-offs can be observed. UT spin-offs tend to be more active in industry (C), financial institutions (K) and specialized business services (M). Saxion spin-offs are more active in wholesale and retail trade than UT spin-offs, as well as in renting and leasing services (N). The exact description of each economic sector can be found in table 4-6. Compared to the UT spin-offs, Saxion spin-offs are more spread out over different economic sectors. This is not surprising, given the broader profile of Saxion, with a lot more non-technical study programs than the UT. Just like the UT spin-offs, also for Saxion spin-offs, there is a strong concentration of spin-offs in the IT sector. And just like for the UT spin-offs, it is quite difficult to directly see from the main economic sectors whether Saxion spin-offs are also much more than average active in the biotech and nanotechnology sectors. Therefore, it is necessary to divide the Saxion spin-offs also into the different “topsectors” (see the previous subchapter for explanation).

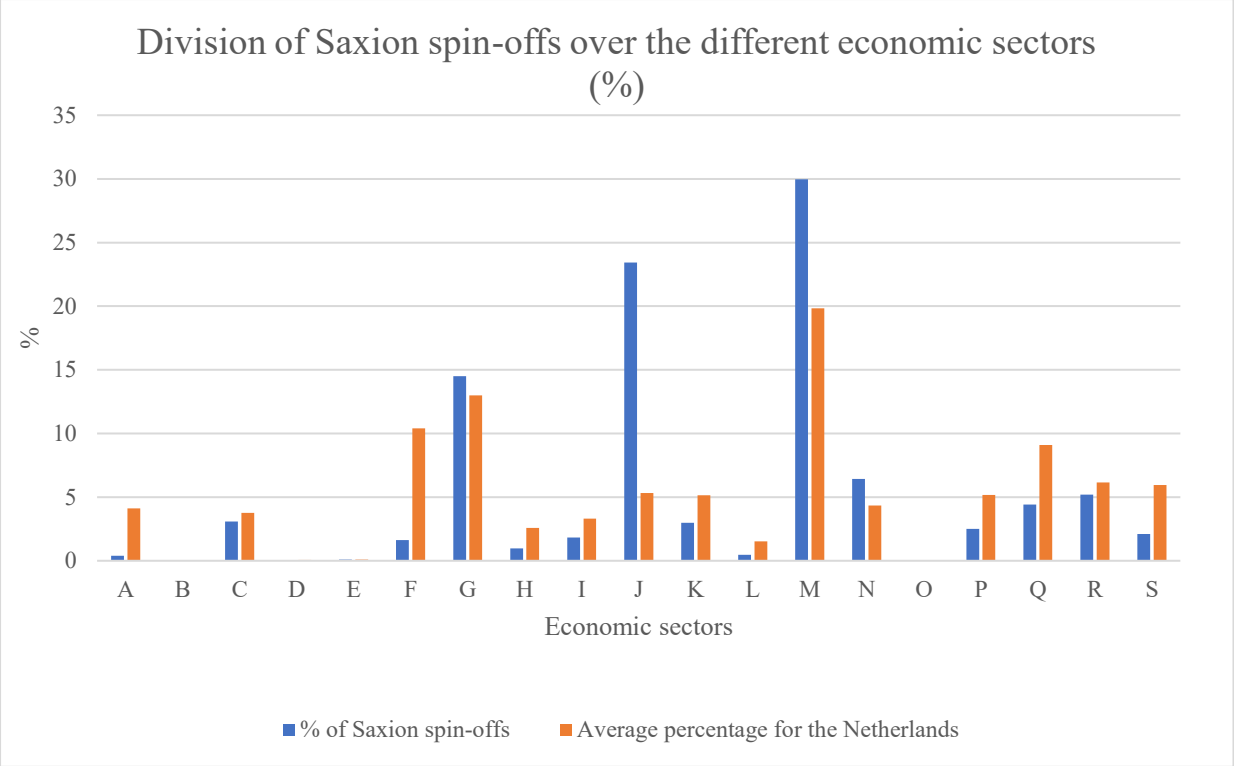


Figure 4.8: Comparison of the division of Saxion spin-offs with the Dutch average over the different economic sectors

Figure 4.8 shows the percentage of Saxion spin-offs in the nine topsectors, compared to the Dutch average. Interestingly, Saxion spin-offs are much more than the UT ones active in the creative sector. But less than average in High Tech Systems and Materials and just a handful in Life sciences & Health, meaning that there are relatively few Saxion spin-offs active in the biotech and nanotechnology sectors.

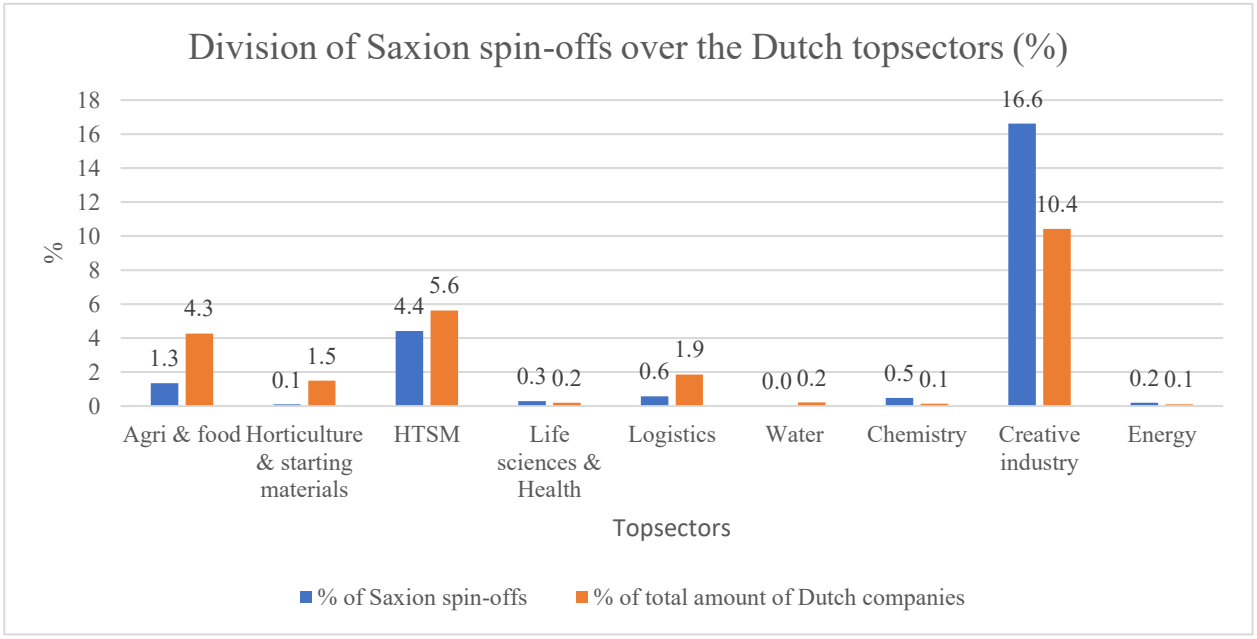


Figure 4.9: Percentage of Saxion spin-offs compared to national average in the nine Dutch topsectors.

SBI Hoofdgroep * Parentorganization Crosstabulation

Count

		Parentorganization		
		University of Twente	Saxion UAS	Total
SBI Hoofdgroep		34	0	34
	A	2	5	7
	B	1	0	1
	C	89	48	137
	D	6	0	6
	E	1	1	2
	F	13	21	34
	G	91	260	351
	H	6	13	19
	I	3	31	34
	J	333	368	701
	K	83	43	126
	L	4	9	13
	M	469	547	1016
	N	29	25	54
	P	57	46	103
	Q	31	56	87
	R	16	80	96
	S	8	38	46
Total		1276	1591	2867

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	224.795[a]	18	<.001
Likelihood Ratio	251.412	18	<.001
N of Valid Cases	2867		

a. 8 cells (21.1%) have expected count less than 5. The minimum expected count is .45.

Figure 4.10: Chi-square test results between economic sector and the parent organization of Saxion and UT spin-offs

The findings for Saxion spin-offs thus only partially confirm the findings of Bagchi-Sen et al. A chi-square test of independence was performed to examine the relation between spin-offs of one parent university and the economic sectors in which those spin-offs are active. The relationship between parent organization and economic sector of the spin-offs is significant: X^2 *(*18, *N*=2867) = 224.80, p=<.001. (See Figure 4.10 for the test results). This means that there are statistically significant differences between the economic sectors in which the spin-offs of the two HEIs are active. The explanation for these differences could be that the UT has a rather strong technical profile, leading to different predominant economic sectors in which spin-offs are active than Saxion, an Applied Science University with a more general profile. A second possible explanation is that research universities may by default generate spin-offs active in different economic sectors. There is however neither another research university nor another university of applied sciences active in the region, to test this.

4.4 University of Twente spin-offs: location of spin-offs in 2020

This subchapter is about the location of UT spin-offs in 2020, with a focus on the number of workplaces within these spin-offs, economic sectors and survival rate for the specific locations where these spin-offs are registered. This subchapter gives an overview of where the UT spin-offs can be found throughout the Netherlands. In the analysis, there is a focus on the eastern part of the Netherlands, as the goal of this study is to assess the economic impact of universities on regions.

There are several specific regions defined within the eastern part of the Netherlands. The area "eastern Netherlands" itself is defined by the provinces Overijssel and Gelderland. Subregions within these provinces are in most of the cases based on the Dutch COROP regional classification, and are:

1. Twente,
2. Noord Overijssel (plus Raalte and Olst-Wijhe),
3. Cleantech Region (municipalities Apeldoorn, Brummen, Deventer, Epe, Heerde, Lochem, Voorst, Zutphen)
4. The Achterhoek (minus Zutphen, Brummen and Lochem),
5. The Veluwe (minus Apeldoorn, Voorst, Epe and Heerde),
6. Arnhem-Nijmegen
7. Zuidwest Gelderland.

Specifically for the region Twente, since so many spin-offs are located there, also the different municipalities within this region have been used for some additional analysis. The rest of the Netherlands has been divided into the 5 largest cities with their agglomerations (using the Dutch COROP regions for that) and the rest of the country:

1. Greater Amsterdam
2. Greater Rotterdam
3. Agglomeration 's Gravenhage
4. Greater Utrecht
5. Brainport Eindhoven
6. Other Dutch regions

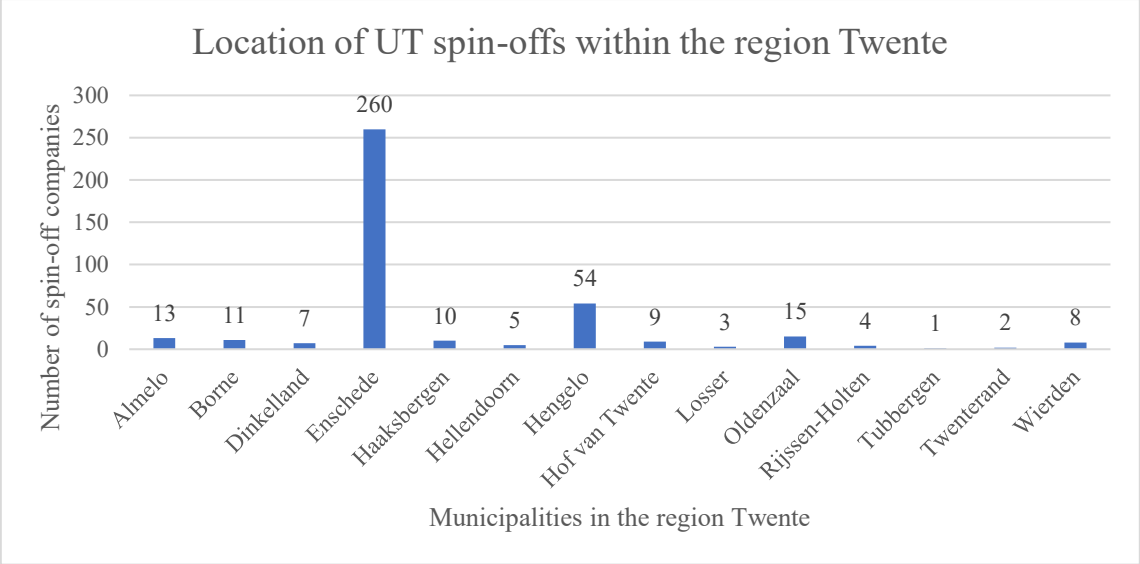


Figure 4.11: Location of commercially active UT spin-off companies within municipalities of the region Twente

The region Twente consists of 14 municipalities, but can be divided into a more "urban" part and a more "rural" part. Evidently, the urban zone (consisting of the municipalities Enschede, Hengelo, Borne, Almelo and Oldenzaal) within the region has the highest population density and consist of around 60% of the population of the region (see also Figure 3.2 for a map). Of all UT spin-offs located in Twente, 88% are located within this urban zone. Enschede as central city in the region (and home to the UT) alone accounts already for 65% of all UT spin-offs. For the ones located in the region Twente it can be safely concluded that UT spin-offs are attracted by urban environments (see Figure 4.11).

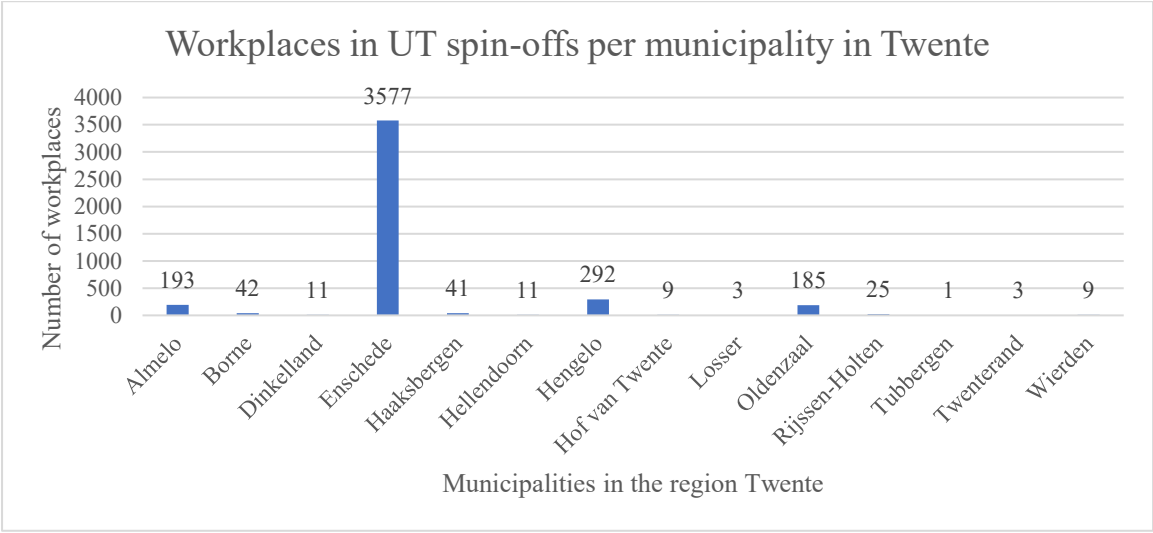


Figure 4.12: Number of workplaces in UT spin-offs in 2020 per municipality in Twente

When looking at the number of workplaces per municipality in Twente (Figure 4.12), the urban municipalities stand out again as well. Not only is the urban area attractive for UT spin-offs, also those spin-offs are largest in size. This can also be seen in Figure 4.13, where the average sizes for the spin-

offs are displayed. Spin-offs located in more urban areas tend to be the largest on average, in terms of the number of workplaces offered.

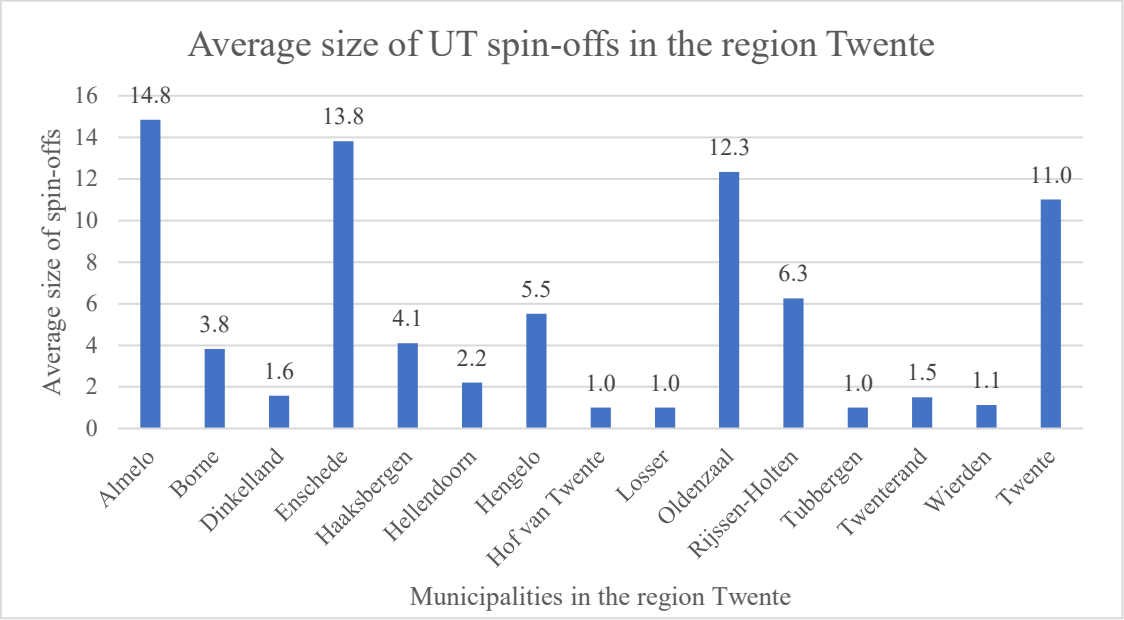


Figure 4.13: Average size of UT spin-offs in Twente in terms of number of workplaces in 2020

In terms of better understanding the regional economic impact of UT spin-offs, it is helpful to calculate the percentage of the total workforce in a municipality that is employed within UT spin-offs. Figure 4.14 shows the result of this calculation. Also here, the more urban municipalities in the region stand out in terms of employment. Clearly, for Enschede with more than 4% of the total employment, UT spin-offs are a considerable economic factor for the city. The indirect economic effects may be even much larger, because spin-offs are known for playing a key role in the regional innovation system, as seen in the literature review. It is just not very well possible to measure these indirect economic effects, at least not within the context of this study.

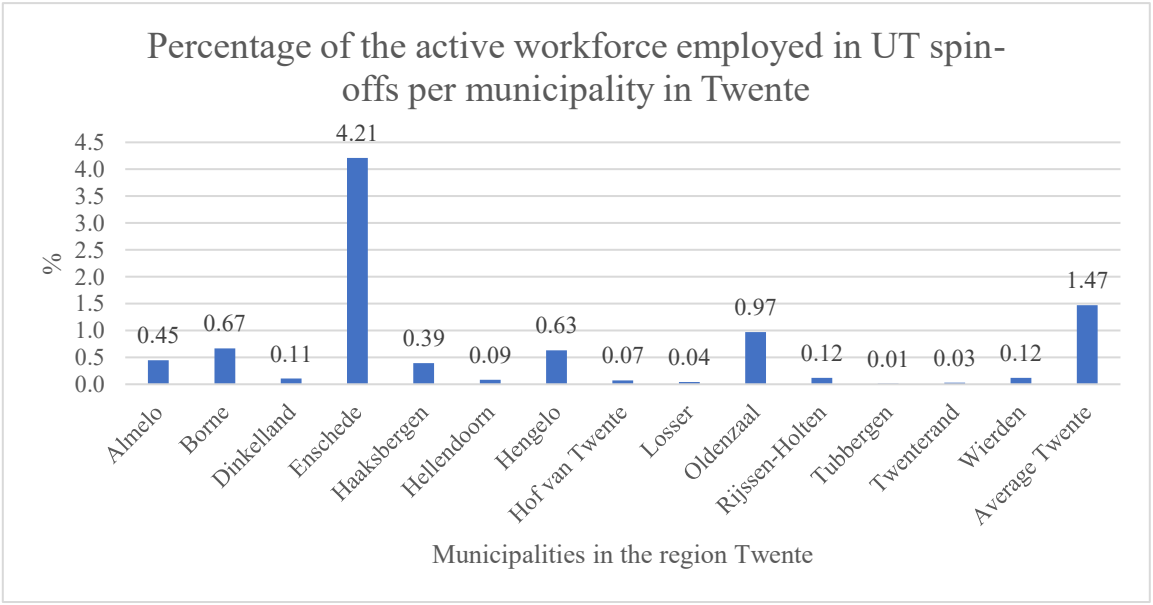


Figure 4.14: Percentage of employment in UT spin-offs of the total employment per municipality in Twente in 2020

UT spin-offs are divided into four different categories, the types I up to IV. Looking at the location within Twente of the different spin-off types, it becomes quickly apparent that the most high tech spin-offs (type I), are almost exclusively located within the municipality of Enschede. Figure 4.15 shows the locations of all spin-off types, for all 713 identified spin-offs which are or were located in Twente.

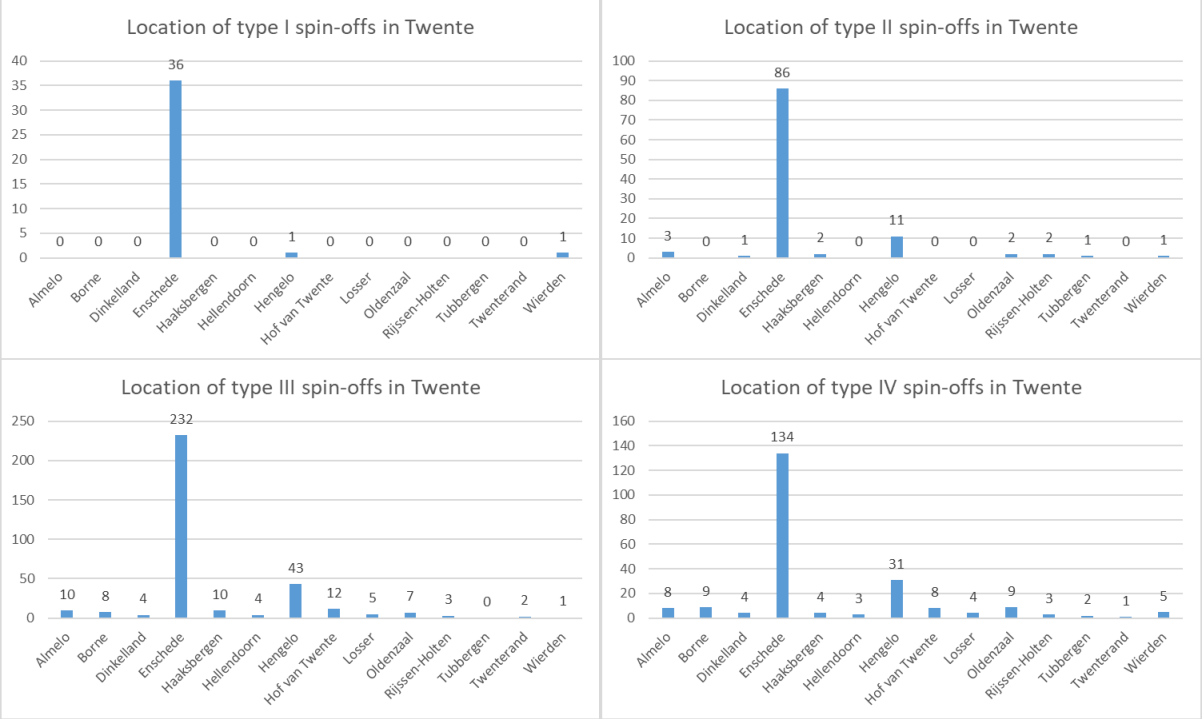


Figure 4.15: Location of the different UT spin-offs per type within the region Twente

Figure 4.15 also makes clear that spin-offs of type III and IV are more spread out over the region than the more knowledge intensive type I and II spin-offs. To complete the picture of the location pattern of the different types of spin-offs, Figure 4.16 shows the percentage of all identified spin-offs of each UT spin-off type, located in Enschede, Twente, Eastern Netherlands and the total for The Netherlands, which is by definition 100% as no foreign based spin-offs are included in the study.

From the type I spin-offs, more than two thirds is located in the municipality of Enschede, and four out of five in the eastern part of the Netherlands. By contrast, from the spin-offs without any formal regional ecosystem interventions, the type IVs, only 25% is located in Enschede and 59% located in the eastern part of The Netherlands. In total, for all UT spin-offs, the percentage of spin-offs located in Twente is 54% and for the eastern part of the Netherlands 68%. This last percentage is significantly lower than for the Saxion spin-offs, which is something not completely unexpected, because Saxion has a by far more regional orientation and relatively more students from the eastern Netherlands than the UT (Bazen, 2020b).

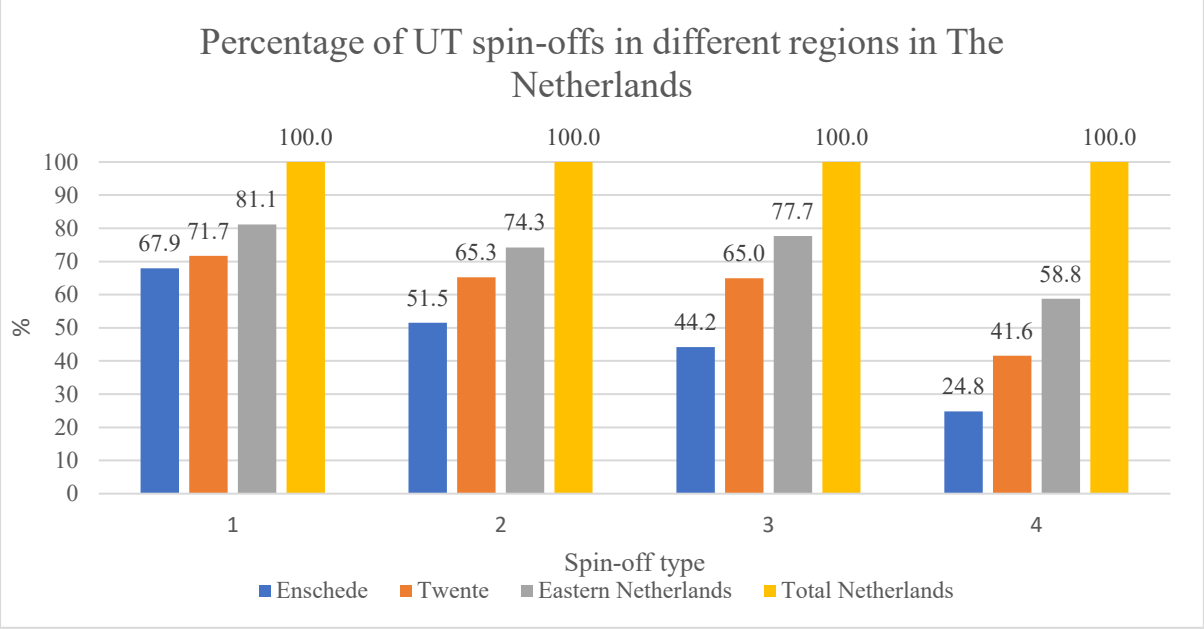


Figure 4.16: Percentage of all identified UT spin-offs per spin-off type, located in a number of regions in The Netherlands

An independent samples T-test (one-tailed), shown in Figure 4.17 with the spin-off type as independent variable and the distance in kilometers to the parent university as dependent variable shows a significant difference in distance to the parent university between the two groups of spin-offs. The most innovative spin-offs (Type I) can be significantly found closer to the university (Mean distance: 37.5km, St.dev: 61.2) than the other spin-off types (Mean distance: 63.1km, St.dev: 69.4). The T-test t value (df=1274) equals 2.62, with a p value of .004.

T-Test

Group Statistics

	Spin-Off-Code	N	Mean	Std. Deviation	Std. Error Mean
Distancetoparent	>= 2	1224	63.118	69.4050	1.9838
	< 2	52	37.454	61.2446	8.4931

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
						Significance			
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference
Distancetoparent	Equal variances assumed	8.766	.003	2.623	1274	.004	.009	25.6643	9.7834
	Equal variances not assumed			2.943	56.710	.002	.005	25.6643	8.7217

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
Distancetoparent	Cohen's d	69.0969	.371	.093	.649
	Hedges' correction	69.1376	.371	.093	.649
	Glass's delta	61.2446	.419	.128	.706

a. The denominator used in estimating the effect sizes.

Figure 4.17: T-test about the differences in distance based on the type of spin-off

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Spin-Off-Code[b]	.	Enter

a. Dependent Variable: Distancetoparent

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.195[a]	.038	.037	67.9536

a. Predictors: (Constant), Spin-Off-Code

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	232467.114	1	232467.114	50.343	<.001[b]
	Residual	5882942.444	1274	4617.694		
	Total	6115409.558	1275			

a. Dependent Variable: Distancetoparent

b. Predictors: (Constant), Spin-Off-Code

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	9.091	7.706		1.180	.238
	Spin-Off-Code	16.513	2.327	.195	7.095	<.001

a. Dependent Variable: Distancetoparent

Figure 4.18: Simple regression model about the prediction of the average distance to the parent university based on the spin-off type.

A simple linear regression to predict the distance to the parent university based on the spin-off type was calculated. A statistically significant regression equation was found ($F(1,1274) = 50.343$, $p = < .001$, with an R^2 of 0.038. The predicted distance is equal to 9.091 + 16.513 (per spin-off code) measured in kilometers. The predicted distance increased with 16.513 kilometers for each subtype of spin-off (1 = most innovative to 4 = least innovative). The detailed calculation and regression model is displayed in Figure 4.18. The rather low R^2 indicates that this model does not very accurately predict the distance to the parent university based on the spin-off type. The model itself is however significant, which means that the type of spin-off is a statistically significant predictor.Since the municipality Enschede has by far the largest concentration of UT spin-offs, it is useful to look at the data of neighbourhoods within Enschede, to find out in which parts of the city the spin-offs are actually located. Figure 4.19 shows a map of the location of UT spin-offs within Enschede. Even on this small geographic scale level, there are large differences between different neighbourhoods in terms of location of spin-offs. Not surprisingly, by far the largest concentration of spin-offs (100+) can be found in the Kennispark area (the business & science park). Other areas of spin-off concentrations are the UT campus area itself, the Enschede city centre and the Roombeek area, which was largely destroyed in the 2000 Enschede

fireworks disaster and rebuilt afterwards. This new neighbourhood houses now a cluster of IT companies (Bazen, 2014), many of which are UT spin-offs. It is surprising to see how few spin-offs are located in most of the other neighbourhoods of Enschede, including several larger industrial zones. Apparently, there are large "agglomerative forces" active (besides the deliberate policy for offering innovative companies a place on the Kennispark area), even on a local scale, which results in the current concentration of businesses.

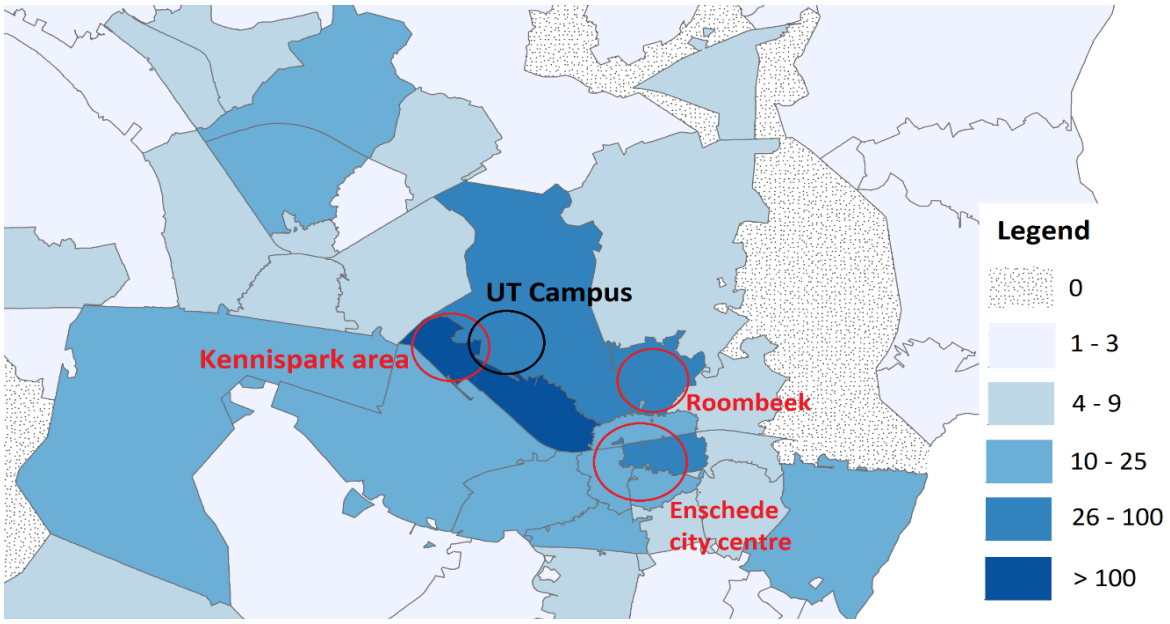


Figure 4.19: Number of UT-spin off companies within the different neighbourhoods of the municipality of Enschede

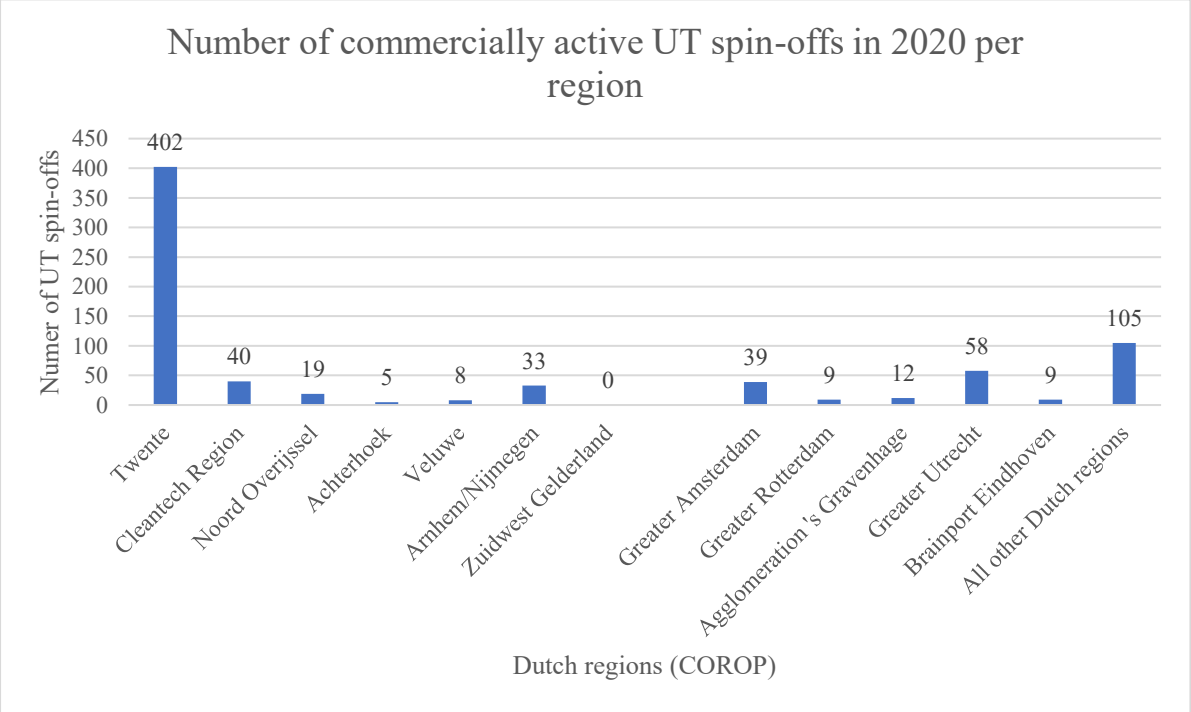


Figure 4.20: Number of commercially active UT spin-offs in 2020 per region

Even though many spin-offs are located in the region Twente, there are several more located in the wider area of the eastern Netherlands (provinces Overijssel and Gelderland) and also in the rest of the country. Figure 4.20 shows the number of UT spin-offs in other regions of the Netherlands. The left part of Figure 4.20 shows the number of commercially active UT spin-offs in the different sub-regions of the eastern Netherlands (see the beginning of this section for details). The right part of the same figure shows the number of commercially active spin-offs in the five largest agglomerations in The Netherlands. All other Dutch regions, not being in the eastern Netherlands or the five largest agglomerations, are on the far right column of the figure.

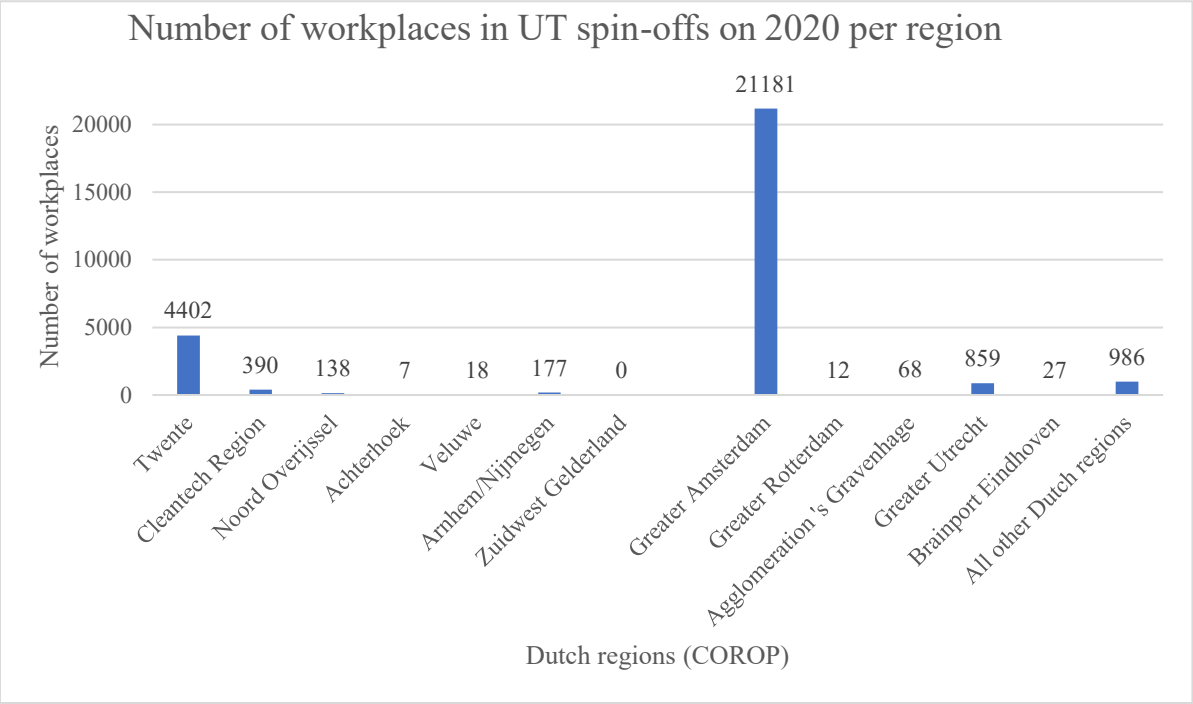


Figure 4.21: Number of workplaces in UT spin-offs in 2020 per region

Utrecht, Amsterdam, the Cleantech Region (Apeldoorn, Deventer, Zutphen) and the Arnhem/Nijmegen region are favourite locations for UT spin-offs outside of the region Twente. It is interesting to note that the second (Greater Rotterdam) and third (Agglomeration 's Gravenhage/The Hague) largest agglomeration in the Netherlands are much less popular than the fourth largest one (Greater Utrecht). Probably the combination of a large city located near the centre of the country with good infrastructure and relatively close to Twente might explain the popularity of the city. Figure 4.21 shows the corresponding number of workplaces in the UT spin-offs per region. The large employment numbers in the Greater Amsterdam region is mainly caused by the outlier Booking.com. When looking at the average size of the spin-offs in these regions (Figure 4.22), for the same reason, Greater Amsterdam stands out. However, even without Booking.com, the average size of UT spin-offs in Greater Amsterdam would be 64.7, still considerably larger than all other regions.

Table 4-8: Location of UT spin-offs in specific economic sectors per region in %

Region	Average for all economic sectors	C	G	J	K	M	N	P	Q
Twente	55.8	76.4	53.8	58.6	53.0	53.9	44.8	38.6	38.7
Cleantech Region	5.5	1.1	4.4	3.9	6.0	7.2	3.4	10.5	3.2
Noord Overijssel	2.1	0.0	0.0	1.8	1.2	2.3	0.0	1.8	9.7
Achterhoek	1.1	1.1	3.3	1.5	0.0	0.2	0.0	3.5	3.2
Veluwe	1.3	1.1	0.0	0.9	1.2	1.7	6.9	1.8	0.0
Arnhem/Nijmegen	4.1	3.4	5.5	2.7	2.4	4.5	3.4	8.8	6.5
Zuidwest Gelderland	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Greater Amsterdam	5.8	0.0	5.5	7.8	6.0	6.4	10.3	1.8	3.2
Greater Rotterdam	1.4	1.1	4.4	1.2	1.2	1.1	0.0	3.5	3.2
Agglomeration 's Gravenhage	1.9	2.2	1.1	2.7	1.2	1.5	0.0	1.8	6.5
Greater Utrecht	7.0	2.2	5.5	8.7	8.4	6.8	6.9	10.5	9.7
Brainport Eindhoven	1.3	0.0	0.0	1.2	2.4	1.7	3.4	0.0	0.0
All other Dutch regions	12.7	11.2	16.5	9.0	16.9	12.4	20.7	17.5	16.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own compilation

There are significant differences in UT spin-off locations for the different spin-off types, as seen before. It is however very well possible that there are differences in location between different economic sectors as well. As discussed in the literature review, agglomeration advantages due to proximity to strong

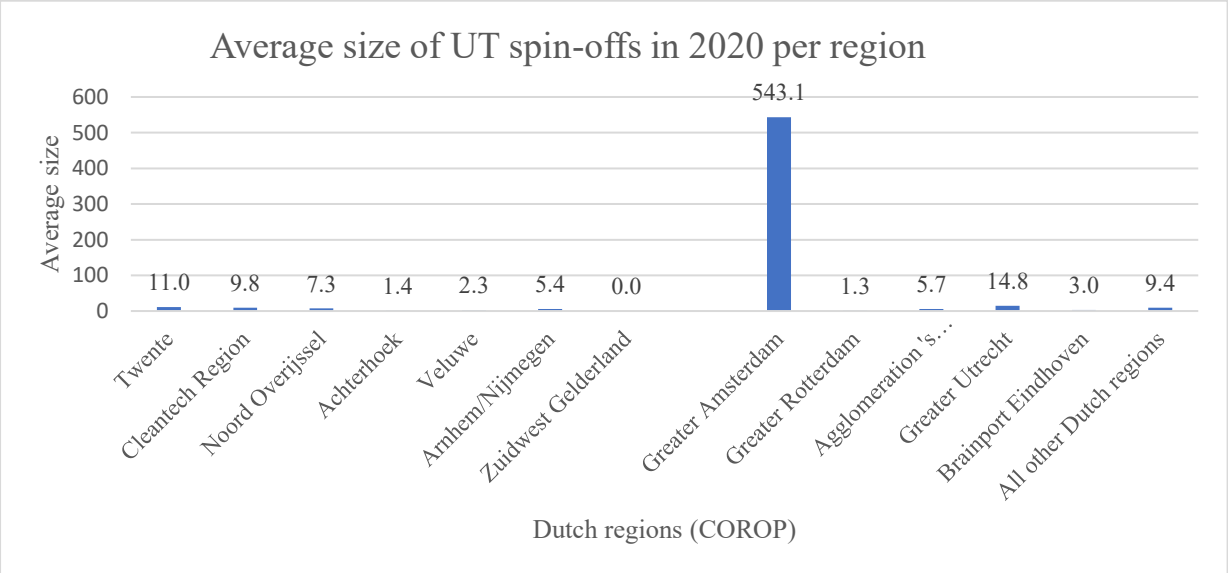


Figure 4.22: Average size of UT spin-offs per region in number of workplaces in 2020

business clusters could also be a strong motivation to want to be located in a certain region. The large Dutch agglomerations are unattractive locations for production oriented spin-offs (category C), but in many cases more than average attractive for companies in the business to business and business to consumer sectors. Especially Utrecht and Amsterdam attract a lot of UT spin-offs in these sectors. In both Utrecht and Amsterdam, there are relatively many IT companies. In Utrecht more than average spin-offs are active in education services (P) and health care related services (Q). In Amsterdam more rental and leasing services (N). It is surprising how little UT spin-offs are attracted to agglomerations such as Rotterdam, The Hague and Brainport Eindhoven, which have at least the same population size as the agglomeration Utrecht. It appears as if Utrecht, with its central location, functions as a clear "intervening opportunity", seen from a perspective in Twente, especially for service oriented spin-offs. It is also clear that other parts of the eastern Netherlands (with the Cleantech Region and Arnhem/Nijmegen as small exceptions) are also not attracting many spin-offs. Spin-offs in education are besides Utrecht quite strongly attracted to the Cleantech Region and Arnhem/Nijmegen. Noord Overijssel does attract quite some spin-offs in health care related services.

shows the location of UT spin-offs in a selection of economic sectors. Only economic sectors with more than 25 spin-offs have been included in this table, to prevent too much influence of "coincidence" from the decision of one or two entrepreneurs. From each of the included economic sectors, the percentage of spin-off companies located in each region is calculated. On average 55.8% of all spin-offs are located in the region Twente, for sector C (Industry) this number is 76.4%, much higher than average. The percentage of spin-offs located in Twente in the business to consumer service sectors (N, P and Q) are much lower than average, 44.8, 38.6 and 38.7% respectively. Given the advantages of being near to large markets, it is understandable that especially these spin-offs are located outside of a semi-peripheral region such as Twente. For industrial firms and to a lesser extent the business to business service sectors, such as J, K and M, geographical proximity to large markets is less critical, reflecting in the higher percentages of companies located in the region Twente.

The large Dutch agglomerations are unattractive locations for production oriented spin-offs (category C), but in many cases more than average attractive for companies in the business to business and business to consumer sectors. Especially Utrecht and Amsterdam attract a lot of UT spin-offs in these sectors. In both Utrecht and Amsterdam, there are relatively many IT companies. In Utrecht more than average spin-offs are active in education services (P) and health care related services (Q). In Amsterdam more rental and leasing services (N). It is surprising how little UT spin-offs are attracted to agglomerations such as Rotterdam, The Hague and Brainport Eindhoven, which have at least the same population size as the agglomeration Utrecht. It appears as if Utrecht, with its central location, functions as a clear "intervening opportunity", seen from a perspective in Twente, especially for service oriented spin-offs. It is also clear that other parts of the eastern Netherlands (with the Cleantech Region and Arnhem/Nijmegen as small exceptions) are also not attracting many spin-offs. Spin-offs in education

are besides Utrecht quite strongly attracted to the Cleantech Region and Arnhem/Nijmegen. Noord Overijssel does attract quite some spin-offs in health care related services.

4.5 Saxion University of Applied Sciences spin-offs: location of spin-offs in 2020

Saxion has its main campus in Enschede, but also two smaller campuses in Deventer and Apeldoorn. Therefore, it is expected that spin-offs from Saxion will be a bit more spread over the Eastern part of the Netherlands than the UT spin-offs, not in the last place because Saxion is a university of applied sciences, with a strong regional focus: The "market share" of Saxion among the secondary school leavers in the region Twente, who chose to study in an applied science study program, is around 70% (Bazen, 2020b). That probably also means that it is more likely that they will be more concentrated in this part of the country and less spread out in different regions. For reasons of easy comparison, the same regional division has been used for Saxion spin-offs as for the UT spin-offs. See the previous subchapter for more details on the exact regional division.

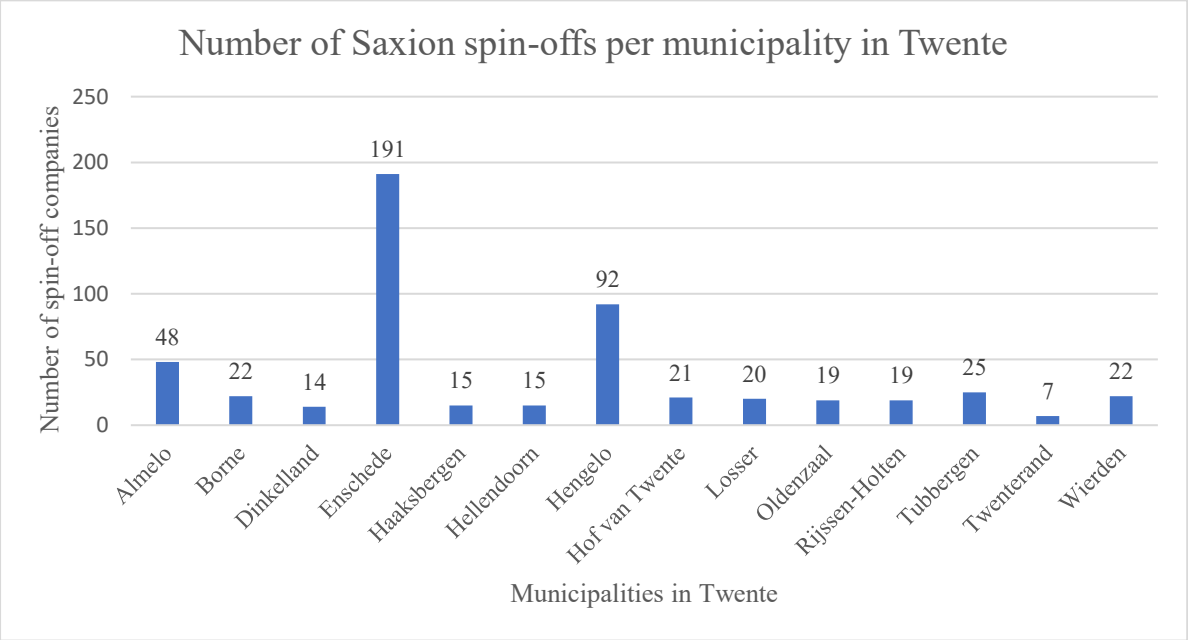


Figure 4.23: Location of commercially active Saxion spin-offs per municipality in Twente in 2019

In the region Twente, just like with the UT spin-offs, Figure 4.23 shows that many spin-offs are located in Enschede, although it is also clearly visible that the Saxion spin-offs are more spread out over the region and are also located in the more rural areas of the region. The same picture is visible for the employment in the region Twente (Figure 4.24): Many jobs in the urbanized municipalities of the region, with the exception of Rijssen-Holten, where also 473 jobs can be found in Saxion spin-offs.

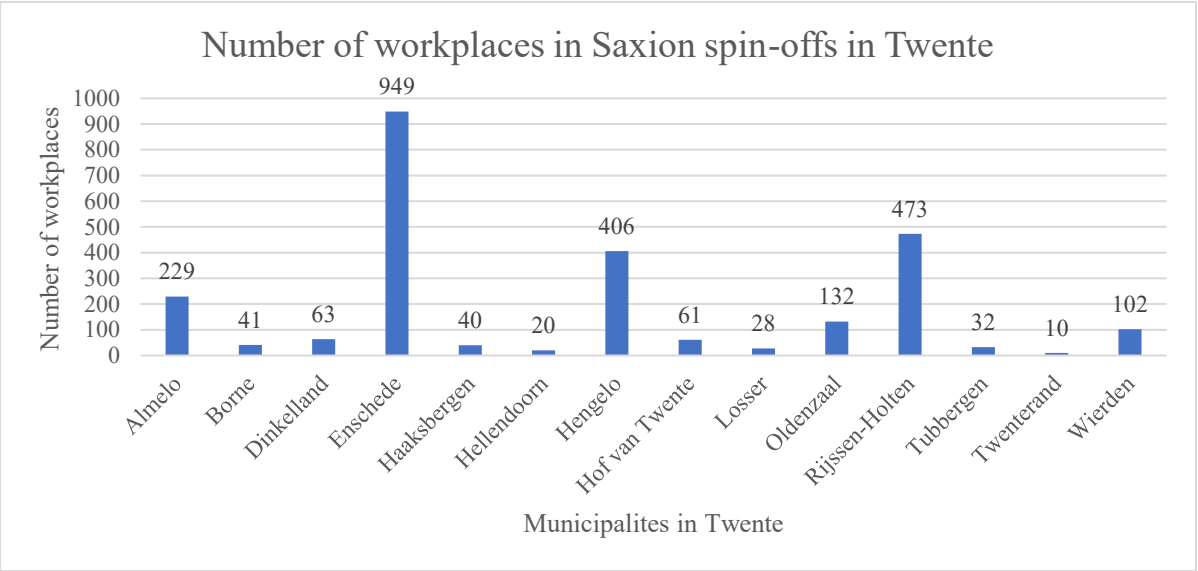


Figure 4.24: Number of workplaces in Saxion spin-offs located in the region Twente in 2019

As can be seen in Figure 4.25, Saxion spin-offs in Twente are on average with 4.9 workplaces quite a bit smaller than UT spin-offs that have 11.0 workplaces in Twente on average. One of the reasons of this difference is the average age difference: UT spin-offs in Twente have an average age of 13.3 years, whereas Saxion spin-offs have an average age of only 7.7 years. As written earlier in this chapter, Saxion started with active support of entrepreneurs only in the second half of the 1990s, much later than at the UT. Spin-offs in Rijssen-Holten stand out in terms of average size of spin-offs. This is caused by a just few spin-offs which have reached a considerable size.

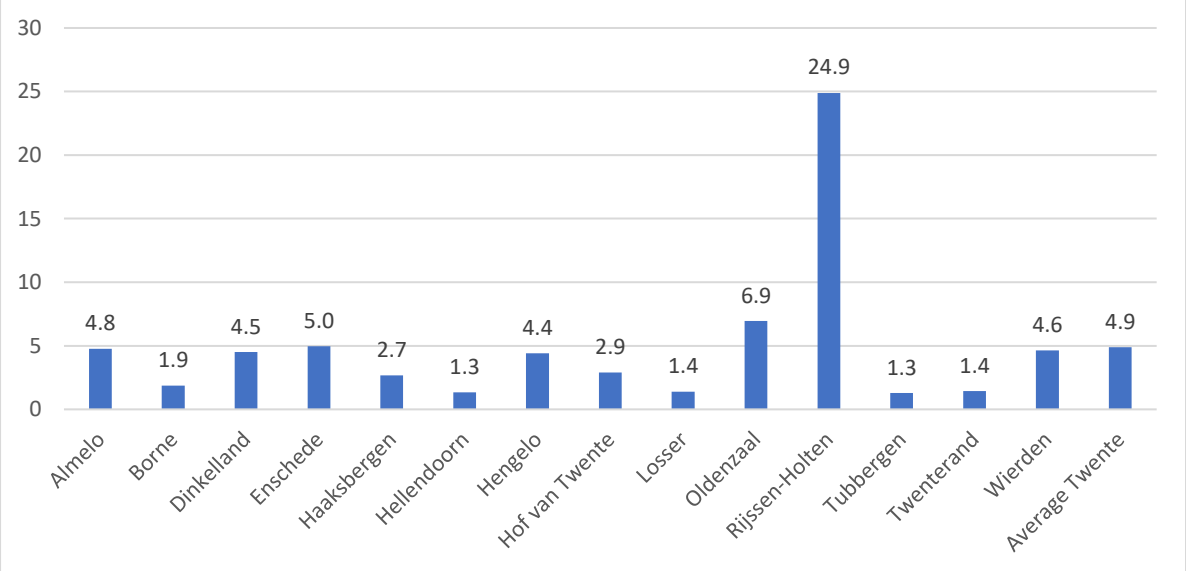


Figure 4.25: Average size of Saxion spin-offs in number of workplaces in Twente in 2019

Figure 4.26 shows the employment percentage in Saxion spin-offs per municipality in Twente. On average the percentage of employment in Twente in Saxion spin-offs is with 0.87% lower than for the UT spin-offs. On the other hand, the workplaces are more spread out over the region than those of the

UT spin-offs. Saxion spin-offs are with more than 1% of the total employment in Rijssen-Holten, Wierden and Enschede important contributors to the local economy.

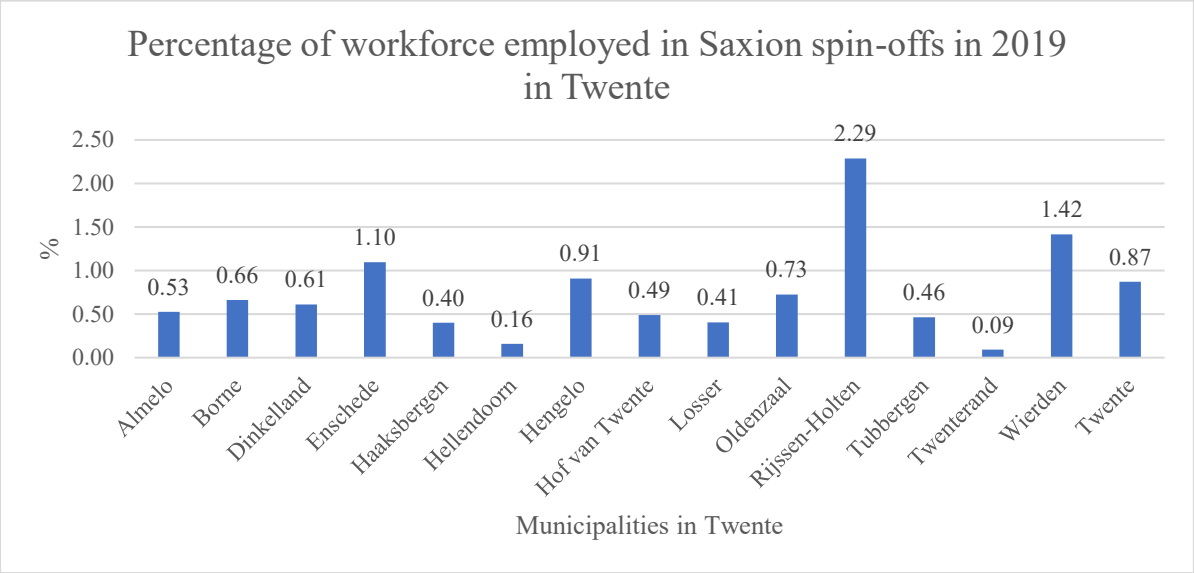


Figure 4.26: Percentage of employment in Saxion spin-offs of the total employment per municipality in Twente in 2019

Since so many Saxion spin-offs are located in the municipality Enschede, it is useful to analyse just like with the UT spin-offs, which locations within Enschede are especially attractive for spin-offs. When looking at the Saxion spin-off locations in Figure 4.27, several similarities and differences with the UT spin-offs are visible.

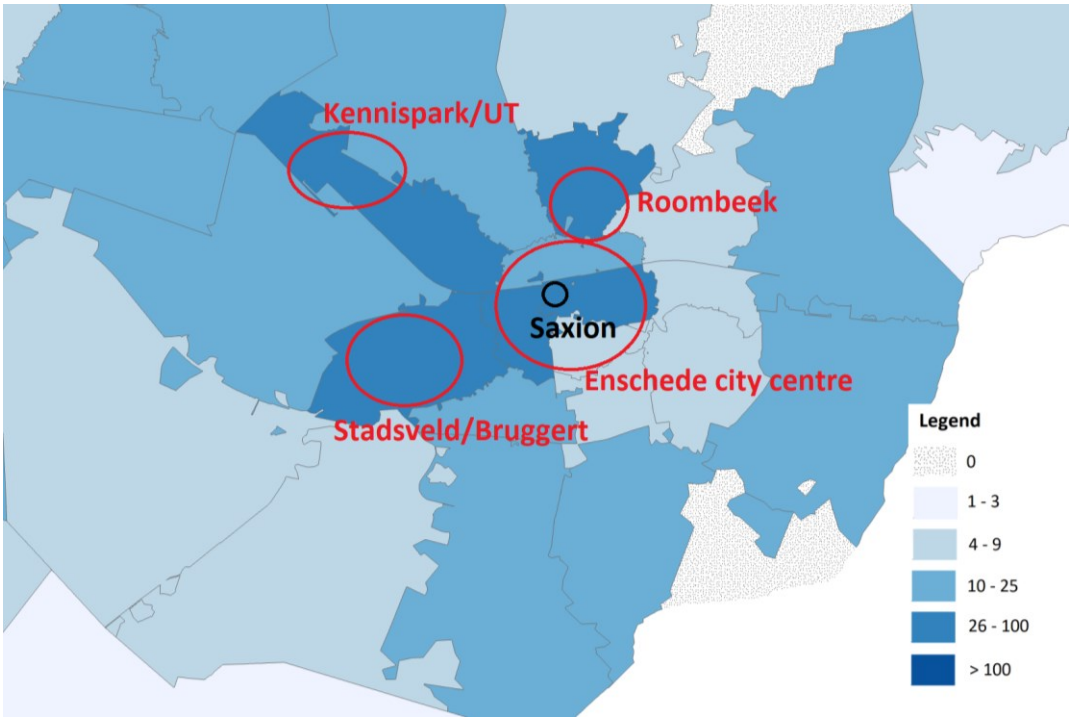


Figure 4.27: Location of Saxion spin-offs within the municipality Enschede

For comparison reasons, the same class boundaries are used for both UT and Saxion spin-offs, making the concentration and dispersion of spin-offs better visible and comparable between the two institutions. Just like for UT spin-offs, there is a concentration of Saxion spin-offs in the Kennispark area. However, this concentration is much lower for Saxion spin-offs. Other similar spin-off concentrations are to be found in the Roombeek neighbourhood and to a lesser extent in the city centre. Saxion spin-offs are more likely to be located in the city centre than UT spin-offs (probably because Saxion itself is located there). Another concentration of Saxion spin-offs can be found in the Stadsveld/Bruggert neighbourhood. In comparison with the UT, Saxion spin-offs are much less concentrated in a few neighbourhoods within Enschede.

Just like the UT spin-offs, there are also Saxion spin-offs registered outside the region Twente. Figure 4.28 shows the division of Saxion spin-offs over different parts of the Eastern Netherlands as well as the rest of the country. A striking difference with the location of the UT spin-offs is that less Saxion spin-offs are located in Enschede itself, but at the same time, more of them are located in the eastern Netherlands. This is a somewhat expected outcome, given the strong regional focus of the university in terms of origin of its students. The lower percentage for spin-offs located in Enschede itself, means that it appears that many Saxion spin-offs do not see profit in having a close geographical proximity to Saxion. As written before, Saxion has two other (smaller) campuses in Deventer and Apeldoorn. Compared to Enschede (where 19.8% of all active Saxion spin-offs are located), in Deventer (5.7%) and Apeldoorn (2.8%) an even smaller number of spin-offs are located.

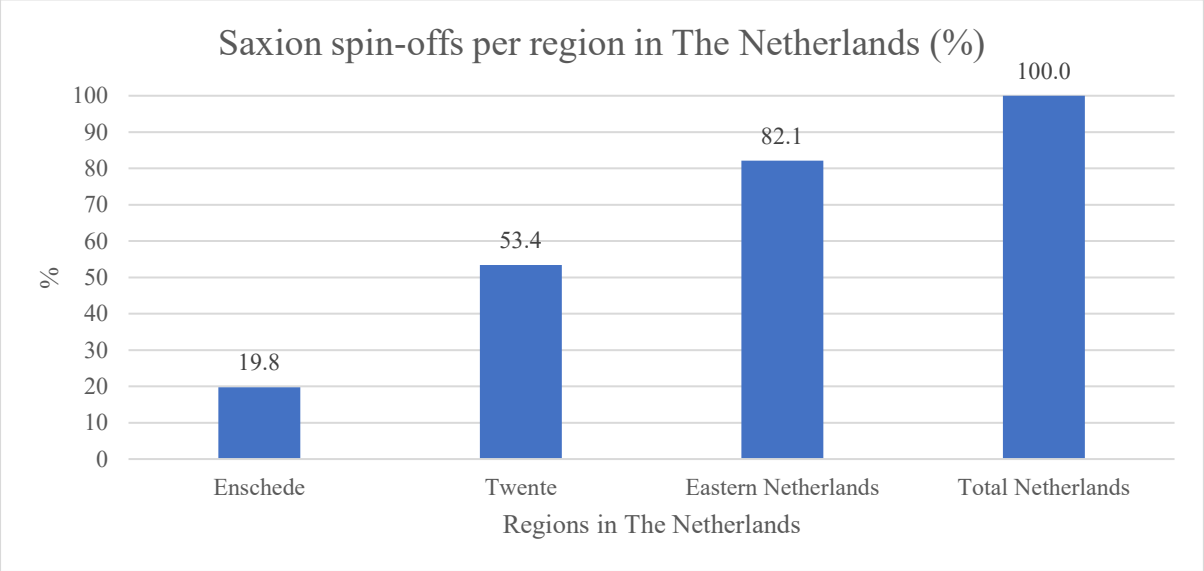


Figure 4.28: Location of commercially active Saxion spin-offs in 2019 (in %)

This is also the case in the entire Cleantech Region, in which both Deventer and Apeldoorn are located, as can be seen on Figure 4.29: Based on the findings on proximity and agglomeratiuon in the literature (see chapter 2), it would be expected that a larger number of Saxion spin-offs would be located in the Cleantech Region as well as a larger employment in these spin-offs. The entrepreneurship support

policy of Saxion is similar for all three campuses, yet it appears that in Twente many more and larger spin-offs are generated. The most important reason for this is likely that the Saxion spin-offs in Twente could already make use of the existing Novel-T/Kennispark Twente ecosystem, built before by the UT. In the Cleantech region, Saxion needed to start completely from scratch and has not yet been able to find enough connection with other available entrepreneurship support structures in the region (Van der Velde, personal communication, 2021). These findings therefore also provide evidence for the entrepreneurial ecosystem theory, which would predict more entrepreneurship in Twente because of better developed structural factors such as regionally available leadership examples (Stam & Van de Ven, 2021).

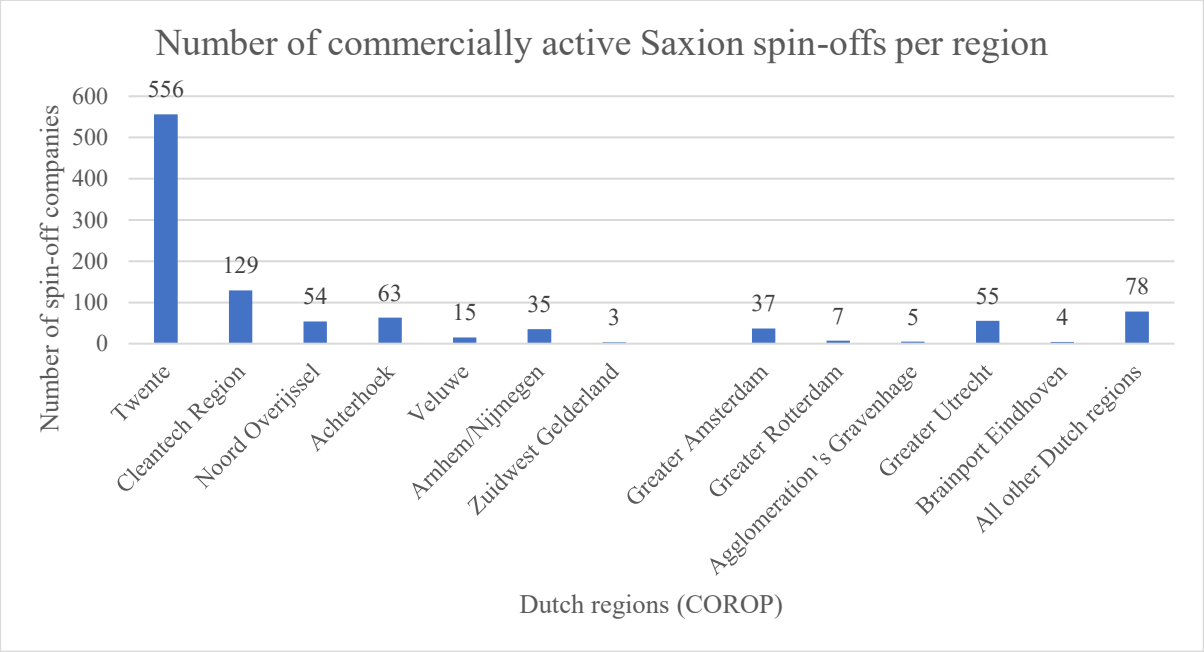


Figure 4.29: Number of commercially active Saxion spin-offs in 2019 per region

Compared to UT spin-offs, Saxion spin-offs are less attracted to large Dutch agglomerations, although Amsterdam and especially Utrecht are somewhat popular locations. Figure 4.30 shows that most of the workplaces in Saxion spin-offs can be found in the region Arnhem/Nijmegen, this is because of a single outlier (EW facility services), which offers over 3500 workplaces. The effects of EW Facility Services in Arnhem/Nijmegen can also be seen in Figure 4.31, where the average size of the Saxion spin-offs in this region is strongly influenced by it. Also in Brainport Eindhoven, one large company (out of a total of 4, see Figure 4.29) is located, bringing up the average size considerably. For the rest of the regions, the spin-off sizes do not differ a lot from each other. It is striking that except Brainport Eindhoven and The Hague, spin-off sizes in large agglomerations as well as in other Dutch regions are smaller than the ones in Twente. It appears as if a location in geographical proximity to the parent university would be beneficial for Saxion spin-offs. In comparison with the UT spin-offs, Saxion spin-offs are smaller on average. This is caused at least partly by the average age difference of the UT and Saxion spin-offs. Another reason may be that among the Saxion spin-offs there are a lot more business to consumer

service based spin-offs than among the UT spin-offs, which are usually more difficult to scale up than product based spin-offs.

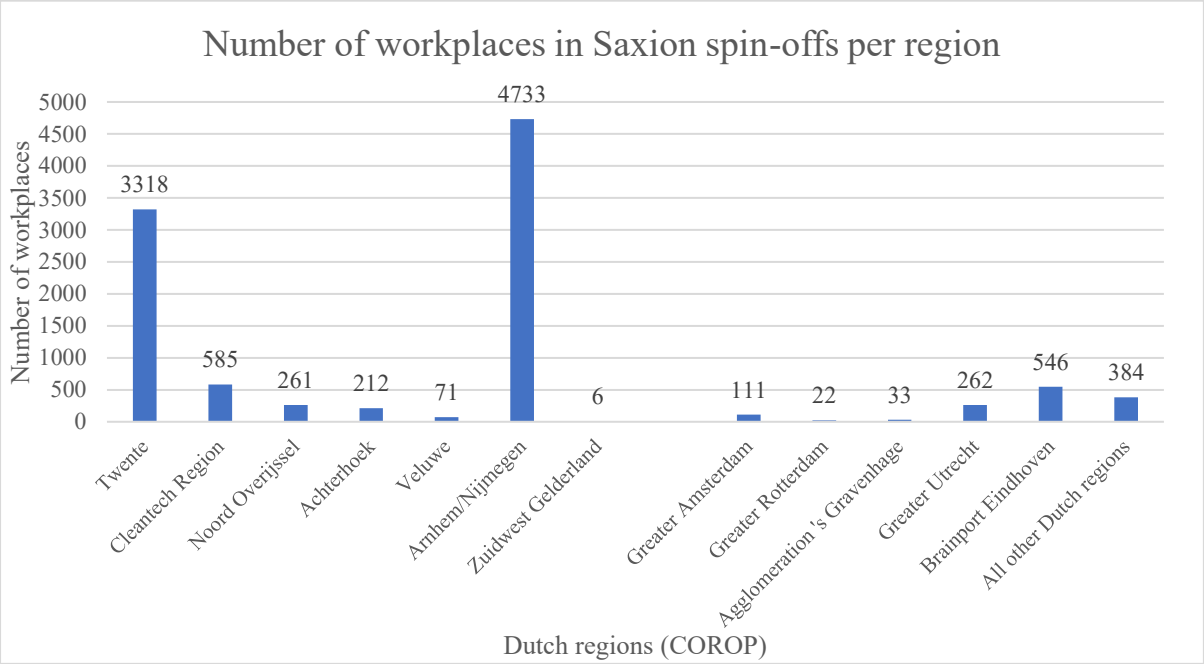


Figure 4.30: Number of workplaces in Saxion spin-offs in 2019 per region

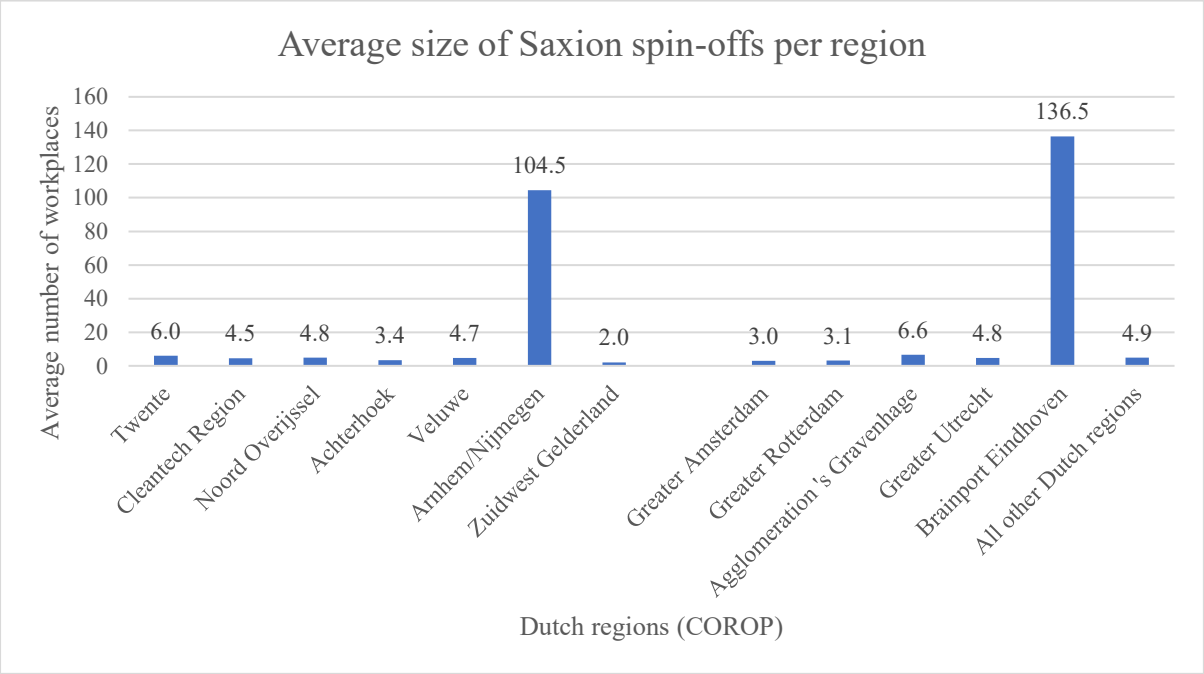


Figure 4.31: Average size of Saxion spin-offs in number of workplaces per region in 2019

The last part of this subchapter is about the location of Saxion spin-offs, seen from an economic sector perspective. Just like with the UT spin-offs, only the economic sectors with 20 or more spin-offs have been taken into the analysis, to avoid too much influence of "coincidence". Table 4-9 shows the result of this analysis, whereby the first column shows the average % of spin-offs located into each region.

Table 4-9: Location of Saxion spin-offs in specific economic sectors per region in %

	Average for all sectors	C	G	J	K	M	N	P	Q	R	S
Twente	53.4	54.2	55.4	56.3	55.8	51.6	48.0	43.5	48.2	41.3	60.5
Cleantech Region	12.4	12.5	15.4	10.3	9.3	16.1	20.0	30.4	7.1	17.5	2.6
Noord Overijssel	5.2	2.1	2.7	7.3	0.0	4.6	12.0	2.2	1.8	10.0	10.5
Achterhoek	6.1	12.5	10.0	4.9	4.7	4.0	0.0	2.2	7.1	8.8	13.2
Veluwe	1.4	4.2	2.3	0.5	2.3	1.6	8.0	2.2	5.4	0.0	2.6
Arnhem/Nijmegen	3.4	2.1	1.2	1.9	7.0	5.3	4.0	4.3	3.6	2.5	5.3
Zuidwest Gelderland	0.3	0.0	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Greater Amsterdam	3.6	2.1	2.3	4.1	0.0	3.3	4.0	0.0	3.6	1.3	2.6
Greater Rotterdam	0.7	0.0	0.8	0.5	0.0	0.2	4.0	0.0	5.4	0.0	0.0
Agglomeration 's Gravenhage	0.5	0.0	0.0	1.4	2.3	0.9	0.0	2.2	0.0	0.0	0.0
Greater Utrecht	5.3	0.0	5.0	5.2	7.0	5.3	0.0	6.5	5.4	6.3	0.0
Brainport Eindhoven	0.4	0.0	0.0	0.3	2.3	0.9	0.0	0.0	1.8	0.0	0.0
All other Dutch regions	7.5	10.4	4.6	6.8	9.3	6.2	0.0	6.5	10.7	12.5	2.6

Source: Own compilation

As already noticed, in comparison with UT spin-offs, the percentage of spin-offs in the eastern Netherlands is higher than for the UT, although the percentage of spin-offs located in Enschede and Twente is lower. Industry (C) is slightly above average located in Twente, but quite a few of them are also located in the region Achterhoek, which is a region with a quite high percentage of employment in industry (Central Bureau of Statistics Netherlands, 2021), indicating that this higher percentage may be due to a cluster-effect. The Cleantech Region and the Achterhoek are also quite attractive for Saxion spin-offs in the trading sector (G). Twente, Noord Overijssel and Amsterdam are attractive for Information and Communication Technology companies (J). In both regions the IT sector is relatively strongly represented (Central Bureau of Statistics Netherlands, 2021), so that also here there may be cluster-effect. In Utrecht, where the IT sector is also relatively strongly represented, this cluster-effect does not show among Saxion spin-offs (this unlike UT spin-offs where Utrecht next to Amsterdam was also one of the regions attracting quite some IT spin-offs). For spin-offs in business-to-business services (M and N), the Cleantech Region is quite an attractive location, and the same applies for spin-offs in education (P).

Twente is the least attractive for spin-offs in culture, recreation and sport (R), but with the exception of Greater Utrecht, these spin-offs appear not to be attracted much by large cities and the diverse cultural life there. Instead, many of them are located in the Cleantech Region, Noord Overijssel and the

Achterhoek. This may be among others caused by the fact that the entire hospitality and business faculty of Saxion is in Deventer and Apeldoorn, and that many spin-offs of this type are attracted by a location relatively close to the university. Noord Overijssel and the Achterhoek are attractive locations for diverse business to consumer service spin-offs, such as wellness centers and repair services. The reasons for the concentration of Saxion spin-offs in sector S in these regions is unclear: Twente, Noord Overijssel and the Achterhoek do have large rural areas with a lot of nature, which may be attractive for wellness centres, but so does the Cleantech Region and the Veluwe. Still, the share of sector S spin-offs in these two regions is small.

4.6 Migration patterns of UT spin-offs

This subchapter is specifically about the UT spin-offs that started their operations in one region, for example Twente, close to the parent university and then decided to move away from this region. Of course, the migration movement could also be the other way round, companies started on a large geographical distance from the UT and decided to move closer to the university. Since Atzema et al. (2015) observe that most migrations happen in the period not long after the start-up phase of a company, when growth of the company more or less forces them to look for another location, the average age of the spin-offs while moving is being calculated. The destination regions of migrating companies are investigated, to see whether there are differences between intraregional and interregional migration patterns. Chapter 1.6 deals with the theoretical background of company migration as well as the potential effects that large agglomerations could have on attracting growing businesses (or differently said: on ambitious entrepreneurs, aiming for growth).

The difference with the previous subchapters about the location of UT and Saxion spin-offs is that the location is telling something about the current situation, and locational choices could have been made based on arguments in favour of a certain location/region from the start of the spin-off and haven't changed throughout time. What is especially interesting in the migration patterns is that for spin-offs that decided to move, and especially the ones moving to a different region, different arguments for a locational choice came into being. In the context of this study, it is very interesting to find out whether these changes in locational preferences have something to do with either regional characteristics of the region of origin, or with changes in the importance of the knowledge relation with the parent university. From the literature on the subject, the conclusion can be drawn that knowledge relations of spin-offs with their parent university usually wither over time (Bathelt & Henn, 2014). The question that follows is if it influences the argumentation of spin-off companies to move away from a certain location that was originally chosen because of being at a convenient (short) distance to the parent university and/or knowledge available in the regional innovation system. If diminishing importance of knowledge relations with the parent university play a role in the migration decision of spin-offs, it could therefore

be expected that interregional migration would occur during more later stages of the company development.

First of all, it is important to look at the actual numbers of migrating and non-migrating spin-offs. It is apparent from literature on the subject that most companies do not move easily away from the region of origin, as migration is seen as something risky. It may disrupt the existing customer and supplier networks as well as that migration is a costly affair. Therefore, if companies move, it is usually over short distances (Pellenbarg et al., 2005; Van Oort et al., 2008). For the UT spin-offs, the migration data is displayed in Table 4-10.

In Table 4-11 can be seen that from the 796 UT spin-offs identified with Twente as region of origin, 489 did not move at all and are still located at the same address as where they were started. 215 spin-offs moved but stayed within the region itself. 49 spin-offs moved from Twente to one of the five largest agglomerations in The Netherlands, 12 moved to a location in the Cleantech Region and 31 moved to other regions. Likewise, 110 UT spin-offs started in the five largest Dutch agglomerations did not move at all, 6 moved to Twente, 46 moved inside or between one of the five large cities, 4 moved to the Cleantech region and 22 to other regions. For the Cleantech Region, 43 companies did not move, 3 moved to Twente, 2 to one of the five largest agglomerations, 8 moved within the Cleantech Region and 6 moved to other regions. The data for UT spin-offs originating from all other regions shows that out of 229 spin-offs, 136 did not move, 11 moved to Twente, 15 to one of the large cities, 3 to the Cleantech Region and 64 moved inside or between a region in the other group.

Table 4-10: Percentages of UT spin-offs migrating and not migrating, including origins and destinations

	Not migrating companies	**Migrating companies**				
Region of origin		*Destination region*				
		Twente	5 Largest Dutch agglomerations	Cleantech Region	Other regions	Total
Twente	61%	27%	6%	2%	4%	100%
5 largest Dutch agglomerations	59%	3%	24%	2%	12%	100%
Cleantech Region	69%	5%	3%	13%	10%	100%
Other regions	59%	5%	7%	1%	28%	100%
	Average: 61%					

Source: Own compilation

Table 4-10 shows the percentages of all UT spin-offs migrating and not migrating. In total, for all regions of origin, 61% of the UT spin-offs did not move from the location where they were established. On average 88% of the UT spin-offs established in Twente did not move at all (61%) or moved within the region (27%). 12% of all established UT spin-offs in Twente left the region, 6% to one of the large Dutch agglomerations, 2% to the Cleantech Region and 4% to any other region within the Netherlands.

The percentage of UT spin-offs staying in the region of the parent university is therefore significantly higher than the percentage reported by Clayman and Holbrook (2003), who found that 79% of the spin-offs from several Canadian universities remained in the region of the parent university. It is also higher than the 83% retention rate reported by Bagchi-Sen et al. (2020) for spin-offs in the UK. They also observed a lower retention rate for university spin-offs in the Greater London area most likely due to a lack of affordable space and/or lack of business incubation. Interestingly, for UT spin-offs started in one of the five largest cities in the Netherlands, the retention rate is also lower than that of Twente, namely 83% (consisting of 59% non-movers, plus 24% movers within the region). In the case of the UT spin-offs this does not lead to a large flow of spin-offs from the large agglomerations towards Twente, but rather towards other Dutch regions. It can be assumed that these companies are "sub-urbanizing" in search for better or cheaper space, but not too far from the market (cf. Atzema et al., 2015). Examination of the available individual company data indeed shows that these companies are moving from Amsterdam to Haarlem, Alkmaar or Hilversum for example or from The Hague to Delft and from Greater Utrecht to the Veluwe or Flevoland. Only in a few exceptional cases such companies move to for example Maastricht or the Achterhoek or the Friesland province.

The previous subchapter on location of the UT spin-offs showed that there is a significant difference in the location of the different types of spin-offs, spin-offs of the first type were more likely to be located in Twente than spin-offs of the fourth type. Therefore, Figure 4.32 shows the differences in migration patterns between the different types of spin-offs, in particular the regional spin-off retention rate for Twente, once they are established. Type I spin-offs that are established in Twente stay for 88.1% of the cases in the region (52.4% of non-movers plus 35.7% moving within the region). Type II spin-offs, the more high tech service oriented companies have a slightly lower retention rate of 87.4% (52.1% plus 35.3%). The type III, regional ecosystem supported spin-offs, have the highest regional retention rate, namely 89.9% (64.8% plus 25.1%). Type IV spin-offs finally, have with 86.9% (62.3% plus 24.6%) the lowest regional retention rate. The differences between the different types are however rather small, ranging from 87% (Type IV) to 90% (Type III).

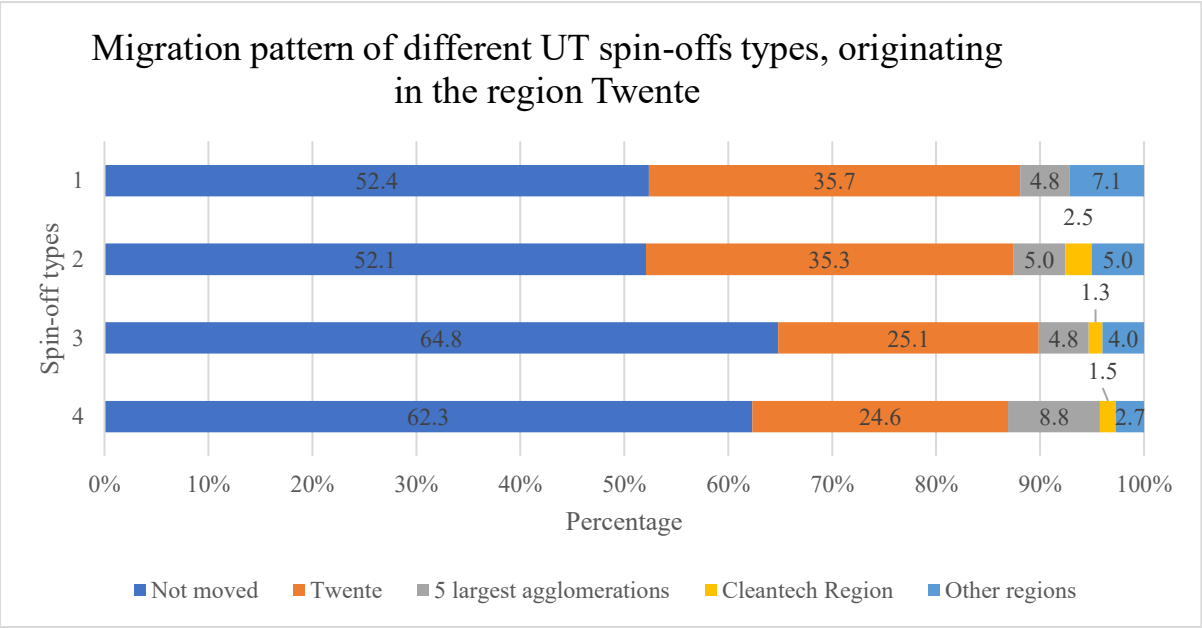


Figure 4.32: Migration pattern of different types of UT spin-offs established in Twente

It is often assumed that spin-offs leave economic non-core regions when they have reached a certain size and consider it for example for venture financing or human resource reasons necessary to move to an economic core region (Soetanto & Van Geenhuizen, 2019). Figure 4.33 shows the percentage of workplaces involved in migration of UT spin-offs, per spin-off type established in Twente. From all the Type I spin-offs, counted for the year of migration, 10.6% of the then existing jobs are moved into another region. This is somewhat smaller than the percentage of type I spin-offs leaving the region, indicating that it are on average the somewhat smaller companies that leave. This pattern of smaller companies leaving the region Twente is clearly visible for the type II and type III spin-offs. For these types, respectively 5.1% and 3.3% of the workplaces have moved out of Twente. For spin-offs of type IV, the situation is slightly different: Here 17.0% of the workplaces have moved out of the region, indicating that the leaving companies are slightly larger than average.

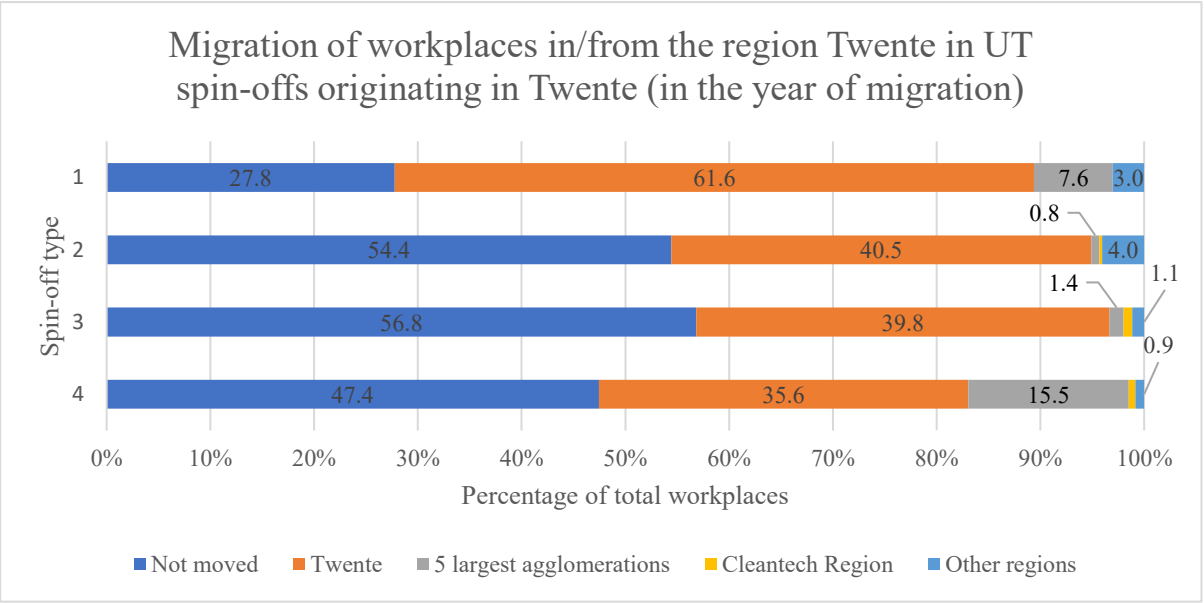


Figure 4.33: Migration pattern of workplaces in UT spin-offs established in Twente, per spin-off type (counted for the year of migration)

To complete the picture, Figure 4.34 is included, which shows the same information as Figure 4.33 but then for the last available year of the employment data (the year 2020). This is to compare the division of workplaces in the actual year of moving with the last available data. The resulting picture is striking: Type I spin-offs established in Twente appear to grow faster in the region Twente than in other regions, as the share of the region Twente in the current employment is larger than in the migration year. The employment share of type II spin-offs is roughly equal is in the year of the company migration. Type III spin-offs in the 5 largest Dutch agglomerations grow faster than the ones in Twente. The 4.8% of the companies that moved to one of the large cities offered in the year of migration just 1.4% of the workplaces, but in 2020 no less than 10%. This growth is however dwarfed by the growth of the type IV spin-offs: 8.8% of the type IV spin-offs established in Twente, left the region for a location in one of the 5 largest Dutch agglomerations. In the year of moving, they offered 15.5% of the workplaces. In 2020 however, these spin-offs offered no less than 69.5% of all workplaces in type IV spin-offs (Note: this large percentage is not because of outlier Booking.com, since this company was not established in the region Twente and therefore does not count in this analysis).

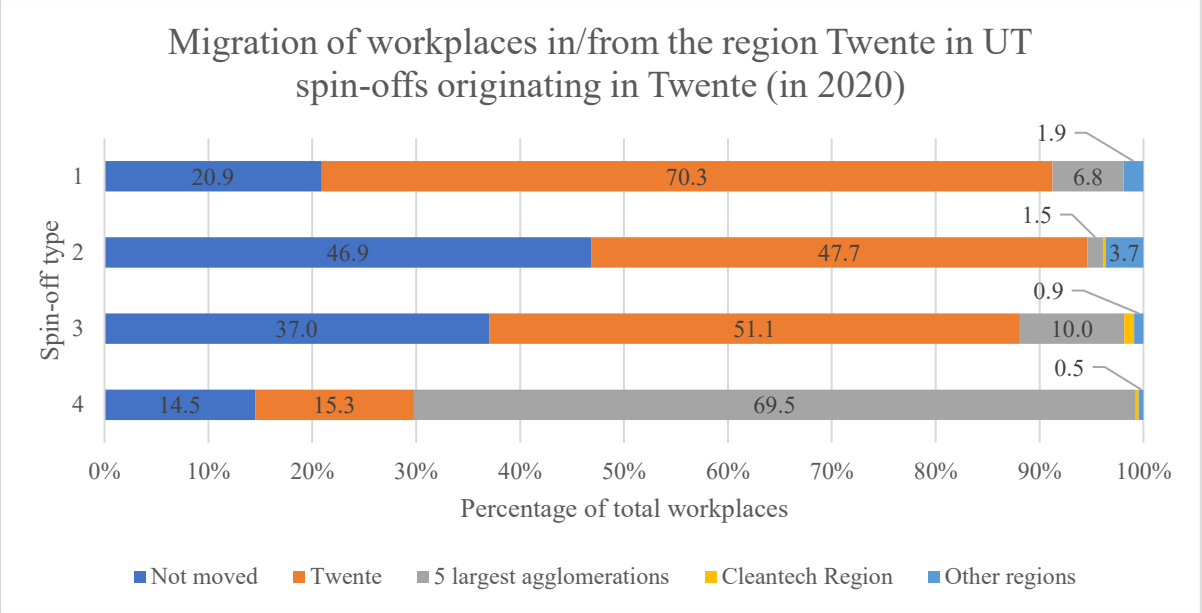


Figure 4.34: Migration pattern of workplaces in UT spin-offs established in Twente, per spin-off type (in 2020)

Table 4-11 shows the absolute numbers underlying the previous figure on the migration pattern of UT spin-offs which were established in the region Twente. The left column shows the spin-off type, the second column the number of spin-offs that have remained at the same address since their establishment. The third column shows the number of spin-offs that have moved to any other address within the region Twente (these are usually spin-offs that move to larger premises), the percentages in brackets behind the numbers is the percentage of all migrations within that category. The 4th, 5th and 6th column show the number of spin-offs that have actually left the region Twente.

Table 4-11: Migration pattern of UT spin-offs (absolute numbers) established in Twente per spin-off type

	Not migrated	**Migrated**				Total
Spin-off type		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	
Type I	22	15 (75%)	2 (10%)	0 (0%)	3 (15%)	42
Type II	62	42 (73%)	6 (11%)	3 (5%)	6 (11%)	119
Type III	243	94 (71%)	18 (14%)	5 (4%)	15 (11%)	375
Type IV	162	64 (65%)	23 (24%)	4 (4%)	7 (7%)	260

Source: Own compilation

Table 4-12: Migration pattern of workplaces in UT spin-offs established in Twente (at the year of migration)

	Not migrated (number of workplaces)	**Migrated (number of workplaces)**				
Spin-off type		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	Total
Type I	55	122	15	0	6	198
Type II	565	420	8	3	42	1038
Type III	953	668	23	14	19	1677
Type IV	445	334	145	6	8	938

Source: Own compilation

Table 4-13: Workplaces in UT spin-offs established in Twente (situation in 2020)

	Not migrated (number of workplaces)	**Migrated (number of workplaces)**				
Spin-off type		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	Total
Type I	55	185	18	0	5	263
Type II	565	575	18	3	44	1205
Type III	953	1314	258	25	23	2573
Type IV	445	468	2130	9	14	3066

Source: Own compilation

Another aspect of migrating companies is the age of the company when migrating. As described in the literature review, intraregional migration is often caused by lack of space or because of looking for a more representative building. Interregional migration is usually caused by "organizational issues" and/or "business economic reasons". These differences in age can be observed in Table 4-14, where the average age of the spin-off while moving is usually higher in the case of an intraregional migration. The average age of spin-offs doing interregional migration is in most cases lower, indicating that spin-offs usually already in earlier stages of their existence discover that the location in their current region does not suit their needs.

Table 4-14: Average age of migrating spin-off companies in years, with region of origin and destination region

Region of origin	**Destination region**			
	Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions
Twente	8.9	6.7	5.3	5.6
5 largest Dutch agglomerations	6.3	9.5	7.3	4.9
Cleantech Region	12.0	6.5	13.3	3.3
Other regions	6.5	12.3	10.7	7.9

Source: Own compilation

The last analysis of spin-off migration is the migration of UT spin-offs per economic sector: It is good to understand whether there are specific economic sectors in which many spin-offs decide to migrate:

Table 4-15 shows the migration pattern of UT spin-offs established in the region Twente per economic sector and indicates the number of spin-offs that did not move at all, moved to any other location within the region Twente, or left the region. Since Table 4-10 already shows that from all spin-offs originating in Twente, 88% stay in the region, the absolute numbers of spin-offs leaving the region, as well as the relative numbers (seeTable 4-16), cannot be expected to be very large. Sectors with more than average percentages of spin-offs leaving the region Twente are G (Trade), J (ICT), K (Financial services), P (Education/training services) and Q (Health care related services). On the other hand, spin-offs in manufacturing (sector C) are much less likely to leave the region Twente. It appears as if for spin-offs in most service sectors there is a greater need to move towards economic core regions. At the same time, it is quite clearly visible that especially financial services companies established in Twente are rather mobile, as only 39% of them have not moved during their lifetime. The average "not-movers rate" for Twente established UT spin-offs is 61% as can be seen in Table 4-10.

Table 4-15: Migration pattern of UT spin-offs established in Twente per economic sector (absolute numbers)

	Not migrated	**Migrated**				
Economic sector		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	Total
C	40	25	1	0	1	67
G	41	9	3	0	5	58
J	142	51	20	2	8	223
K	20	23	6	2	0	51
M	168	82	16	5	11	282
N	10	3	0	0	1	14
P	17	6	0	2	3	28
Q	7	4	1	0	2	14

Source: Own compilation

Table 4-16: Migration pattern of UT spin-offs established in Twente per economic sector (%)

	Not migrated	**Migrated**				
Economic sector		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	Total
C	60%	37%	1%	0%	1%	100%
G	71%	16%	5%	0%	9%	100%
J	64%	23%	9%	1%	4%	100%
K	39%	45%	12%	4%	0%	100%
M	60%	29%	6%	2%	4%	100%
N	71%	21%	0%	0%	7%	100%
P	61%	21%	0%	7%	11%	100%
Q	50%	29%	7%	0%	14%	100%

Source: Own compilation

When looking at the number of workplaces that have left the region with the migrating companies per economic sector, it can be seen in Figure 4.35 that this number is not very high. The figure shows the relative number of jobs leaving the region, for the year of migration. The only sector in which more than 10% of the jobs were "lost" for the region Twente due to out-migration is for spin-offs in ICT (Sector J).

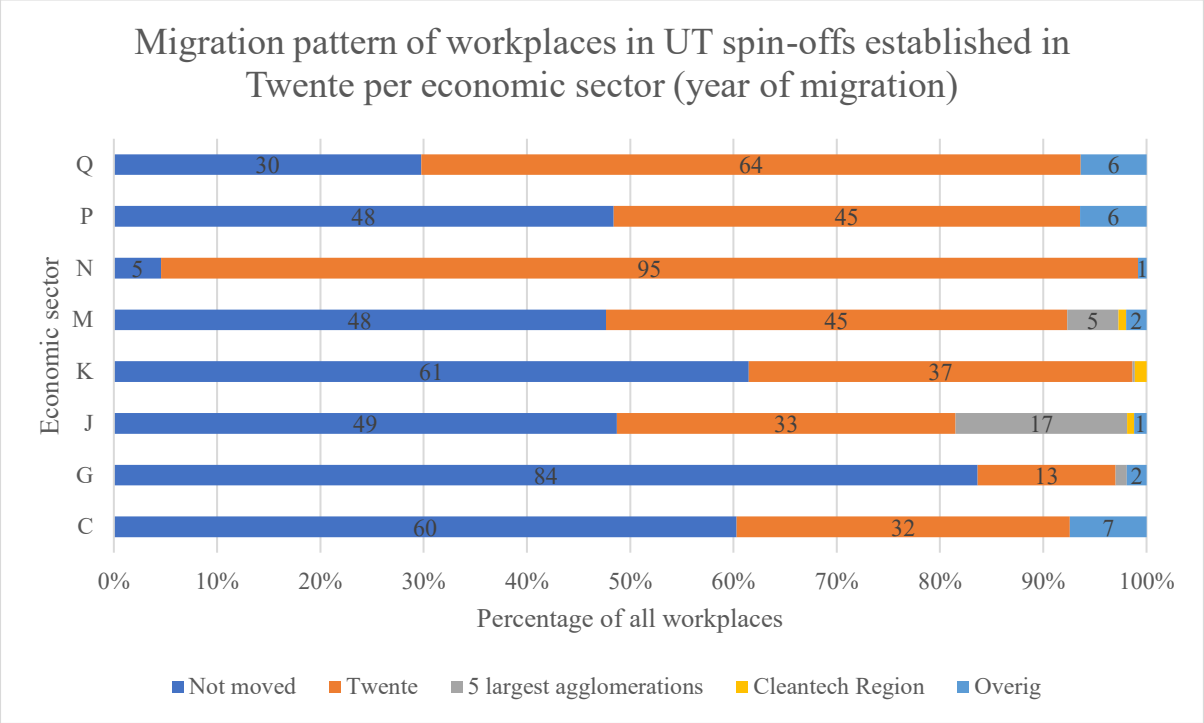


Figure 4.35: Migration pattern of workplaces in UT spin-offs established in Twente, per economic sector (counted for the year of migration)

It shows that on average only smaller companies are involved in interregional migration, also when looking from the perspective of the economic sector in which they are involved. This is consistent with the data on the average age of spin-offs, which shows that on average "young companies" are involved in interregional migration. Such young companies have most likely not yet had enough time to grow to a significant size. When looking at the growth potential of the migrating companies, it is helpful to look at the employment in 2020, for the same migrating companies established in the region Twente and compare the employment size for the "stayers" in Twente with the "leavers". Figure 4.36 shows the relative sizes of the staying and leaving UT spin-offs established in Twente. There are very large differences per economic sector visible. Especially in health care services, the migrating companies that have left the region Twente for a location in one of the largest Dutch agglomerations now employ 81% of all people. A similar high number is visible for the spin-offs in sector J (ICT). Sector C (Industry) shows the opposite, none of the spin-offs that were active in industry that were established in Twente and migrated away from the region survived, given the fact that in 2020 there are no workplaces left in other regions. It is also visible in all economic sectors that the employment share of the non-migrated

companies is decreasing, a clear sign that company growth and migration are correlated, in the sense that growing companies look for new premises where they have more room to expand, while not giving up on the advantages of being rooted in the regional entrepreneurial ecosystem.

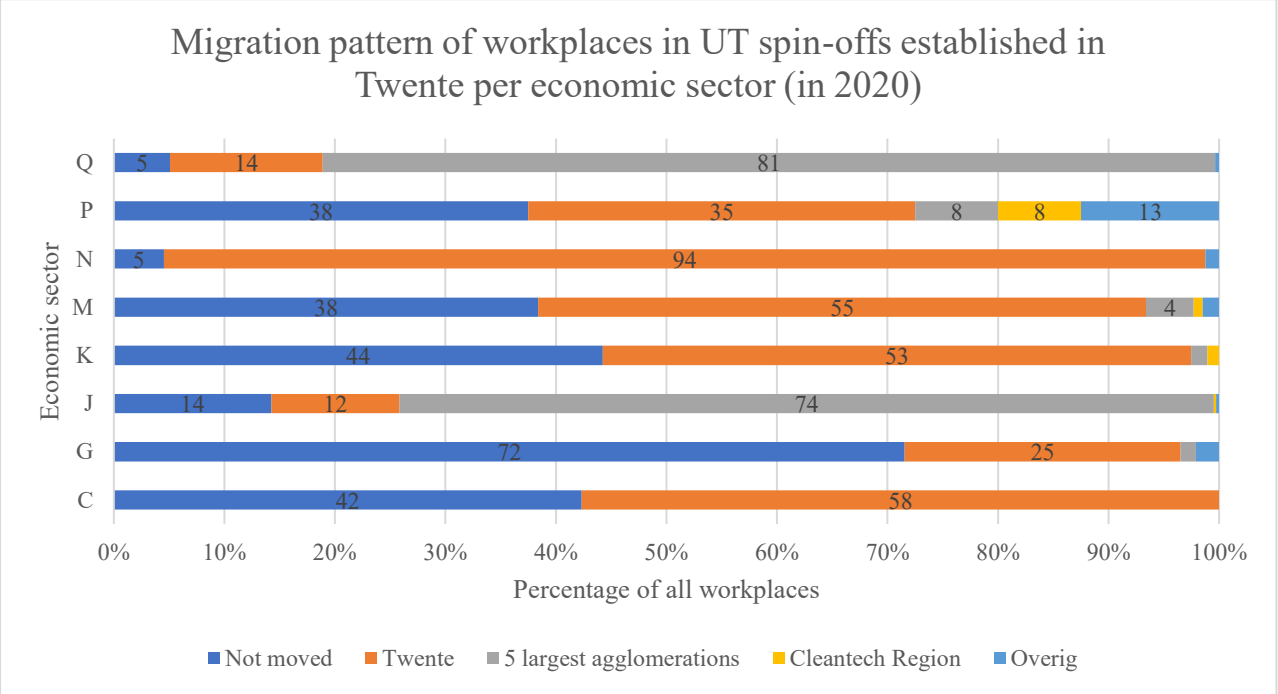


Figure 4.36: Migration pattern of workplaces in UT spin-offs established in Twente, per spin-off type (in 2020)

As mentioned in the study of Bagchi-Sen et al. (2020), spin-offs are more than average active in ICT (sector J), biotech/life sciences (part of sector Q) and nanotechnology & materials (part of sector C). Given the innovativeness of these sectors, and the occurring agglomeration effects, it is understandable that most of the businesses with growth potential in these sectors are attracted to the largest Dutch agglomerations. Sector C (production industry) is an interesting exception, spin-offs in this economic sector are not likely to move away from Twente in the first place, and if they did, they did not survive. For companies in this sector, the region Twente appears to have strong locational advantages.

4.7 Migration patterns of Saxion spin-offs

This subchapter on the migration patterns of Saxion spin-offs follows largely the same structure as the UT spin-offs. Unfortunately, due to incomplete data of spin-offs before 2016, only the migration patterns from the last five years can be analysed. However, from this last five years, all analyses can be carried out. Just like for the UT spin-offs, the focus of this subchapter is on Saxion spin-offs that have started their commercial operations in the region Twente and then moved to other regions.

From the subchapter on the location of Saxion and UT spin-offs, it already became clear that Saxion spin-offs are more than UT spin-offs spread out over the eastern part of the Netherlands, and are not that much concentrated in Enschede alone. On the other hand, Saxion spin-offs are much more than UT

spin-offs concentrated in the eastern Netherlands. It is therefore no surprise that the numbers of Saxion spin-offs migrating away from the eastern Netherlands are much smaller than those of the UT. Even though the migrations of Saxion spin-offs are known, because of the lack of detailed employment data from before 2016, there can be no analyses done on for example the changes in workplaces after migration. This also applies to the analysis on the different spin-off types. Since Saxion spin-offs are almost exclusively type III and IV spin-offs, it is mainly useful to compare Saxion spin-offs with these UT spin-off types.

Table 4-17 shows the number of Saxion spin-offs migrating and not migrating. Similar to the UT and expected from the literature, if Saxion spin-offs move, they mostly move over small distances, within the region of origin. The interregional migration is low, also compared to the type III and IV UT spin-offs. 1207 Saxion spin-offs did not change their address during their existence. From them, 667 originate in the region Twente. Another 156 spin-offs moved within the region, and 62 of them left Twente. These 62 companies consist of 34 companies that moved from Twente to one of the 5 largest Dutch agglomerations, 9 that moved to the Cleantech Region and 19 that moved to any other region in the country. Likewise, for the 121 spin-offs originating in the 5 largest Dutch agglomerations, the majority did not move at all, and from the ones that did move, by far the largest number (24) stayed within these agglomerations. Also, for spin-offs from the Cleantech Region and other regions, the similar pattern of a much larger intraregional migration is visible.

Table 4-17: Number of Saxion spin-offs migrating and not migrating, including origin and destination

	Not migrating companies	**Migrating companies**				
Region of origin		*Destination region*				
		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	Total
Twente	667	156	34	9	19	885
5 largest Dutch agglomerations	87	1	24	1	8	121
Cleantech Region	182	3	2	41	9	237
Other regions	271	5	8	2	60	346
Total	1207					1589

Source: Own compilation

Table 4-18 shows the percentages of the Saxion spin-offs that migrated or stayed on their original address. On average 75.9% of the spin-offs did not move, although the ones originating from the large agglomerations are a bit more likely to move, as only 71.9% of them stay put. As written above, most of them stay in the largest agglomerations, however 6.6% of them move to other regions, indicating that those may be "suburbanizing" spin-offs. For the spin-offs originating from Twente, it is clearly visible that the most likely destination for those moving out of the region Twente is one of the large

agglomerations in the country. Interestingly, this is not the case for Saxion spin-offs originating in the Cleantech Region, there other regions as well as Twente appear to be more attractive.

Table 4-18: Percentages of Saxion spin-offs migrating and not migrating, including origin and destination

	Not migrating companies	**Migrating companies**				
Region of origin		*Destination region*				
		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions	Total
Twente	75.4%	17.6%	3.8%	1.0%	2.1%	100%
5 largest Dutch agglomerations	71.9%	0.8%	19.8%	0.8%	6.6%	100%
Cleantech Region	76.8%	1.3%	0.8%	17.3%	3.8%	100%
Other regions	78.3%	1.4%	2.3%	0.6%	17.3%	100%
	Average 75.9%					

Source: Own compilation

Even though there is no reliable data on the exact year of the migration for Saxion spin-offs if the migration took place before 2017, still the average age of the Saxion spin-offs can be shown, related to their migration history.

Table 4-19 shows the average ages of the spin-offs in 2019, grouped by their migration history. As with the UT spin-offs, companies that were involved in intraregional migration are on average older than the ones involved in interregional migration, showing once again evidence for the observation that spin-offs feel already in a rather early stage of their existence that the business economic situation is not according to their needs. The on average older age of the companies involved in intraregional migration shows that such companies move when the current location doesn't suit their needs anymore (i.e. becomes too small), a situation which most likely occurs only in later stages of development. An interesting exception is the rather high average age of spin-offs originating in the largest agglomerations and moving to other regions. This is another piece of evidence for the suggestion that such spin-offs are well established companies that "suburbanize" away from the largest agglomerations in order to find more space for their business operations.

Table 4-19: Average age of Saxion spin-offs in 2019 in years, in migration categories

	Not migrating companies	**Migrating companies**			
Region of origin		*Destination region*			
		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions
Twente	7.3	8.6	7.3	6.9	7.4
5 largest Dutch agglomerations	8.1	2.0	8.9	3.0	14.2
Cleantech Region	7.3	7.3	7.0	8.7	7.2
Other regions	8.0	6.6	7.3	11.0	9.6

Source: Own compilation

Because reliable employment data for Saxion spin-offs before 2016 are missing, only the number of workplaces for the last available year (2019) can be shown, grouped by the migration history of those spin-offs moving, as well as for those not moving.

Table 4-20 shows the percentages of workplaces in Saxion spin-offs in 2019 for each of the different migration categories. Most workplaces in the region Twente can be found in companies that did not migrate during their existence (82.5%). Spin-offs that originated in Twente and moved to another location within Twente are good for another 15.2% of the workplaces, so that the percentage of workplaces that sort of "left the region" Twente only count for 2.3%. The situation for the Cleantech Region is roughly similar to that of Twente, however the percentages of workplaces in all other regions and in the largest Dutch agglomerations are quite different: especially in the largest agglomerations, most of the workplaces can be found in companies that have migrated within these cities and only a smaller percentage of the workplaces (32.3%) can be found in spin-offs that didn't migrate. It also becomes clear that for spin-offs originating outside the region Twente or the Cleantech Region, these two regions are not particularly attractive regions to relocate to, given the very small percentages. This means that at least for university spin-offs, these regions do not appeal very much to companies outside the region. The regions do succeed however, and this is similar for both UT and Saxion spin-offs, in having a rather high spin-off retention level. It appears therefore as if the regional innovation system as well as its entrepreneurial ecosystem is functioning, but rather internally oriented.

Table 4-20: Workplaces in Saxion spin-offs in % (situation in 2019), grouped by migration history

	Not migrating companies	**Migrating companies**			
Region of origin		*Destination region*			
		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions
Twente	80.4	17.1	1.6	0.3	0.7
5 largest Dutch agglomerations	32.3	0.1	58.7	0.1	8.8
Cleantech Region	79.5	0.7	0.3	17.5	2.0
Other regions	63.3	0.1	0.2	0.0	36.4

Source: Own compilation

The next analysis in this subchapter is the migration pattern of Saxion spin-offs per economic sector. Table 4-21 shows the results of this analysis. It shows all Saxion spin-offs which are established in Twente, grouped per economic sector in which they are active. It shows the number of spin-offs that did not migrate at all, as well as the ones that relocated to another address within the region Twente as well as to one of the 5 largest Dutch agglomerations, the Cleantech Region or any other Dutch region. For easy comparison between the different sectors, Table 4-22, with relative numbers is added. Similar to the UT spin-offs, Saxion spin-offs in industry (sector C) are most likely to stay in the same location where they are founded. ICT spin-offs (sector J) are just like the UT spin-offs the most mobile and the most likely to leave the region Twente. An interesting difference between Saxion and UT spin-offs in health care services (sector Q), is that the Saxion spin-offs established in Twente are all staying in the region, whereas for the UT, the largest sector Q spin-offs where found outside Twente

Table 4-21: Migration pattern of Saxion spin-offs established in Twente per economic sector (absolute numbers)

	Not migrated	**Migrated**			
Economic sector		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions
C	24	2	1	0	0
G	121	21	3	0	3
J	151	52	13	1	5
K	18	5	1	0	1
M	229	53	13	6	8
N	11	1	0	0	1
P	17	2	0	1	0
Q	23	3	0	0	0
R	25	8	1	0	1
S	16	7	1	0	0

Source: Own compilation

Table 4-22: Migration pattern of Saxion spin-offs established in Twente per economic sector (%)

	Not migrated	**Migrated**			
Economic sector		Twente	5 largest Dutch agglomerations	Cleantech Region	Other regions
C	88.9%	7.4%	3.7%	0.0%	0.0%
G	81.8%	14.2%	2.0%	0.0%	2.0%
J	68.0%	23.4%	5.9%	0.5%	2.3%
K	72.0%	20.0%	4.0%	0.0%	4.0%
M	74.1%	17.2%	4.2%	1.9%	2.6%
N	84.6%	7.7%	0.0%	0.0%	7.7%
P	85.0%	10.0%	0.0%	5.0%	0.0%
Q	88.5%	11.5%	0.0%	0.0%	0.0%
R	71.4%	22.9%	2.9%	0.0%	2.9%
S	66.7%	29.2%	4.2%	0.0%	0.0%

Source: Own compilation

The numbers from Table 4-21 and Table 4-22 are generally low, which is not surprising, given the data from the general location of all Saxion spin-offs. These are less likely than UT spin-offs to be located in the largest Dutch agglomerations as well as more likely to stay within the eastern part of the Netherlands. However, Saxion spin-offs are less concentrated in Enschede and less often found in close proximity to the parent institution than the UT spin-offs. Given the nature of the Saxion spin-offs (mainly comparable with type III and IV UT spin-offs), it can be concluded that for Saxion spin-offs knowledge relations with the parent university are less important than for (most) UT spin-offs.

To test whether the factors mentioned in the literature review and analysed in this chapter will provide a statistically significant prediction on the question whether a spin-off company has moved or not, a logistic regression analysis has been carried out. The results of this statistical test can be observed in x. The used regression analysis method was Enter. The predictors entered in the model were: 1. The distance to the parent institution, 2. The age of the spin-off company, 3. The size of the spin-off company. The distance to the parent institution is seen as a predictor because the literature on the subject describes that spin-offs tend to start near to the parent university, because of the organizational similarity and subsequent knowledge relations, while in later stages those knowledge relations tend to wither away. Therefore the chance is bigger that far away located spin-offs have moved (cf. Bathelt & Henn, 2014). For the same reason, the age of the spin-off is also included in the model. The third predictor is the size of the spin-off. Growing spin-off companies will likely have to look for different and larger spaces, so it is logical to assume that larger spin-off companies will have moved (cf. Pellenbarg, 2005; Van Oort et al., 2008). The output of the logistic regression test is displayed in Figure

4.37. The model shows that, keeping all other predictor variables constant, the odds of a migration increased by 0.002 for each extra kilometer that the spin-off is located further from the parent university. The p value for this predictor is less than .001, making this a statistically significant predictor. The second predictor in the model is the age of the spin-off. Keeping all other predictors constant, the odds of a migration increase by 0.044 for each year of age of the spin-off. The p value for this predictor is less than .001, making this also a statistically significant predictor. The model also shows that the third predictor, the size of the spin-off does not lead to a noticable increase or decrease in the odds that a migration has taken place. This indicator is not statistically significant, with a p value of .548.

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	84.076	3	<.001
	Block	84.076	3	<.001
	Model	84.076	3	<.001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	2815.516[a]	.035	.049

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table[a]

			Predicted		
			HasMoved		Percentage Correct
	Observed		No	Yes	
Step 1	HasMoved	No	1628	47	97.2
		Yes	678	30	4.2
	Overall Percentage				69.6

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Distancetoparent	.002	.001	18.038	1	<.001	1.002
	Spinoff_age	.044	.006	61.547	1	<.001	1.045
	SpinOffSize	.000	.000	.361	1	.548	1.000
	Constant	-1.490	.086	302.168	1	<.001	.225

a. Variable(s) entered on step 1: Distancetoparent, Spinoff_age, SpinOffSize.

Figure 4.37: Binary logistic regression model to predict a spin-off company migration

When looking at the total model, with a X^2 of 84.076, the model is statistically significant with a p value of less than .001. The model predicts the correct outcome in 69.9% of the cases. There are likely other - still unknown - statistically significant predictors, as the amount of false negatives (678 cases) is very high. Nonetheless, these numbers prove that at least two of the three reasons mentioned in the literature on company migration hold for the population of UT and Saxion spin-offs.

5 Conclusions and recommendations

5.1 Introduction

This chapter deals with the conclusions of this study and gives some policy recommendations for increasing the attractiveness of semi-peripheral regions for university spin-off companies, to increase the economic development as well as the economic safety & security for the population of such regions. Even though the results of this study are in the first place applicable to the research area itself, namely the eastern Netherlands, several generalizations can be made that can be helpful for understanding the situation with innovative university spin-offs in other regions. As for the structure of this conclusieon and recommendations chapter: Chapter 5.2 provides the main conclusions for this study, by answering the research questions and the main research question on the issue whether university spin-offs can be gamechangers in the development of the regional economy. Chapter 5.3 provides some recommendations for policy makers based on generalizations of the conclusions. Since this study is mainly a case study about the influence of university spin-offs of a research university and a university of applied sciences in the semi-peripheral eastern part of the Netherlands, it is always necessary to exercise some caution in the generalization of this type of conclusions. Chapter 5.4, the final part of this thesis, consists of seven theses with new and novel findings related to the research results and conclusions of this study.

5.2 Conclusions

To answer the main research question, the sub-questions need to be answered first. Therefore, this subchapter consists of a consecutive list of answers on the four sub-research questions.

The first sub-question is: *In which way could university spin-offs be defined and what is their importance for the development of the regional economy in their region of origin?* The literature study on spin-offs have clearly shown that, there is a lot of scholarly debate on which businesses should be counted as university spin-off and which ones not. Since the spin-offs in this study are studied with their impact on the regional economy in mind, it does not seem useful to stick with a very narrow definition, both timewise (business must be started during study/work or directly after leaving) as well as on student/staff relationship with the university (only researchers/employees count). Instead, those companies are included within the definition of being a university spin-off, that are started by any individual who has a formal involvement in the university, either as staff member or as student. Since many spin-off entrepreneurs start their business a couple of years after leaving the university, because of initial research and development work, in the definition it has been included that a company is considered to be a university spin-off, when the business is started less than five years after leaving the university, either as student/graduate or staff member. The five year limit is set to make sure that there is still an identifiable link with the parent university as well as not making the timeframe too long, so that any company that is started by any former graduate/staff member at any given time during their

career counts. This five year time period is in line with observations in the literature that it is not an exception that an innovative company finally markets a product after four years of research and development. The extra fifth year is added, to make sure that all relevant cases are included in the definition.

The resulting group of spin-off companies adhering to the definition is very diverse. It consists of businesses in many economic sectors, ranging from agriculture to personal services, as well as having different levels of innovativeness and different levels of entrepreneurial ecosystem support. The classification of spin-off companies into four different, more homogeneous sub-types (a slight adaptation of the framework of Pirnay et al. (2003)) has given valuable additional insights in the development and spatial behaviour of these spin-offs. What is more, university spin-offs from research universities differ a lot from spin-offs of universities of applied sciences: The independent t-test showed that the population of UT and Saxion spin-offs significantly differs from each other, in economic impact in terms of size of employment. An independent (one-tailed) T-test on the economic impact of spin-offs in terms of the size of the spin-off companies in terms of number of workplaces from both institutions shows that UT spin-offs have a significantly larger size (Mean: 35 workplaces, St.dev: 563.3) and therefore regional economic impact than Saxion spin-offs (Mean: 5.5 workplaces, St. dev: 56.6), $t(2382)=2.07$, $p=.019$, see also Figure 4.1. Therefore the spin-offs from these two institutions should be and have been treated separately. In this way, the conclusions on spatial patterns and development can be drawn with a lot more accuracy.

There is some scholarly debate on the importance of university spin-offs in their actual contribution to regional development. The majority of authors argue that university spin-offs have a contribution to the region (far) beyond their direct impact based on their number of workplaces. Those authors argue that such spin-offs, because of their innovative character, bring new ideas and positive externalities in the form of increased knowledge spillovers to the regional innovation system (ie. other businesses around profit from the innovative products and services brought on the market by the university spin-offs). A minority of authors argue that the role of university spin-offs is overrated and that only few measurable results of positive knowledge spillovers can be presented: maybe with the exception of a handful of top-class universities. In other cases, these authors argue, the support of starting spin-off enterprises costs much more than there will be in terms of regional economic effects in return. Therefore they argue, the money spent on technology transfer and spin-off support can be better spent on different purposes, thereby decreasing the opportunity costs for society. Weighing the different arguments, the position is chosen that spin-offs do have a positive effect beyond their direct economic impact on the regional innovation system of the region in which they are located. Therefore, the number of workplaces within spin-offs is not seen as a measure of the total economic impact of the UT and Saxion spin-offs for the region Twente and the broader eastern part of the Netherlands. There is no methodology available on

how to calculate the size of this regional "multiplier" effect of spin-offs, so therefore there are no claims in this study about the total economic effect of university spin-offs. This is a matter for further research.

The second research question is: *What spatial pattern (including migration) can be identified for university spin-off companies from the Eastern part of the Netherlands?* The expectation based on the literature on the subject was that the large majority of spin-off companies would be located in close geographical proximity to the parent university. Just how "close" exactly "close proximity" is, remains somewhat fuzzy throughout most available studies. In this study, it becomes clear for both the spin-offs of the UT and Saxion, that the majority of the spin-offs (respectively 54% and 58%) are located in the region Twente (and the majority of these, within 10 kilometres distance from the parent university). For the broader eastern part of the Netherlands, the respective percentages are 68% and 82%. Saxion has a much more regional profile, most of its students are from the eastern part of the Netherlands, whereas the UT has a more national profile (actually also more international, but due to measuring difficulties, spin-offs located in any other country than the Netherlands have been deliberately left out of this study). Another interesting observation is that the UT spin-offs in the region Twente are much more concentrated in Enschede than the Saxion spin-offs. From all UT spin-offs located in Twente, 65% are located in Enschede, whereas for Saxion spin-offs this percentage is only 37%. In total 35% of all UT spin-offs are located in Enschede, while Saxion spin-offs are more spread out throughout the region, with 25% located in Enschede. Even on a very low spatial level the concentration of spin-offs (due to strong agglomeration advantages of their knowledge relations with the parent university) is clearly visible: over 60% of all UT spin-offs in Enschede are located in one neighbourhood, where the business and science park "Kennispark" is located. Saxion spin-offs are more spread out throughout the city, with some smaller concentrations mainly within the city centre area. These findings confirm the conclusions of studies that indicate that many spin-offs can be found in very close proximity (2km or less) from the parent university.

In terms of migration, spin-offs are indeed, as the literature suggests, "sticky". They are likely to stay in the region where they are established. For UT spin-offs established in Twente, the regional retention rate is around 90%, for Saxion spin-offs it is with around 95% even higher. Even though this spin-off retention rate can be certainly called very high, it can also be noted that spin-offs moving out from Twente are growing on average at a much faster rate than the ones staying in the region. This is especially the case for fast growing UT spin-offs that have received only limited support from the regional ecosystem around the UT and/or Saxion (type IV spin-offs). There are also differences between spin-offs in certain economic sectors. Spin-offs in industry (for both universities) are most likely to stay in Twente, and especially spin-offs in ICT (for both universities) and financial services (for both universities) are a bit more likely to leave the region. In terms of employment, some interesting conclusions can also be drawn. Especially in UT spin-offs in ICT and Health care which left the region Twente, on average these leaving spin-offs are growing very rapidly, if they have moved towards one

of the five largest Dutch agglomerations. Since these economic sectors are seen as highly dynamic and attractive for university spin-offs with innovative technology (Bagchi-Sen et al., 2020), it confirms the expectation from the literature, that for such dynamic and strongly developing economic sectors agglomeration effects of being around similar types of businesses are especially important. Interestingly, for spin-offs in industry, this development appears to be opposite: UT spin-offs in this sector which remain in Twente, grow faster than the ones leaving. For Saxion spin-offs in industry this is an even stronger effect: to date, none of the industrial companies leaving the region Twente has even survived.

The third research question is: *Which differences in innovativeness, company development and spatial pattern can be observed for spin-offs from research universities and universities of applied sciences in the eastern part of the Netherlands?* The results of the study show that university spin-offs from research universities and those of universities of applied sciences are significantly different from each other. As shown in the previous research question, an independent samples t-test was executed to test if the two subgroups of spin-off were equal. The result of the test is that the two groups significantly differ form each other in terms of company development, and these differences also show very clearly in the observed spatial and migration patterns. On average, spin-offs from the Saxion University of Applied Sciences tend to stay more in the eastern part of the Netherlands than those of the University Twente, meaning that the direct economic impact of the applied science university on the region itself is larger, especially when looking on a subregional level beyond the large agglomeration of spin-offs in the city of Enschede, close to the parent university. Saxion spin-offs are more likely to be located in the more rural parts of the region, indicating that these spin-offs are creating an economic impact in the municipalities outside the largest city in the region. Therefore, the economic impact of spin-offs of applied science universities should not be underestimated when thinking from the perspective of development of the entire region in mind. However, notwithstanding the larger spread over the region, the innovativeness of applied sciences spin-offs is likely lower. Therefore, when studying in more detail the indirect economic effects of the spin-offs on the region (ie. how effective the university spin-offs can upgrade the products or processes of other businesses in the region, the picture may very well be quite different. The methodology of this study cannot provide a definitive answer to this question and is therefore a subject for further study.

The fourth research question is: *To what extent do knowledge and resource links play a role as location factor for different types of spin-off companies from a university in a peripheral region?* The results of the study show that the importance of knowledge links is dependent on the type of spin-off. Two thirds of the total number of the most high-tech UT spin-offs (type I), the ones with codified intellectual property, are located in Enschede. What is more, almost all of those type I spin-offs in Enschede are located on the business & science park “Kennispark”, which is less than 2 kilometres from the UT campus. The other types of spin-offs are less concentrated in this area, with the lowest concentration

for the type IV spin-offs, which have received only implicit support from the university and/or the business and science park ecosystem. It therefore be concluded that the strength of the knowledge relations is a very important location factor for the most innovative high-tech spin-offs. An independent samples T-test (one-tailed), shown in Figure 4.17 with the spin-off type as independent variable and the distance in kilometers to the parent university as dependent variable shows a significant difference in distance to the parent university between the two groups of spin-offs. The most innovative spin-offs (Type I) can be significantly found closer to the university (Mean distance: 37.5km, St.dev: 61.2) than the other spin-off types (Mean distance: 63.1km, St.dev: 69.4). The T-test t value (df=1274) equals 2.62, with a p value of .004.

A simple linear regression to predict the distance to the parent university based on the spin-off type was calculated. A statistically significant regression equation was found ($F(1,1274) = 50.343$, $p = < .001$, with an R^2 of 0.038. The predicted distance is equal to 9.091 + 16.513 (per spin-off code) measured in kilometers. The predicted distance increased with 16.513 kilometers for each subtype of spin-off (1 = most innovative to 4 = least innovative), see also Figure 4.18.

Differences in development are also visible between the spin-off types in terms of number of workplaces. The most innovative type I spin-offs are less often businesses with just a single proprietor than the – usually – less innovative type II, III and IV spin-offs. On the other hand, when looking at the average number of workplaces, especially some type IV spin-offs have grown into very large sized businesses, making the type IV spin-offs the group of spin-offs with by far the largest number of workplaces. The large average size of type IV spin-offs is however caused by a handful of outliers. When excluding the outliers in type IV spin-offs, type III and IV are roughly similar in size and only marginally larger than the type I and II spin-offs. Therefore, the conclusion of this study largely contradicts the findings of Bolzani et al. (2020), who conclude that spin-offs located in close proximity to the parent university and have strong knowledge links are usually less commercially successful. When excluding a few extraordinarily successful spin-offs (in particular Booking.com and Just eat/Takeaway.com), this relationship cannot be observed. What is more, compared to Saxion spin-offs, which are on average less innovative as UT spin-offs, given that Saxion is a university of applied sciences, UT spin-offs have on average a larger size (even when excluding the mentioned outliers) and are more often located in close proximity to the university, in order to profit from the knowledge spillovers there. The results of this study also partly contradict the conclusions of Egeln et al. (2004) who argue that for spin-offs from public institutes geographical proximity to business incubators is of little significance. This conclusion does not hold for the more innovative spin-offs, which have a strong tendency to cluster around the parent university. It does however indeed show that for less innovative spin-offs, and among them especially fast-growing ones in ICT or in B2C sectors, a location close to the parent university/business incubator is less relevant.

Combining the answers of all the research questions leads to the final conclusion, whichs is the answer on the main research question: *In what way and to what extent do different types of university spin-off companies influence the regional innovation system and to what extent could the differences in spin-off types explain the spatial behaviour of these spin-off companies?* The main research question can also be read as: to what extent are university spin-off game changers, in the sense of having the ability to fundamentally change the regional economic structure (also known as the regional innovation system), to help improve the economic structure of such a region from a peripheral economic situation towards the direction of being an economic core region. From both the study of the literature as well as the empirical results, it becomes clear that university spin-offs can indeed be such game changers. They do help with changing the economic structure as the most innovative spin-offs that have the strongest knowledge relations with the parent university do very often stay in the region of origin. However, in terms of direct economic impact in terms of the number of generated workplaces, the effects of university spin-offs appear to be limited and should not be overestimated. Nonetheless, their indirect effect on the further development of the regional innovation system should not be underestimated, as the main purpose of university spin-offs is to translate newly found university knowledge into business. This means that also their customers within the region (other businesses), will profit from the adaptation of such innovations and will have the opportunity to significantly increase their level of innovativeness over the years. The amplitude of these indirect effects could not be measured in this research, but remain on the agenda as subject for further research.

5.3 Recommendations

This subchapter provides some recommendations for policy makers and revolves around the question of the policy implications for increasing the effectiveness of policies regarding the support of university spin-off companies (taking into account their identified location and migration pattern), related to regional economic development? Since the goal of this study is to contribute to the understanding of the role of university spin-off companies in the development of (semi-) peripheral regions, it is very important to apply the results of this study for policy makers.

First and foremost, it becomes clear from all available sources that changing the economic structure of a (border) region which has been peripheralized due to economic changes (in the case of the region Twente, because of the collapse of the textile industry), is a long-term process, which takes decades of conscientious investment and building. The literature on the subject clearly shows there is no “wonder pill”, which can be applied to get quick results. Instead, it is necessary to have long term commitment to a chosen path. The economic development of the region Twente over the last four decades can be for a large part explained by the policy of developing academic entrepreneurship, initiated by the University Twente, and strongly supported by the municipal government of Enschede, the regional government of Twente and the province of Overijssel as well as – in later stages – also by Saxion university of applied sciences, in supporting the development of the NovelT entrepreneurial ecosystem. The result is a

schoolbook example of triple helix cooperation (Etzkowitz & Leydesdorff, 1995b) between government, university and business. The support measures of the UT have had a largely "low selective" character (Benneworth & Charles, 2004), which means that companies from many different economic sectors have been supported. There was barely any selection of specific economic sectors fitting within one or a few top-down selected business clusters. Instead, entrepreneurship support measures were given to any student/graduate/staff member with a reasonable business idea to commercialize university knowledge. When looking at the pool of university spin-offs in this study, it shows that even with such a low selective policy model of supporting entrepreneurship, only a few economic sectors stand out as areas in which university spin-offs are most successful. For the most innovative high tech spin-offs, these are the economic sectors industry (more in particular in high tech systems and materials as well as life sciences and health), rather closely following the specializations of the UT. The same applies for the ICT sector, which also yields a lot of spin-off companies, just as predicted by the literature on the subject. In other words: the specialization of the university provides by itself the business opportunities for entrepreneurial students/staff members. Agreeing with Shapero (1975) that entrepreneurship is coinciding with "moments of life displacement", such as leaving the university as a student/graduate or the end of a temporal employment contract at the end of a research project, it is important to show at exactly such moments the options of getting support for building a new venture, preferably based on newly developed knowledge.

It can be seen in the results of this study that the regional spin-off retention rate of spin-offs established in a semi-peripheral region such as Twente is high. This means that it is important to stimulate the establishment of companies in the region of the parent university in the first place. This is especially relevant for more innovative spin-offs which have a need for intensive knowledge relations with the parent university, in order to further develop their product (or service). Product based spin-offs appear to have a stronger need for such knowledge relations than service based spin-offs, therefore requiring most likely more support. There is of course no guarantee that spin-offs stay in the region: The results of this study show that especially fast growing and therefore iconic spin-off companies are likely to leave the region of origin, in search for a location in the large Dutch agglomerations. In the literature on this subject is concluded that those companies search for a site close to major markets and/or where human capital and venture capital can more easily be found. This should however not discourage policy makers from continuing to support the development of new businesses in such regions: evidence from the region Twente shows that on the longer term these policies have indeed helped to improve the regional economic situation. This is caused by the impact of the spin-off companies on the regional innovation system, which goes further than the direct economic impact of the number of workplaces within these spin-offs (Bercovitz & Feldman, 2006; Clayman & Holbrook, 2003; Hayter, 2013). Even when semi-peripheral regions like Twente are sometimes classified as "incubator regions", where entrepreneurs have good opportunities and support for starting a business and then, when the business

develops, are moving out to economic core regions, where the business could really grow further. The results of this study show that for both the UT and Saxion, this is only a limited phenomenon. Spin-offs of both universities are quite likely to stay in the region of origin. Data on migration shows that on average spin-offs move between regions in earlier years of their existence than that they move within regions. This is strong evidence to support the conclusions of Pellenbarg et al. (2005) that companies have different motives to move between regions (mainly business economic reasons) and within regions (mainly space and place related issues). In later stages of their existence, when growing to more mature stages, many spin-offs move to a different location within the same region, for example to a location with more space for expansion or to a better accessible location. For policy makers working on regional development strategies, this is also an important moment. If such companies cannot find suitable locations within their region of origin, they may also decide to leave the region altogether. And given the multiplier effect that these spin-off companies have on the regional innovation system, the out-migration of such companies has much more consequences for the innovation potential of the region than the loss of just 25-50 jobs in a single spin-off company. When looking at the differences between research university spin-offs and university of applied sciences spin-offs, for the former the geographical proximity to the parent university (knowledge spillovers) seems to be much more important than for the – usually – lower tech spin-offs of universities of applied sciences. In terms of supporting the development of university spin-offs, a strong focus on the research university spin-offs would lead to a strengthening of the regional innovation network, however, most of the economic and employment effects would be just felt in or around the city with the research university. For universities of applied sciences spin-offs, it can be assumed that their contribution to the regional innovation system would be on average lower, however, these spin-offs are much more spread out through the region, providing also economic impact in more rural communities. In terms of policy support, both type of spin-offs therefore have their own strong points.

6 Main conclusions and novel findings of the dissertation

As the final part of this study, I propose seven novel theses based on the research results. The theses here reflect the conclusions and recommendations following from the study, as written down in the previous subchapters. The first thesis I propose is about the geographical proximity and goes as follows:

1. *Geographical proximity to the parent university matters for spin-offs, however just for one specific type of spin-offs, namely the most innovative ones with codified intellectual property (Bazen, 2018b).*

The research results show that especially the most innovative spin-offs are located close to the university: the statistically significant regression model predicting the distance from the university based on the type of spin-off proves that university spin-offs are a very heterogeneous group of companies. It appears from the data and statistical analysis that the majority of less innovative spin-offs see a location close to the university as not especially necessary or beneficial for their business operations. This shows the importance of knowledge links of innovative spin-offs with their parent university. Apart from a few conceptual papers (See for example Bolzani et al., 2020; Pirnay et al., 2003), there are – to the knowledge of the author – no empirical studies available that focus on the diversity of university spin-offs and the corresponding differences in development and spatial pattern. Therefore, this study is providing a new framework of understanding why certain spin-off companies prefer to be located close to their parent university.

The second thesis is about the difference between research universities and universities of applied sciences:

2. *Spin-offs from research universities and universities of applied sciences spatially behave in a different way, with research university being more concentrated close to the university and university of applied sciences spin-offs more spread out among the region, also in the more rural areas (Bazen, 2020b, 2021).*

The independent t-test showed that the spin-offs of research universities and the spin-offs of universities of applied sciences are two significantly different groups of spin-offs. University spin-offs from research universities are – a bit exaggerated – either located near the parent university or located in the largest population centres within the country (consistent with the expected predictions based on the agglomeration effects). Spin-offs from an applied science university are more spread out through the region of the parent university, but on average don't feel that a location in close geographic proximity to such an institution is beneficial for them.

As third thesis, I would like to draw the attention to the effect of the regional entrepreneurial ecosystem on university spin-offs:

3. *The entrepreneurial ecosystem is of great importance for the appearance of university spin-offs. Regions with a stronger developed entrepreneurial ecosystem produce substantially more university spin-off companies (Bazen, 2020a; Bazen, 2020b).*

Unlike the university of Twente, Saxion university of applied sciences has campuses in two cities. There are large differences in numbers of spin-offs when comparing the region Twente, with the Enschede campus and the Cleantech region with the Deventer and Apeldoorn campuses. Even though the Deventer and Apeldoorn campuses together are half the size of the Enschede campus, the number of Saxion spin-offs in Twente is no less than four times higher than in the Cleantech Region. Since the university has a similar entrepreneurship support strategy in both campuses, the large difference must be caused by external factors, the regional entrepreneurial ecosystem. In Twente the regional entrepreneurial ecosystem is more developed, especially also because of the Novel-T support organization.

The fourth thesis I would like to propose is about the effect of support institutions on the development of spin-offs:

4. *Support organizations can significantly improve the regional entrepreneurial ecosystem and are therefore invaluable organizations in terms of innovative entrepreneurship support (Bazen, 2017; Petkovski, Fedajev, & Bazen, 2022).*

From the research results it becomes clear that entrepreneurship support organizations, in case of university spin-offs in the eastern Netherlands, mostly the Novel-T organization, play an important role in providing support with the start of new businesses and the translation of university knowledge to commercial products/services. As is seen in the previous thesis as well as the general research results of the second campus area of Saxion (in Deventer), missing such support organizations significantly decreases the birth and survival rates of spin-offs.

As fifth thesis I would like to formulate:

5. *In terms of regional development of semi-peripheral regions, it is more useful to focus entrepreneurship support on product-based spin-offs than on service-based spin-offs (Bazen, 2021).*

For spin-offs of both the UT and Saxion the research results show a clear tendency that product-based spin-offs (for example in the sector industry) have a larger chance to stay in the region of origin than service-based spin-offs (for example in ICT, health care or personal services). This can be explained by the stronger dependency on knowledge from the university at such spin-offs. For service-based spin-offs it is in most cases more profitable to be in places where large groups customers and potential workers are, than to be specifically at places where knowledge is generated.

The sixth thesis is about the general consequences for the economic safety and security of the region

6. *Supporting spin-off companies is useful for the economic development of regions, as it increases the absorptive capacity of the region for new innovative technologies (Bazen & Flooren, 2020).*

A strong focus on the research university spin-offs would lead to a strengthening of the regional innovation network, however, most of the economic and employment effects would be just felt in or around the city with the research university. For universities of applied sciences spin-offs, it can be assumed that their contribution to the regional innovation system would be on average lower (the independent sample t-test shows significant differences in development and economic impact between spin-offs from research universities and universities of applied sciences).These spin-offs however on the other hand are much more spread out through the region, providing also economic impact in more rural communities. In terms of policy support, both type of spin-offs therefore have their own strong points: Research university spin-offs in fostering innovation in the region and university of applied science spin-offs by spreading university knowledge over larger regions. All in all this means that spin-offs both in rural as well as in urban parts of the region actively support the further development of the absorptive capacity of the regional businesses for new innovative technologies and/or services.

7. *University spin-offs are game changers in terms of improving the regional economic structure, however the effect is only significant in the largest cities with the highest knowledge & resource links available (Bazen, 2018b; Bazen, 2020b, 2021).*

The evidence from this study shows that university spin-off companies are indeed game changers in regional economic development, although their direct economic effect in terms of number of workplaces is quite limited. Only in the city of Enschede, where both universities of this study are located, there is a significant direct economic influence of the spin-offs on the economy, around 5% of all jobs in the city are within university spin-offs, making these types of businesses a factor of major local importance. It can be assumed that the location of these spin-off businesses close to the parent university is an important location factor for them: it helps to provide human capital (young graduates) as well as relatively easy access to university knowledge and (if relevant) common research projects. In more rural parts of the region, the direct employment effects are much lower. What has not been measured and therefore one of the limitations of this study, are the indirect effects of the spin-off companies, in the sense of how those companies help to improve the production, logistic and/or sales technology for regional customers (usually SMEs). Measuring these indirect effects of spin-offs on the regional innovation system is subject for further study. But even without the indirect effects, based on just the direct effects, it can already be concluded that university spin-offs are a potential game changer for peripheral regions.

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List of publications related to the dissertation

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List of publications related to the dissertation

Books (5)

1. **Bazen, J. C.**: Measuring the effects of the Novel-T supported entrepreneurial ecosystem: University of Twente Spin-off monitor 2021. Saxion University of Applied Sciences, Enschede, 71 p., 2021.
2. **Bazen, J. C.**, Flooren, M.: Ondernemerschap bij Saxion studenten, alumni en medewerkers: Een onderzoek naar de economische impact van Saxion spin-offs op de regio. Hogeschool Saxion, lectoraat Regio Ontwikkeling, Uitgever, 33 p., 2020. ISBN: 9789462130302
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Journal of Tourism and Services. 5, 77-94, 2014. ISSN: 1804-5650.

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