Awti Adviesraad voor wetenschap, technologie en innovatie

Erasmus Centre for Entrepreneurship

KNOWLEDGE INTENSIVE START-UPS IN THE NETHERLANDS AND THE UNIVERSITIES' ENTREPRENEURIAL ECOSYSTEMS

The Advisory council for science, technology and innovation (AWTI) has commissioned this report as a background study for the AWTI advisory report *'Beter van start. De sleutel tot doorgroei van kennisintensieve start-ups'*. This background study has been carried out by the Erasmus Centre for Entrepreneurship and was finished in March 2020. This publication and AWTI's advisory report were published in October 2020 and may be found at www.awti.nl.

The Advisory council for science, technology and innovation (AWTI) advises the Dutch government and parliament on policy in the areas of scientific research, technological development and innovation. The AWTI provides advice when it is applied for or when the council deems it necessary. It enjoys an independent position towards the Ministers and their Departments, as well as towards other parties involved. The advisory council consists of a maximum of 10 members, each originating from different sectors of society, such as research institutes and trade and industry. The members do not represent any special interests.

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1. Introduction

This research is conducted by Erasmus Centre for Entrepreneurship on behalf of the Adviesraad voor Wetenschap, Technologie en Innovatie (AWTI). The AWTI was requested by the Dutch House of Representatives (Tweede Kamer) to provide an answer to three concerns about knowledge-intensive start-ups. The AWTI translated these into one main hypothesis and requested Erasmus Centre for Entrepreneurship to provide their input based on three research questions presented below. This first section introduces the context of the research, the approach employed and the structure of the research report.

1.1 Context

The Dutch economy is among the richest in the world. This has been the case since the seventeenth century. Yet, the Dutch economic landscape has undergone major changes throughout the centuries: from being the most prominent actor in worldwide trade to being a leader of agricultural sophistication; from the prevalence of large firms during the *managed* economy to the exploitation of the virtues of new and smaller firms during the *entrepreneurial* economy. The Dutch entrepreneurial ecosystem, by and large defined as the interplay between businesses, knowledge institutions and policy makers, has ever since always been in motion and contributed immensely to the success of its local economy, not in the least stimulated by creative and diverse entrepreneurship, world-class knowledge centres and clever policy-making. It is indeed not by chance that in 2018 the Netherlands ranked second, after Switzerland in the Global Innovation Index from WIPO.[1]

As the current technological landscape around the globe continues to develop and becomes more advanced, so do the entrepreneurial ecosystems surrounding and nurturing knowledge-intensive start-ups. The Dutch ecosystem is not an exception: it embeds dynamic and evolving entrepreneurial activities. However, there is widespread concern shared by the Dutch House of Representatives that Dutch knowledge-intensive start-ups, considered as one of the prominent actors in the national innovation ecosystem, experience difficulties in scaling up and rarely create new jobs. If that is true, policy-making has an opportunity to intervene to ensure that the Netherlands keeps evolving and stays the innovative and entrepreneurial ecosystem it has been for so many years.

The Dutch House of Representatives expressed the above-mentioned concerns through the official communication 789, 31 288 (Hoger Onderwijs-, Onderzoek- en Wetenschapsbeleid) of 31st of October 2019 to the AWTI. More specifically, they address the following three pressing questions:

[1] https://investinholland.com/news/the-netherlands-moves-up-to-no-2-on-global-innovation-index-2018/

- How can obstacles be removed so that more [knowledge-intensive] start-ups can grow into sustainable businesses that will create jobs?
- The Netherlands is known for its high number of academic start-ups, but they rarely seem to create jobs: is this due to any Dutch peculiarity?
- What measures can be taken to stimulate more growth [for knowledge-intensive start-ups], including in the labour market?

In order to provide a solid answer to the aforementioned questions, the AWTI is interested in research about how the Dutch government can create the optimal conditions that allow for the knowledge transfer and exchange (in the field of science, technology and innovation) between knowledge institutions and enterprises. As such, the focus of this study is on knowledge-intensive start-ups that have a formal or informal affiliation with a parent organisation, for example a knowledge-institution or the research and development (R&D) department of another company. The research is thus specifically designed to provide useful insights upon which the AWTI may base their recommendations and policy implications, i.e. to identify potential areas of improvement that could be affected by government intervention in the field of knowledge-intensive start-ups — in particular, around the creation and enhancement of the university-centred entrepreneurial ecosystem.

1.2 Methodology

The present research is centred around the hypothesis that *Dutch knowledge-intensive start-ups experience difficulties in scaling up and rarely create new jobs*. This hypothesis, advanced by AWTI and built on the concerns expressed in the House of Representatives' communication 789, 31 288 (Hoger Onderwijs-, Onderzoek- en Wetenschapsbeleid) of 31st of October 2019 to the AWTI, is investigated using the following research questions:

1. How are Dutch knowledge-intensive start-ups performing compared to Dutch start-ups in general in terms of their respective growth paths? Are there significant differences among the sectors in which such knowledge-intensive start-ups operate?

2. How are Dutch university-centred entrepreneurial ecosystems performing compared to the success factors highlighted by the research in the field? How is this affecting Dutch knowledge-intensive start-ups?

3. What can we learn from best practices of (university-centred) entrepreneurial ecosystems abroad?

To address the *first* research question, a quantitative analysis of Centraal Bureau voor Statistiek (CBS) data of Dutch knowledge-intensive start-ups is conducted in comparison to Dutch start-ups in general.[2] Since there is a scarcity of spinoff and spinout databases available for companies founded in the Netherlands, the sample of knowledge-intensive start-ups is limited to those found via desk research and direct contact (e.g. with knowledge institutions). This amounted to 460 firms in total, of which a proportion was analysed that had at least 2 employees in their founding year and declared their income and employment statistics over at least 5 consecutive years. From a dataset of enterprises founded in the Netherlands (hereafter referred to as regular Dutch start-ups) between 2005 and 2016, a comparative dataset (to that of knowledge-intensive start-ups) was thereby extracted to produce the subsequent analysis. All dominant contributors were removed from the final analysis to produce an accurate description of the performance of these start-ups, i.e. outliers that skewed the results were excluded from the analysis. In this analysis, the performance of Dutch companies is based specifically on their respective **employee** and **sales** growth paths.

The approach to answer the *second* research question is two-fold:

- **A literature review** is first conducted to identify the critical factors (success factors and bottlenecks) that exist in entrepreneurial ecosystems where a parent organisation, i.e. knowledge institution or another corporate, plays a central and leading role in the development of knowledge-intensive start-ups, i.e. UCEE (university-centred entrepreneurial ecosystem) and CCEE (corporate-centred entrepreneurial ecosystem);
- **Thirteen qualitative interviews** (on average one hour per interview)[3] are then conducted to investigate what role and impact these critical factors have on Dutch knowledge-intensive start-ups[4] and their respective entrepreneurial ecosystems.

Finally, to answer the *third* research question, a desk research of three relevant best practices outside the Netherlands, namely ETH Transfer (ETH Zürich, Switzerland), KTH Innovation (KTH Royal Institute of Technology, Sweden) and Yissum (The Hebrew University of Jerusalem, Israel), is conducted to extrapolate important learnings for the Dutch ecosystems.

[2] The data is presented by CBS as anonymous Dutch enterprises that are found within a specific year (excluding freelancers, i.e. ZZP'ers).

[3] See: 7.2. Profiles of interviewees.

[4] It is important to mention that this part of the research study mainly focuses on UCEEs as knowledge-institutions play an important role in both ecosystems and the university-centred entrepreneurial ecosystems are more directly influenced through policy making than their corporate-centred counterparts.

1.3 Structure of the report

The research paper is organised as follows. In Section 2 a literature review is provided that includes a conceptualisation of knowledge-intensive start-ups and their entrepreneurial ecosystems as well as a discussion of the critical factors influencing their success at the micro, meso and macro levels. Section 3 reveals the performance of Dutch knowledge-intensive start-ups based on a quantitative analysis. Using a qualitative analysis of interviews with relevant actors in the Dutch ecosystem as a foundation, Section 4 provides insights into the experience of knowledge-intensive start-ups in the Dutch entrepreneurial ecosystem. Section 5 discusses case studies of the Swedish, Swiss and Israeli university-centred entrepreneurial ecosystem best practices. Finally, Section 6 presents the conclusions that can be derived from this research. Appendices and references are provided at the end of this report.

2. Literature review

This section first provides a conceptualisation of knowledge-intensive start-ups and their entrepreneurial ecosystems. Then, the critical factors affecting the success of knowledge-intensive start-ups at the micro, meso and macro levels within their entrepreneurial ecosystems are revealed based on a discussion of extant literature.

2.1 Knowledge-intensive start-ups

Start-ups are often a manifestation of the intersection between knowledge spill-overs and entrepreneurial activities and this is widely acknowledged in the literature to be the key vehicle for introducing new innovations into the market (Agarwal, Audretsch, & Sarkar, 2007). Such effects are particularly evident in the case of knowledge-intensive start-ups, where the commercialisation of knowledge investments causes the spill-over of a piece of knowledge that could have otherwise remained dormant and unexplored in the organisation that created the knowledge in the very first place (Agarwal et al., 2007). Depending on whether knowledge-intensive start-ups originate within a knowledge institution or another enterprise, they present distinct characteristics and can be classified, respectively, as academic spinoffs (ASOs) or corporate spinouts (CSOs).

The present study focuses on Dutch knowledge-intensive start-ups and on the ecosystem in which they emerge and develop. Knowledge-intensive start-ups are herein defined as:

> Spinoffs and spinouts that are formed as a result of an investment in knowledge-intensive activities by existing organisations (a knowledge institution, e.g. university, for ASOs or another enterprise for CSOs) and that entertain a formal or an informal relationship with the parent organisation (Treibich, Konrad, & Truffer, 2013). Usually, these start-ups originate from the isolation of a particular research unit or project and its subsequent transformation into an independent company (Cirillo, Breschi, & Prencipe, 2018).

Knowledge-intensive start-ups can be further categorised into ASOs and CSOs, in which ASOs are defined as:[5]

[5] Not every new knowledge creation within a knowledge institution results necessarily in the initiation of a new venture. The commercialisation process in which scientific discoveries are converted into entrepreneurial opportunities happens through a technology transfer process of which academic entrepreneurship is only one effective channel (OECD, 2019). Indeed, technology transfer may occur through various channels such as publishing papers, licensing (of patents, for instance) to an established firm or through the creation of new firms based on the technology developed at the knowledge institute (Åstebro et al., 2012). Only the latter can be considered an academic spinoff.

"New companies established by the exploitation of a core technology or technology-based idea generated with or within a university, where the founding member(s) may or may not be affiliated to the academic institution." (Hossinger et al., 2019: p.2). New venture formation by faculty, staff or students who innovate in an academic or non-profit research context — and subsequently create a firm that directly exploits this knowledge — results in the initiation of an ASO (Agarwal & Shah, 2014). In the Netherlands, academic spinoffs include all start-ups affiliated to Dutch Universities, Medical Centres and institutes of NWO and KNAW (Technopolis, 2015).

On the other hand, a CSO is defined as:

A start-up that is established when a part of an existing company or (private) organisation, such as a department, business unit division or even a project team, becomes an independent business. The spinout company often takes personnel, assets, IP, technology and existing products from the parent organisation and the management team of the new company usually originates from the same parent organisation (Festel, 2013).

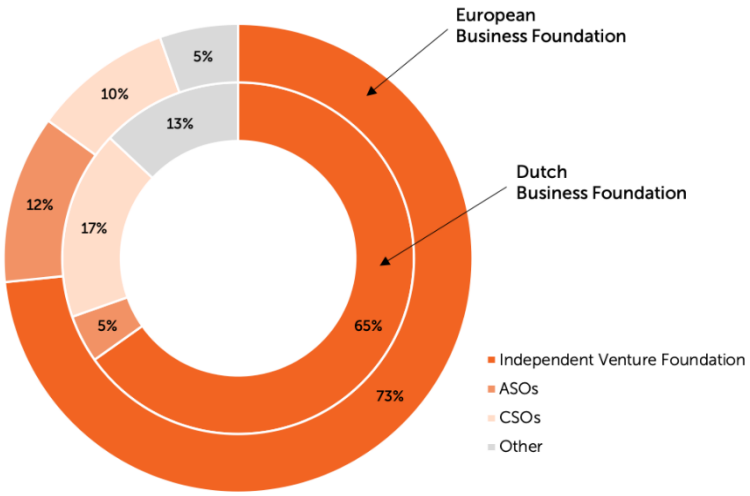

Figure 1: European Business Foundation vs. Dutch Business Foundation. Source: Erasmus Centre for Entrepreneurship.[6]

In Europe, start-ups generally originate from an independent venture foundation[7] and knowledge-intensive start-ups represent only a small group of the young companies that are

[6] Based on data from the European Startup Monitor (Kollman, Stöckman, Hensellek & Kensbock, 2017).
[7] Independent venture foundation in this case means that the founders of these startups consider that their ventures were formed independently from existing (knowledge) institutions or corporations.

created every year (see Figure *1*). Specifically, 21.2% of start-ups in Europe are spinoffs, of which 9.6% are a CSOs, while 11.6% are and ASOs (Kollmann et al., 2017). Quite comparably, the OECD (2019) estimates that ASOs represent around 15% of all start-ups within a technologically advanced country. The Netherlands has one of the highest shfares of CSOs (17.4%) in Europe, while only approximately 4.4% of start-ups in the country are spinoffs from a university or another research institution (Kollmann et al., 2017). Overall, it is clear that knowledge-intensive start-ups therefore represent a minority in the (European and Dutch) start-up landscape.

It is not clear why the Netherlands has such an uneven distribution of ASOs and CSOs compared to the European average. A potential explanation could derive from the fact that CSOs in the Netherlands seem to achieve more growth in terms of employment, turnover and profit development when compared to ASOs and independent start-ups (Braaksma & de Jong, 2005). However, there is no evidence connecting the performance of knowledge-intensive start-ups to the origin of their parent organisation or to the local Dutch ecosystem. Research shows in fact that both ASOs and CSOs produce similar benefits in the private sector for job creation and economic growth, with the only difference in the higher associated social costs of creating ASOs (Czarnitzki et al., 2014).

Moreover, literature has yet to reach consensus on whether knowledge intensive start-ups perform better or worse than their regular industry counterparts, simply because there is a lack of research about spinoffs' later stage development (Prokop, Huggins & Bristow, 2019). Such inconclusive evidence may be due to the fact that there are different values besides economic performance that are at stake. The definition of ASO success itself has yet to reach a consensus, resulting in the measurement of spinoff success to vary from researcher to researcher. Nevertheless, knowledge-intensive start-ups have demonstrated a relatively higher performance in terms of entry success rate (Agarwal et al., 2007) and value created for shareholders (Veld & Veld, 2004). Moreover, ASOs are often found to less likely fail, to perform better in terms of proof of concept research, patenting and receiving follow-on venture capital investment (Czarnitzki, Rammer & Toole, 2014) and to follow more successful exit strategies in terms of acquisition or going public (Agarwal & Shah, 2014). On the other hand, though, the evidence becomes conflicting when it comes to other indicators of performance such as sales or employment rate (Czarnitzki et al., 2014) with lower cash-flows and revenue growth. Some studies even demonstrate that most ASOs never outperform regular start-ups and that only a few are remarkably successful (Civera, Meoli & Vismara, 2019).

2.2 The Entrepreneurial Ecosystem of knowledge-intensive start-ups

Innovation does not take place in isolation but is rather the outcome of a thick web of knowledge exchanges within and across organisations, or entrepreneurial ecosystems, which provides the basis for start-ups to thrive (Cirillo et al., 2018). Entrepreneurial ecosystems can be defined as "combinations of social, political, economic, and cultural elements within a region that support the development and growth of innovative start-ups." (Johnson, Bock & George, 2019; p.3) and where connections are considered to have a deterministic function (Prokop, et al., 2019).

Knowledge-intensive start-ups emerge from a so-called "knowledge-context" in which the entrepreneur develops informational advantages that serve as the basis for the creation of a new firm. The knowledge context emerging from parent organisations provides entrepreneurs with critical technology, operations and market knowledge (Agarwal & Shah, 2014). Knowledge intensive start-ups thus exist within a specific entrepreneurial ecosystem that evolve based on the dynamic characteristics and interactions between and among individuals and institutions.

Just as all start-ups emerge and evolve within a distinct entrepreneurial ecosystem, so do knowledge-intensive start-ups. Their entrepreneurial ecosystems can be categorised into university-centred entrepreneurial ecosystems (UCEEs) and corporate-centred entrepreneurial ecosystems (CCEEs) as depicted in Figure *2* below. This categorisation stems from the fact that, on top of all the players and factors that regularly have a role within an ecosystem, particular influence is exerted by the parent organisation with which the knowledge-intensive start-up has a direct (formal or informal) relationship.

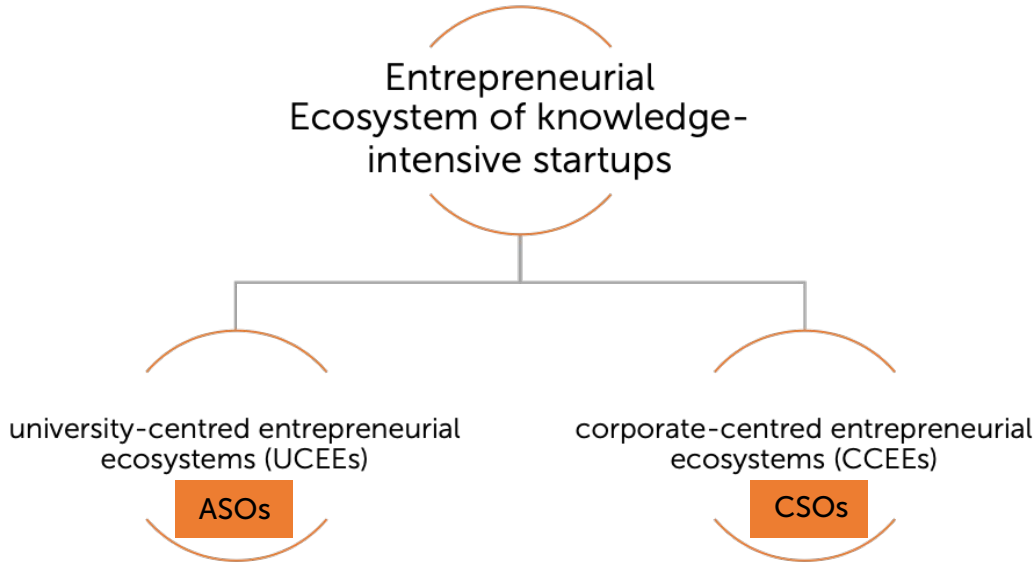

Figure 2: Entrepreneurial Ecosystems of knowledge-intensive start-ups. Source: Erasmus Centre for Entrepreneurship.

ASOs emerge from and develop within university-centred entrepreneurial ecosystems (UCEEs) consisting of a complex set of characteristics, e.g. **entrepreneurship culture, locational factors, availability of internal and external financial resources** (Hayter, Nelson, Zayed & O'Connor, 2018) that are typical of a built environment that affects start-ups' emergence and growth at the micro, meso and macro levels (Hossinger, Chen & Werner, 2019). Similarly, CSOs are embedded in CCEEs that revolve around a private organisation and are influenced by five key factors, namely (potential) entrepreneurs, private investors, large companies, universities and policy makers (Aaltonen, 2016). Knowledge institutions therefore play a central role in both cases by generating new ideas and technologies, supporting the entrepreneurial culture and fostering **network effects** (Civera et al., 2019). Studies on entrepreneurial ecosystems suggest that the development of knowledge-intensive start-ups is affected by comparable success factors in both UCEEs and CCEEs (Agarwal et al., 2007). Since the former are more responsive to policy-making and top down intervention (Johnson et al., 2019), the qualitative interviews (Section 4) and international best-practices (Section 5) part of this research focuses mostly on university-centred ecosystems while the literature review considers both ecosystems.

2.3 Critical factors for the success of knowledge-intensive start-ups

Within an entrepreneurial ecosystem, different factors at the micro, meso and macro levels exist that affect the successful development of knowledge-intensive start-ups. In particular:

- *Micro* level refers to all the characteristics that are specific to the start-up as a business unit and particularly, to its founding team;
- *Meso* level indicates how the parent organisation impacts the establishment and growth of the start-up;
- *Macro* level brings the perspective of the socio-economic context in which the venture takes place.

It is important to mention that all three levels are interdependent and that the outcome of a critical factor in a specific level often has repercussions on other factors in different levels. The following sub-sections describe different critical factors that exist at each level and their respective characteristics. These critical factors determine the development of knowledge-intensive start-ups and as such, can be considered as both success factors and/or bottlenecks depending on the perspective taken or lack thereof.

2.3.1 Micro level: the founding team

Start-ups are usually faced with severe resource constraints given their size and lack of market experience (Aaltonen, 2016), but knowledge-intensive firms are extremely resource-demanding as they typically either commercialise early stage inventions that existing companies have failed to commercialise or bring about innovations that are too radical in nature for existing companies to be interested in (Rasmussen & Borch, 2010). Knowledge-

intensive start-ups therefore normally compensate this at the micro level with a higher level of experience and expertise in their founding team (Agarwal & Shah, 2014).

Scientific orientation

The first critical factor at the micro level affecting the successful development of a knowledge-intensive start-up is its scientific orientation, defined here as the level of (high) quality scientific education and research experience of the founding team. As further discussed in the meso level, there is evidence that the quality of universities and research institutions is positively correlated with the success of spinoff companies (Festel, 2013) and therefore having high quality expertise produced by knowledge institutions is important to take into consideration. Scientific orientation is determined by:

- Science-based education: ASOs and CSOs mostly operate in science-based technology fields, such as biotechnology, science & engineering and healthcare (OECD, 2019). The better the scientific orientation of the founding team, the greater the absorptive capacity to assimilate new scientific knowledge and improve the final product (Wennberg et al., 2011);
- Prior research experience: Scientific expertise, such as research experience and annual publications before and after starting a firm (Heaton, Lewin & Teece, 2019), enable the further development of selected technologies and correlated services to bring about the successful formation of the start-up (Festel, 2013);
- Years of schooling and higher education: The general human capital of the founding team helps facilitate the integration and accumulation of new knowledge and provides founders with a higher societal position; therefore, the founding team is more likely to be exposed to entrepreneurial opportunities (Wennberg, Wiklund & Wright, 2011);

Market experience and knowledge

Another important factor at the micro-level is represented by the market experience and knowledge of the founding team, which is determined by:

- Prior industry experience: Founders' familiarity with the relevant industry in which their new ventures operate. In the Dutch context specifically, there is evidence that prior industry experience provides founders with more relevant product-related knowledge (Wennberg et al., 2011);
- Entrepreneurial skills: Not only are entrepreneurial skills necessary to successfully start up a business (Wennberg et al., 2011), but more importantly to manage it and operate it at a later stage (Civera et al., 2019). This is a particularly relevant for ASOs, as academics often lack the operational and market knowledge to take their innovations to the market on their own (Agarwal & Shah, 2014; Colombo & Piva,

2005). In particular, ASOs are found to be more successful when engaging with experienced entrepreneurs (Prokop, et al., 2019).

It is important to mention that the same critical factors stay valid for any new talent that is attracted to the company as an employee. Particularly in the Dutch context, Technopolis (2015) highlights the need for technical skills (i.e. bétatalent) and the associated financial problems with attracting such knowledge intensive talent from abroad. The importance of capturing value through alliances therefore comes into play and further information will be provided in the meso and macro level discussions.

2.3.2 Meso level: the parent organisation

Given the formal or informal link that is maintained by knowledge-intensive start-ups with their parent organisation, the wider context of the corporate or knowledge institution producing the spinoff/spinout company has a substantial influence on their establishment and success (Wennberg et al., 2011).

Direct and proactive support

The first success factor for a knowledge-intensive start-up at the meso level that is identified in the literature is represented by the direct and proactive support of the parent organisation. Most notably, the stronger the relationship with the parent organisation, the greater the chances that the start-up will be successful (Berchicci et al., 2011). More specifically, the following critical points are identified:

- Long-term relationship: Knowledge intensive start-ups that continue their interactions with their parent organisations beyond their creation phase often experience additional benefits such as mutual learning from a shared knowledge base (Treibich, et al., 2013). In particular, a long-term relationship with the TTO after the early stage of a spinoff's lifecycle is found to be positively correlated with their survival (Prokop, et al., 2019);
- An effective Technology Transfer Office (TTO): A dedicated TTO with effective commercialisation policies and a strong incentive system leads to successful technology transfer from academia to industry and more successful ASOs. This seems to be particularly true for larger parent organisations as knowledge spill-overs can occur more easily (Boh, De-Haan & Strom, 2016);
- Top-down support: A clear and articulated organisational strategy from the parent organisation towards start-ups positively impacts the success of ASOs and CSOs (Festel, 2013);
- Role models: Prior ASO successes of researchers perceived as close-by with a successful commercial path seem to also facilitate the initiation of new ASOs (Rasmussen & Borch, 2010).

Conflicting strategy and goals

The relationship between knowledge-intensive start-ups and their parent organisation is, however, not always optimal. A relation of dependence between knowledge-intensive start-ups and their parent organisation often emerges that might hinder their success rates (Treibich et al., 2013). In fact, ASOs especially find themselves experiencing conflicting strategy and goals with their parent organisation, which is identified as a critical factor for their successful development. Research often reports:

- A cultural divergence: Resistance in the university environment to commercialise research results due to concerns related to the role of academia in society and to the disparate incentive and rewarding systems between public and private research (Festel, 2013); Knowledge institutions tend indeed to value disinterested (i.e. non-commercial) research (Rasmussen & Borch, 2010);
- The need for separate paths: The challenge for new ventures is to decouple from the research setting and integrate into the commercial setting. This entails obtaining legitimacy at several levels within the parent organisation (e.g. with colleagues, departments and central management) as well as setting up ASOs as a business firm independent from the university, without losing important ties to the university resources (Rasmussen & Borch, 2010).
- Intellectual property (IP): Patenting and IP protection represent a potential solution of overcoming the conflicting goals of these organisation (Åstebro et al., 2012), but the ownership of IP has unfortunately become a sensitive issue. Even if there is evidence that the ownership of equity in spinoffs increases the potential upside gain and results in ASOs to be an attractive option to universities and research institutions (Festel, 2013), recent studies in the Netherlands show that university ownership of IP and time-consuming IP negotiations often hinders entrepreneurial incentives (Technopolis, 2015; de Block & Duijst, 2020).

Network and knowledge

Parent organisations affect the success of their spinoffs and spinouts also with their connection to external knowledge and actors. The third ecosystem's critical factor at the meso level is represented by the parent organisation's network and knowledge. This is particularly important as it was identified by Prokop, Huggins & Bristow (2019) in their empirical study of 870 UK ASOs as the most important ecosystem factor for the long-term survival of an academic spinoff.

The third ecosystem's critical factor at the meso level is represented by the parent organisation's network and knowledge. This is determined by:

- Technological and market know-how from parent organisation: Knowledge intensive start-ups usually inherit general technological, organisational and market-related knowledge from their parents, which is considered vital information that helps them identify opportunities and access markets (Civera et al., 2019). Especially in the

case of ASOs, the technological knowledge provided by the parent organisation is often novel, but far from a marketable product that can generate revenue streams in terms of sales (Wennberg et al., 2011). In other words, while the broad-based (technological) knowledge acts as a catalyst for the introduction of novel products, the lack of commercial and market expertise of universities represents a barrier for the following growth of ASOs.

- Incubation and acceleration programmes: Participating in such programmes offer knowledge-intensive start-ups an incubation period to develop their technology and business plan under the guidance of experienced coaches, thereby incrementally reducing the venture's market and technological risk (Boh, et al, 2016);
- Connection to external networks: The connection to external networks is particularly relevant for firms established through the commercialisation of (academic) research because they increase learning and knowledge as well as growth opportunities (Civera et al., 2019). In particular, knowledge spill-overs can more easily occur and therefore the technology transfer is more efficient (Boh et al., 2016);
- Functional ties with service intermediaries: Parent organisations often provide ties to technology service firms, accounting and financial service or law firms, as well as user communities (Aaltonen, 2016). This success factor seems to be particularly relevant for CSOs, as they can be more easily introduced to managers in supporting services, such as venture capitalists (Berchicci et al., 2011).

2.3.3 Macro level: the socio-economic environment

Finally, the socio-economic environment in which the venturing process takes place has also demonstrated to be important in determining the establishment and success of knowledge-intensive start-ups. Without a strong external entrepreneurial infrastructure to support the relevant institutions to foster the emergence of knowledge intensive start-ups, scientific discoveries cannot be successfully commercialised and novel ideas cannot be transferred to the industry.

Entrepreneurial infrastructure

The first critical factor at the macro level thus points to the (regional) entrepreneurial infrastructure surrounding knowledge-intensive start-ups (Muscio et al., 2016), which can be further broken down into:

- Entrepreneurial culture: Regional entrepreneurial services and facilities beyond those provided by universities (e.g. science parks, incubators, service providers) are helpful for the development of early-stage ASOs. Moreover, regional environments influence the strategies of universities and thus how they organise and manage their TTOs (Hayter et al., 2018);
- (Fertile) economic environment: A fertile economic environment is positively associated with knowledge-intensive activities and the spinoff process benefits more

from high regional levels of innovative performance in comparison to the activities of the parent university (Muscio et al., 2016);

- Access to finance: Those regions with more sources of venture capital are more likely to generate knowledge intensive start-ups (Muscio et al., 2016) and prior relations with venture capitalists is positively associated with ASO performance (Rasmussen & Borch, 2010). A lack of financing has been traced back to the micro level in which investors are often discouraged due to a lack of solid and well-rounded teams (EU, 2019):
    - ASOs seem to be specifically disadvantaged in the Netherlands as there is often a lack of funding from venture capitalists that are primarily focused on short-term profit maximisation. Some ASOs in the country are reluctant to seek venture capital due to unpaid debts from public funding institutions (Technopolis, 2015);
- External (international) networks: Relationships beyond the university level are more important than formal search and contact mechanisms (Rasmussen & Borch, 2010).

Industry influence

It is also argued that the industry within which knowledge-intensive start-ups operate matters (Muscio et al., 2016) and the literature provides ample evidence of the influence of industries in the establishment and success of knowledge-intensive start-ups:

- Industry funding: There is evidence that a higher proportion of industry funding is positively associated with ASO performance (Rasmussen & Borch, 2010);
- Industry partnerships: The importance of a complementary external environment has been confirmed in studies that show the success of drawing upon robust regional entrepreneurship ecosystems for the establishment of knowledge intensive start-ups. Such successful institutions develop and maintain industry partnerships that further strengthen their entrepreneurial culture (Boh et al., 2016);
- Industry composition: The knowledge base that academic entrepreneurs draw upon can often initiate changes that trigger the formation of new industries, since academics are often involved in creating novel technologies. However, this means that ASOs are also less likely to survive in more concentrated industries (Agarwal & Shah, 2014). Similarly, the success of CSOs is also dependent on extent to which there is space in the industry for such knowledge intensive ventures to develop. Industry structure is particularly valuable for CSOs pursuing more advanced technologies and novel markets (Berchicci et al., 2011);
- Industry lifecycle: Academic founded firms are more likely to occur in early stages of the industry lifecycle and often result in collaborative or complementary relationships with established firms. This means that the technologies commercialised through ASOs are often in early stages of the development cycle and the start-up environment permits subsequent development to take the technologies to the market. As such, ASOs are not only more likely to continue operations by

potentially going public, they also seem to pursue acquisition as a successful exit strategy (Agarwal & Shah, 2014).

2.4 Summary

It is clear from the literature review that there are several overlapping critical factors that exist at different levels of the entrepreneurial ecosystems affecting the development and success of knowledge intensive start-ups. Besides the critical factor related to the conflict between public and private incentives associated with ASOs specifically, ASOs and CSOs seem to share comparable success factors and bottlenecks within their respective ecosystems. The literature also highlights the importance of a balance between science and academia, technology and research. An overemphasis on research activities while neglecting commercial activities could hinder the development of knowledge intensive start-ups. At the same time, without a scientific orientation towards venture development, knowledge intensive start-ups risk their potential to provide valuable innovations to the market.

The table below summarises the critical factors[8] affecting ASOs and CSOs at each level in their respective entrepreneurial ecosystems:

Table 1: Critical Factors for Knowledge-Intensive Start-ups in Entrepreneurial Ecosystems

Levels in the Entrepreneurial Ecosystem	Critical factors	UCEE	CCEE
Micro: founding team	Scientific orientation	●	●
	Market experience and knowledge	●	●
Meso: parent organisation	Direct and proactive support	●	●
	Conflicting strategy and goals	●	o [9]
	Network and knowledge	●	●
Macro: external environment	Entrepreneurial infrastructure	●	●
	Industry influence	●	●

[8] Critical factor here represents both a success factor and bottleneck depending on the perspective taken. These are limited to those that are emphasised in the literature consulted.

[9] In the extensive literature that was reviewed, conflicting strategy and goals between a corporate and their spinouts was not covered as a critical factor. In contrast, there was an overwhelming emphasis in the relationship between ASOs and the knowledge institutes from which they spun off. This does not necessarily mean that there exists no conflict at all between CSOs and their parents, future research might further explore this relationship.

3. Dutch knowledge-intensive start-ups

This section assesses the performance of Dutch knowledge-intensive start-ups in order to provide a quantitative analysis of their relative performance compared to regular start-ups in the Netherlands. Their performance is analysed using data from CBS to gain a better understanding of their employment growth and sales patterns over time. A general overview of the growth path of Dutch knowledge-intensive start-ups is firstly provided, followed by a comparative analysis (with regular Dutch start-ups) of employment and sales growth.

3.1 Growth path of knowledge-intensive start-ups in the Netherlands

On average, knowledge-intensive start-ups in the Netherlands seem to already have around 8 employees after their first year of establishment (as depicted in Figure 3 below). Although these knowledge-intensive start-ups seem to experience a slow yet steady growth in employment until the end of their third year, the number of employees per knowledge-intensive start-up drops after five years back to the initial amount of employees that existed at the end of their first year. When it comes to sales, however, a different pattern emerges. The average amount of sales per knowledge-intensive start-up seems to be around €800,000 after their first year of establishment (see Figure 3), which only drops to around €600,000 after their second year, before reaching a steady growth path until the end of their fifth year that reaches an impressive €1,100,000 in average sales.

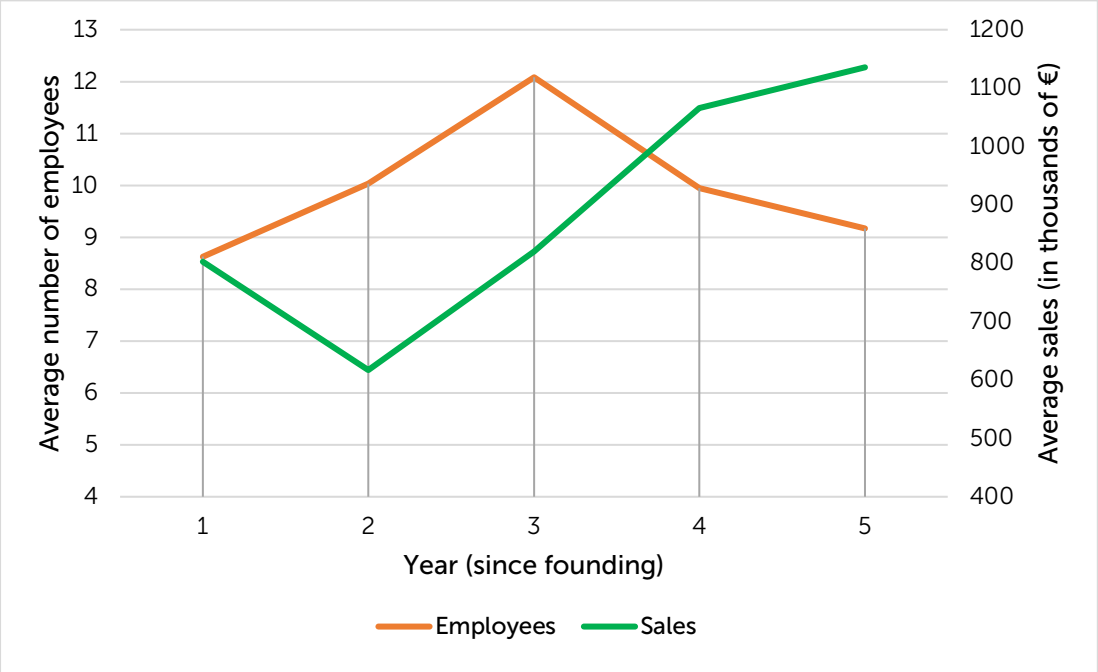

Figure 3: Employee and sales growth of knowledge-intensive start-ups

3.2 Employment

Performance in terms of employment is firstly analysed by considering sector-specific employment in Dutch knowledge-intensive start-ups and thereafter, their employment growth path in comparison to regular start-ups in the Netherlands.

3.2.1 Employment per sector[10]

The most prominent sectors (in terms of average number of employees) within which knowledge-intensive start-ups operate is depicted in Figure 4. Understandably, the "Professional, scientific and technical activities" sector stands out by having the highest average number of employees when compared to other sectors — due to the scientific orientation and technical nature of knowledge-intensive start-ups. The "Information and communication" and "Other service activities" are also sectors that perform better than average (across the depicted sectors, the overall average number of employees is 12).

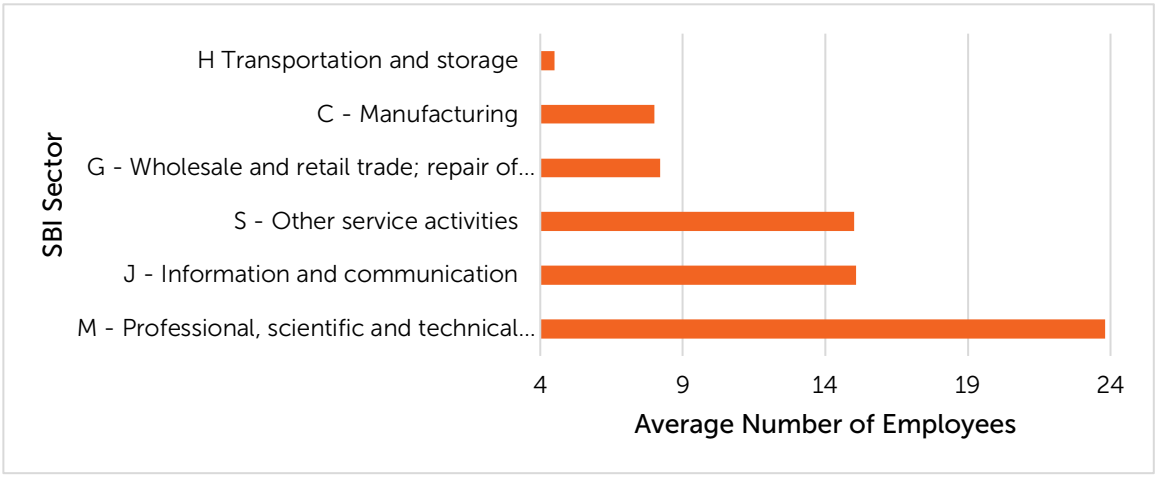

Figure 4: Average number of employees per knowledge intensive start-up, per sector in 2017

3.2.2 Employment growth

When considering employment in start-ups *at a specific point in time*, knowledge-intensive start-ups seem to outperform regular start-ups with a higher average number of employees from the first to the fifth year after founding (see Figure 5). The high number of employees could potentially be due to the fact that for ASOs especially, (multiple) professors and academics could be involved in the ventures. However, when taking into account the employment growth path *over time*, knowledge-intensive start-ups have difficulties

[10] These sectors represent the SBI (Standaard Bedrijfsindeling) 2008 classification. See https://www.cbs.nl/en-gb/our-services/methods/classifications/activiteiten/standard-industrial-classifications--dutch-sbi-2008-nace-and-isic--/the-structure-of-sbi-2008-version-2018 for more details.

maintaining the employee growth experienced in their second and third years. In contrast, regular start-ups, although starting with a lower average number of employees, are able to achieve a steady employment growth path over time and almost reach the same amount of employees as knowledge-intensive start-ups at the fifth year of founding. The employment growth in knowledge-intensive start-ups is therefore not as sustainable as in regular start-ups within the first five years of the ventures.

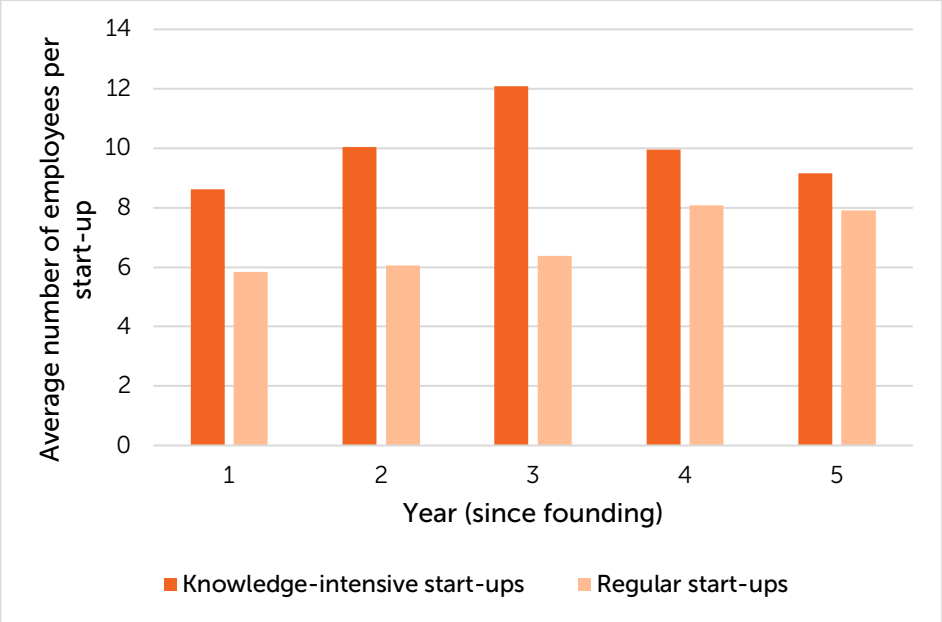

Figure 5: Employment growth over time

3.3 Sales

Similarly, performance in terms of sales is firstly analysed by considering sector-specific employment in Dutch knowledge-intensive start-ups and thereafter, their sales growth path in comparison to regular start-ups in the Netherlands.

3.3.1 Sales per sector[11]

As depicted in Figure 6, the average sales per sector is generally consistent with the most prominent sectors for average number of employees (see Figure 4) – with the exception of the "Other service activities" sector outperforming the "Information and communication" sector. Nevertheless, the same 3 sectors also dominate in average sales – with all 3 of these sectors yielding higher than average (€1,549,000) sales values. Again, the "Professional,

[11] These sectors represent the SBI (Standaard Bedrijfsindeling) 2008 classification. See https://www.cbs.nl/en-gb/our-services/methods/classifications/activiteiten/standard-industrial-classifications--dutch-sbi-2008-nace-and-isic--/the-structure-of-sbi-2008-version-2018 for more details.

scientific and technical activities" sector has the most outstanding performance when it comes to knowledge-intensive start-ups generating sales, on average.

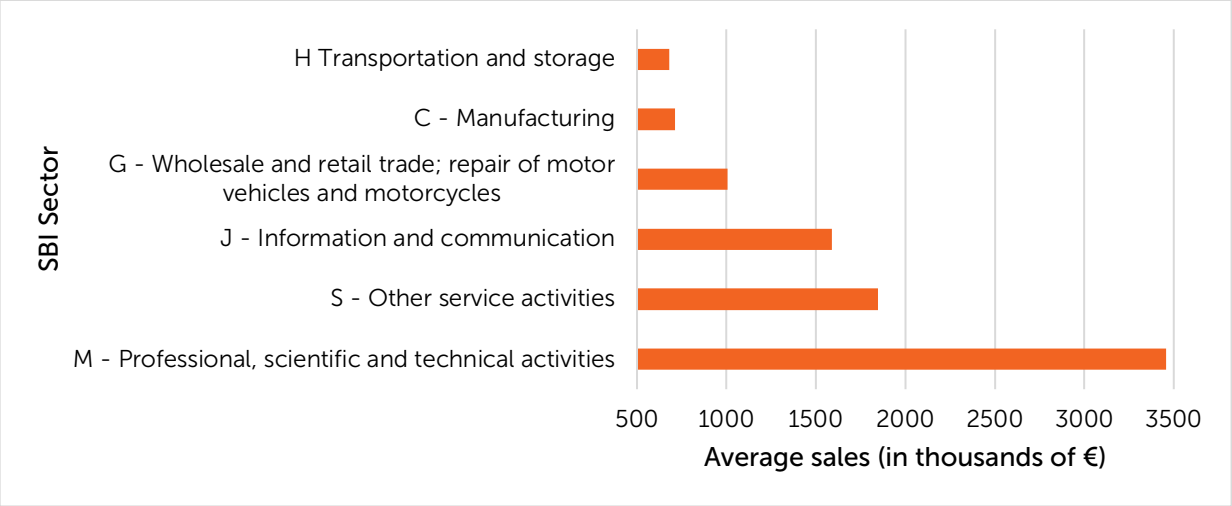

Figure 6: Average sales per knowledge-intensive start-up (in thousands of €), per sector in 2017

3.3.2 Sales growth

Comparatively, however, knowledge-intensive start-ups in general are struggling to reach the level of sales generated by regular start-ups as demonstrated in Figure 7. This could be explained by the costly nature of R&D and other knowledge-intensive activities required in the early years of spinoff and spinout ventures. Furthermore, the development phase of knowledge-intensive start-ups could take longer than regular start-ups to bring their more knowledge-intensive products to the market.

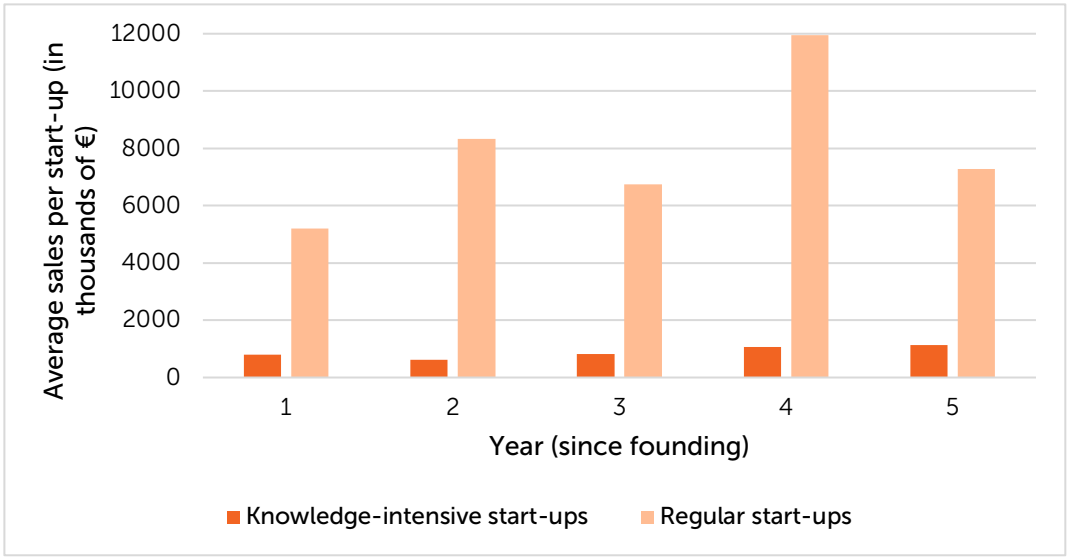

Figure 7: Sales growth over time

3.4 Summary and limitations

From the above analysis, it is clear that knowledge-intensive start-ups have a lower performance relative to regular start-ups in the Netherlands. This is based on both employment and sales indicators. The pattern of employment growth over time implies an unsustainable growth path for knowledge-intensive start-ups – albeit a higher average number of employees when compared to regular start-ups. The average sales generated by knowledge-intensive start-ups, although steadily growing over time, only represents a small fraction of those earned by regular start-ups. This investigation of the first research question, concerned with how Dutch knowledge-intensive start-ups are performing compared to Dutch start-ups in general in terms of their respective growth paths, therefore reveals that Dutch knowledge-intensive start-ups perform relatively worse when it comes to employment and sales indicators. From an international perspective (ESM, 2016), Dutch start-ups in general also seem to fall behind when it comes to creating jobs. Although European start-ups are considered job engines by creating 12 jobs on average, start-ups in the Netherlands only created 6 jobs on average in 2016 (Kollmann et al., 2017). Therefore, the hypothesis *Dutch knowledge-intensive start-ups experience difficulties in scaling up and rarely create new jobs* has already been partially validated.

The sample used to reach these results was acquired through desk research and direct contact with parent organisations (e.g. the TTO of a Dutch knowledge-institution) that provided a full list of their spinoffs or spinouts borne in a given timeframe. It is important to keep in mind that the sample is therefore not statistically representative of the whole population of Dutch ASOs and CSOs, but based on the limited information available. Unlike other countries[12], an official overview of knowledge-intensive start-ups is extremely difficult to retrieve in the Netherlands. In addition to that, when not missing, data is often incomplete or based on self-declaration, which makes the evidence-based conclusions less reliable. Since the Dutch government invests considerable effort in this area, keeping better track of data for future reference, so that it will be possible to make more evidence-based conclusions, is advisable. Furthermore, this study only considers sales and employee growth to measure the performance of knowledge-intensive start-ups against regular start-ups, due to data availability. Other variables outside of the scope of this research could be more relevant to analyse. Especially for knowledge-intensive start-ups that often serve a different purposes compared to regular star-ups, different performance indicators (such as funding-related variables, readiness of the technology and its impact factor) would be more applicable.

[12] When compared to countries such as the United Kingdom, that keep an online updated database where information is easily retrievable: http://www.spinoutsuk.co.uk/

4. Dutch University-Centred Entrepreneurial Ecosystems (UCEEs)

This section addresses the university-centred entrepreneurial ecosystems in the Netherlands by firstly providing an overview of the national context. Insights from the interviews are then discussed at the micro, meso and macro levels.

4.1 Entrepreneurial ecosystems

The entrepreneurial ecosystem of a certain area or region is the result of the combination of efforts of different actors, such as governmental and non-governmental organisations, the business community, universities and other knowledge institutions. In recent years, there has been an increase in entrepreneurial activities, driven by a considerable investment of universities in entrepreneurship education in the Netherlands as well as in the rest of Europe. Indeed, universities have been recently taking up a more pivotal role in entrepreneurship ecosystems as part of their "third mission", i.e. a set of long-term objectives that, next to education and research, prescribes them to diffuse knowledge and drive innovation to address societal and economic challenges (EUA, 2019). Knowledge transfer, licensing and spinoff activities are all examples of recent actions that universities undertake to fulfil their third mission. In this sense, the notion of the university-centred entrepreneurial ecosystem (UCEE) as described in the literature review is a recent phenomenon affected by a set of a specific top-down policies.

Since the modern university is no longer considered to be merely an institution of higher learning, knowledge institutions are increasingly becoming more involved in commercial spheres and thus can form the core of innovation ecosystems (Heaton et al., 2019). Dutch universities appear to have been active in recent years by making their ecosystems more entrepreneurial. Nowadays, Dutch UCEEs are considered to be generally successful (Technopolis, 2015) thanks to the historical record of top-quality research and education of the local knowledge institutions and to a strong public commitment to encourage university entrepreneurship to grow. Not surprisingly, the Dutch government ranks globally among the top institutions supporting ASOs and is even the number one backer of university spinoffs by exited capital (see Figure 8). This implies that, next to the multinational biopharmaceutical corporate giant Amgen, the Dutch government is the leader when it comes the value of ASO exits – which specifically amounted to $1.5bil in 2017 (Heles, 2018).

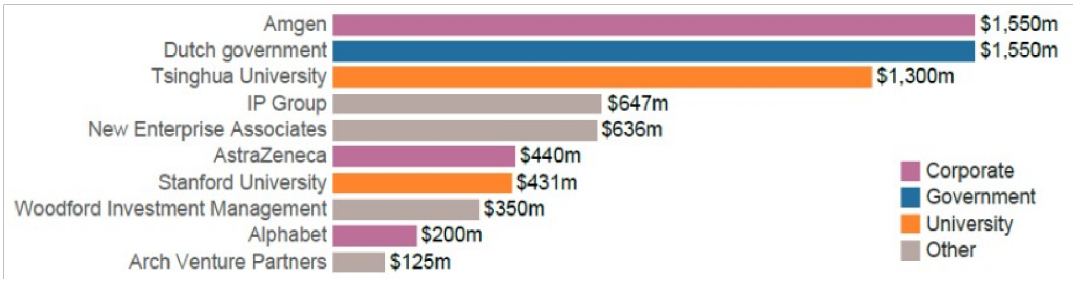

Figure 8: Top backers of university spinoffs by exited capital 2013-2017. Source: Global University Venturing (2018).

The European Commission recommends academic institutions to "communicate clear incentives for researchers who take part in knowledge transfer activities." As such, many member states have implemented laws to foster the establishment of knowledge-intensive start-ups (Civera et al., 2019). The Dutch Government has been particularly active in supporting entrepreneurship at the university level. It is not by chance, for instance, that in the Netherlands the number of university students interested in entrepreneurship and starting their own companies has been significantly growing in the last five to ten years. A study of 37 Universities of Applied Sciences across the Netherlands specifically showed that the amount of students seeking to gain ECTS in entrepreneurship increased from 50% to 64% in just two years (2010 to 2012) (OECD/EU, 2018). The first Dutch policy initiative to encourage the emergence of "technostarters" (i.e., knowledge-intensive start-ups) can be traced back to the 2004 Action Programme TechnoPartner, and to the Education and Enterprise Action Programme of the Ministry of Economic Affairs[13], which between 2007 and 2011 led to the establishment of six regional Centres of Entrepreneurship.

The Dutch Government also offers a wide portfolio of public programmes (financially) supporting university entrepreneurship to grow, such as Innovatiebox, WBSO, Innovatiekrediet and Valorisatieprogramma. At the same time, the government supports private initiatives with the same mission, such as NLevator, set up to connect different parties and regional ecosystems so that entrepreneurs can get faster and easier access to key resources, such as financing, coaching, training, partners, etc. (Technopolis, 2015). There are also initiatives such as the Academic Startup Competition[14] organised by the Dutch Association of the Netherlands (VSNU) and Techleap as well as programmes offered by Holland in the Valley[15] that specifically support Dutch academic spinoffs.

But how can we evaluate the performance of Dutch university-centred entrepreneurial ecosystems? And are there any success factors or bottlenecks that are more relevant to the Dutch context? The following subsections provide an overview of the impression gained from

[13] In Dutch: Actieprogramma Onderwijs en Ondernemen
[14] http://academicstartupcompetition.nl/ in 2020 the 2nd edition of the competition will take place.
[15] http://nlintheusa.com/hollandinthevalley/

thirteen interviewees[16] involved in the Dutch (university-centred) entrepreneurial ecosystem based on the same repartition used in the literature review across micro, meso and macro levels. Most of the hypotheses built upon the critical factors derived from the literature seem to be confirmed, with some peculiarities for the Dutch ecosystems.

4.2 Micro level: the founding team

All founding teams in the analysis reveal **a strong scientific orientation** with at least one member of the founding team with a strong research background (e.g. having a PhD or R&D experience), which is in line with the literature pointing to the importance of scientific expertise for successful spinoff/spinout activity. An interesting finding is that in some cases, members of the founding team leave while only one member stays to continue with the spinoff/spinout when the focus shifts towards the sustainability of the business plan. This is linked by several respondents to the lack of entrepreneurial and managerial skills in the initial founding team, which corresponds to findings from the literature demonstrating a lack of entrepreneurial and managerial competences (Colombo & Piva, 2005; Agarwal & Shah, 2014).

Successful ASOs have a combination of **strong market expertise and academic background.** This is not surprising given that research studies highlight the importance of complementary assets to transform innovative ideas into viable commercial products and services. Given the recognition that there is a lack of business expertise in the founding teams, several respondents show that an external CEO was brought in at the early stages, which is often without help from the knowledge institute (even though this is a service that some TTOs offer). Almost all respondents lament **a lack of entrepreneurial skills** when ASOs and CSOs are created or at least consider themselves or other members of the founding team not prepared enough in terms of business-related skills. Dutch universities appear to be aware of this and design specific activities to offer ASOs with more support in this regard[17]. However, more can arguably be done to stimulate researchers to develop the entrepreneurial skills necessary to start up a company — or at least to more easily find a co-founder with such a skillset.

Another general finding from the interviews is that the Dutch (university) ecosystem offers a fertile environment to experiment innovative technologies and source high quality talent, which contrasts with the research that reveals a lack of technical talent in the Netherlands (Technopolis, 2015). The impression was therefore that team expansion is not an issue faced by Dutch knowledge-intensive start-ups. However, founding teams still experience a lack of sufficient understanding of venture capital and struggle to find talent that have both the necessary market experience as well as the technical and scientific skills required to innovate.

[16] The sample of interviewees is composed of 9 ASOs, 1 CSOs and 3 TTOs (see 7.2. Profiles of interviewees in the Appendix).
[17] The TTO of Erasmus MC offers an entrepreneurship workshop to researchers and employees and other technical universities, such as TU Eindhoven and TU Delft, offer validation programmes via, Startup*EHV and Yes!Delft respectively.

For example, it is not always easy to find the right sales and marketing staff that are able to understand the complex technologies involved in the products.

4.3 Meso level: the parent organisation

4.3.1 Direct and proactive support

The quality of the relationship between knowledge-intensive start-ups and the TTO to which they belong is **extremely variable** in the Netherlands and depends on several micro factors. When asked to score the relationship between the knowledge intensive start-ups and the TTOs, the average falls at around 2.5 out of 5, with some respondents scoring it very high and some very low. The mixed results could possibly be related to the age of these start-ups, with the younger ones demonstrating that they feel well-supported while the ones that were established back when the TTOs existed for purely administrative reasons (with only one or two staff members) having more negative experiences. Regardless of the score, most start-ups seem to be more or less satisfied with such a relationship, i.e. even those who rank their cooperation with the TTO insufficient do not call for a stronger bond or support.

Such a strong oscillation in the results is in line with the literature that points to both the benefits that TTOs provide when facilitating the diffusion of technology from academia to industry as well as the problem that they tend to generally serve university policies instead of scaling their knowledge-intensive ventures. The interviews provide evidence that **support is provided when applying for seed funds and subsidies at the early stages** of their lifecycle in all cases considered. However, when reaching a level of maturity, there seems to be (from both the knowledge-intensive start-up and the parent organisation) **a desire of independence** and thus a lack of support at later stages of development. According to one respondent, in the Netherlands the purpose of a TTO is to "enable, foster, stimulate and provide people with the tool to make it easier to make that step towards impact" and to "back off" when the start-up is able to reach that impact on its own. Quite interestingly, the recent establishment of independent organisations (such as StartLife and Eindhoven Engine) that work together with the universities (in this case, respectively, WUR and TU/E), knowledge institutes and corporates seem to be 'filling the gap' with their more founder-centric approach to the clear benefit of knowledge intensive start-ups at different stages of development.

Although there is no clear evidence of direct and proactive support from parent organisations, one of the most helpful contributions from the parent organisation seems to be their **reputation.** The name and the branding of the parent organisation helps with the credibility of the technology behind the product, e.g. in investment negotiations. This benefit of reputation works both ways: not only can the connection with the knowledge institutes benefit the start-ups, the knowledge institutes also use spinoffs/outs as examples of the (technological) success of the projects originated within their own ecosystem. Nevertheless, some respondents also point that this reputation is not always beneficial when it comes to investors, who are wary to become involved with start-ups that specifically have universities or other public organisations

as a shareholder. Therefore, reputation in terms of the *technological* credibility that the parent organisations bring to the knowledge-intensive start-ups seems to work in their favour while at the same time harming their *commercial/investment-readiness* credibility.

4.3.2 Conflicting strategy and goals

As expected from the literature review, parent organisations tend to be more research-focused rather than have commercial interests to the benefit of their spinoffs/spinouts. It seems to be difficult to find a common ground between the knowledge intensive start-ups and their parent organisations, especially when commercial interests are at stake. Issues arise when the knowledge institution acts as a (majority) shareholder, even if the goal of the TTO is often to help establish ASOs until they can become independent from the university. This explains why one respondent particularly indicated a good relationship with their TTO but not with the university. Several knowledge-intensive start-ups experience shareholders[18] as a barrier to growth, with an extreme case in which one of the founders left their company as a result. A respondent that has both the spinoff perspective (by founding several spinoffs) as well as that of the parent organisation (by having a prominent role at the knowledge institute) explicitly mentioned that the when the university owns a big proportion of shares, it affects the freedom to operate and attract new investors. In this sense, the university was argued to have a "different heartbeat" that is slower than that of entrepreneurs and therefore the interest is not in funding and growth, but rather in negotiating power as a majority shareholder. This conflict arises both when the shareholders are parent organisations as well as when they are external parties, such as big corporates.

A central theme that emerged from the interviews is (the protection of) IP. A clear and transparent agreement on IP is a crucial factor for the development of the start-up, as expected from the literature[19]. The IP either stays with the knowledge institution and licensed to the spinoff/spinout or is owned by the company (that dedicates time and resources to the application independently). [20] In some cases, applying for an IP is considered very advantageous (e.g. to protect inventions) while not so much in others (e.g. when the technology risks being exposed to competitors in a publicised patent application). In those cases, in which the IP is not owned by the knowledge institute, the spinoffs/spinouts seem to experience no conflicting goals with their parent organisations.

[18] This refers to the behaviour of shareholders in general and is not limited to the parent organisation but could also be an external funder (e.g. big corporate).
[19] Dutch universities have different policies in this regard. For instance, TU Delft sometimes takes shares in their spinoffs, University Twente never does and TU Eindhoven asks students, at the beginning of their studies, to sign a declaration where they take distance from intellectual property developed through their studying career (de Block & Duijst, 2020).
[20] It is important to mention that applying for IP is judged as an expensive and time-consuming activity and that ownership is mostly taken up by the organisation that carries these costs.

4.3.3 Network and knowledge

The interviews revealed mixed opinions regarding the benefits from the network of the parent organisations. Since cooperation exists across knowledge institutions in the Netherlands, respondents recognised that having connections to such a network helped attract good quality talent to help expand their founding teams. Indeed, the importance of TTOs collaborating with big corporates is highlighted as an important channel to provide connections to customers, suppliers and investors, which is emphasised in the literature. This is, for instance, exemplified by the cooperation between TU/E and corporates such as Philips, ASML and KPN for joint research programmes as well cooperation with other robotics and high-tech manufacturers in the Brainport region.

However, when it comes to finding investors and partners, the knowledge intensive start-ups seem to primarily rely on their own (shareholder, CEO or independent) networks. This could be linked to the fact that several TTOs emphasise a focus on offering services at the early (pre-seed) stages, e.g. supporting the application to public subsidies. As such, several knowledge intensive start-ups experience difficulties when looking for a second round of funding — especially when the seed funding comes from a university in exchange for a significant proportion of shares in the company.

There is no clear evidence that the knowledge of the parent organisation is beneficial for the establishment of knowledge intensive start-ups, contrary to what the literature suggests. Often PhD candidates and professors from founding teams share research findings on an informal basis, rather than to the benefit of the ASOs and only in one case was a professor formally permitted to work for both the parent organisation and their start-ups. Only a few respondents took part in incubation or acceleration programmes offered by their knowledge institutions. Nevertheless, such programmes are unanimously considered helpful given the lack of entrepreneurial and business expertise present at the early stages of the start-ups. Overall, access to knowledge from parent organisations does not seem to play an important role for (the establishment and success of) knowledge intensive start-ups.

4.4 Macro level: the socio-economic environment

The Dutch ecosystem is often compared to that of the United States with the latter being more abundant in venture capital. It has been noted by many of the respondents that one large sum of investment is more important than many small ones. From the perspective of the knowledge intensive start-ups, it is confirmed that it is not the lack of funds that is the issue but rather the way it is distributed. The former may be the cause of the relatively weaker performance in sales and employment growth compared to regular start-ups (as revealed in the previous section) together with a more conservative, risk-averse mentality of the founding team.

The overall impression from the interviews is that the Dutch (university-centred) entrepreneurial culture is **risk-adverse**, especially for people with more years of experience and there seem to be no role model specific to the knowledge-intensive start-ups field yet. Nevertheless, there is evidence that there is an **encouraging entrepreneurial spirit** throughout the Netherlands (from the agri-tech Wageningen to the Brainport region), which provides the sufficient infrastructure for start-ups to flourish. The challenge, however, comes when knowledge intensive start-ups are ready to scale. Exit via acquisition and IPO are considered as likely outcomes for knowledge intensive start-ups when their product or service has been successfully integrated into the market and thus ready to scale, but reaching that level in a sustainable way is often seen as the real challenge. It has been highlighted by many respondents that the market potential is just as important as the scientific quality of the technology (or even more so).

Unfortunately, the **(conservative) funding structure** [21] of the Netherlands seems to be hindering this type of growth, which in turn results in knowledge intensive start-ups to expand abroad and benefit international economies instead. A case in point is Harbour Biomed[22], a (now global) biopharmaceutical company that initially spun off from a core technology developed at Erasmus MC, which was funded by and then sold to a group of Chinese investors and eventually relocated to Shanghai. On top of this, it was highlighted that there is a lack of 'giving back' from the perspective of the parent organisations. The current culture is argued to consist of a unidirectional support provided by knowledge institutes while knowledge-intensive start-ups that have become successful do not find the need to contribute to further the development of their parent organisations.

TTOs and knowledge intensive start-ups operating in different industries seem to have different experiences. The healthcare sector or the start-ups operating in Artificial Intelligence specifically seem to value the protection of the knowledge developed by the start-ups. The IP involved is thus often still owned by the parent organisation and only transferred to the start-ups via licensing agreements[23]. Knowledge intensive start-ups in healthcare therefore seem to be relatively more dependent on their parent organisations when compared to other sectors that are less sensitive to IP issues.

4.5 Summary and limitations

The dynamics of the entrepreneurial ecosystem in the Netherlands seem to be relatively accommodating for Dutch knowledge-intensive start-ups. At the micro level, the characteristics of knowledge-intensive start-ups' founding teams is in line with the literature pointing to a strong scientific orientation as well as the importance of market expertise. When

[21] The impression from the interviews is that the Dutch funding structure is conservative in the sense that funding institutions seem to be more risk adverse when it comes to providing finance to start-ups.
[22] http://www.harbourbiomed.com/en/aboutus.htm l ; https://www.innovationquarter.nl/en/harbour-biomed-and-rotterdam-strengthen-ties-during-shanghai-rotterdam-sister-city-anniversary/

it comes to the meso level, it is clear that there is no straightforward relationship between parent organisations and their knowledge-intensive start-ups. Although the Dutch government has dedicated resources to the development of their UCEEs, there is still room for growth especially after the initial stages of the spinoff's lifecycle. This is implied by the insights drawn from the interviews indicating that there is a lack of financial support at the macro level for knowledge-intensive start-ups that are aiming to scale up. Compared to other European countries, it therefore makes sense that the Netherlands falls a bit behind when it comes to raising external capital. Overall, 68.1% of start-ups in Europe have already received external capital while this only applied to 57.7% of Dutch start-ups in 2016. The conservative Dutch funding structure was also reinforced in the same study (ESM, 2016) demonstrating the Netherlands as the third highest European country with venture *debt* as a main source of financing[24] (Kollmann et al., 2017).

The qualitative part of this study also presents its limitations. As already explained, this study focuses mostly on the UCEE and therefore mostly ASOs were selected as interviewees. It is enough to provide a general impression of the Dutch UCEEs (and partially CCEEs) – see Table 2 below for the overall impression gained from the interviews (with green indicating a positive image, red a negative image and orange, a mixed image). However, for more accurate conclusions, a more balanced interview sample could have been acquired. Indeed, even though the selected interviewees still represent a diverse sample (see Appendix 7.2), in the future it would be advisable to broaden to spectrum to more CSOs and to conduct specific analyses per entrepreneurial ecosystem to dive deeper into the peculiarities of each UCEE and CCEE.

Table 2: Critical Factors for Knowledge-Intensive Start-ups in Dutch Entrepreneurial Ecosystems

Levels in the Entrepreneurial Ecosystem	Critical factors	Dutch Knowledge-Intensive start-ups
Micro: founding team	Scientific orientation Market experience and knowledge	
Meso: parent organisation	Direct and proactive support Conflicting strategy and goals Network and knowledge	
Macro: external environment	Entrepreneurial infrastructure Industry influence	

[24] The other categories for sources of financing are as follows: Savings of founders, Family and friends, Government subsidies, Business angel, Internal financing, Venture capital, Incubator/company builder/accelerator, Bank loans, Crowdfunding/crowdinvesting.

5. Best practices

This section considers several best practices outside of the Netherlands. A brief discussion of best practices abroad is firstly provided. Thereafter, relevant case studies from Swiss, Swedish and Israeli University-Centred Entrepreneurial Ecosystems (UCEEs) are discussed in more detail.

5.1 UCEEs: best practices from abroad

Despite representing a successful case in Europe and abroad, the Dutch UCEEs are limited in their performance and have room for improvement – as revealed in the previous sections. If the Dutch Government aims to continue pursuing the objective of encouraging innovation and technological advancement by means of university entrepreneurship, the lessons of best practices from the countries that are leading in terms of knowledge-intensive start-up performance may therefore offer inspiration and guidance in realising this.

Three examples of successful UCEEs from Switzerland, Sweden and Israel are analysed in more depth in the following sections. Such countries were chosen not only because are they leading examples in the world in the production of successful academic spinoffs, but also because they are comparable with the Netherlands in terms of size and level of socio-economic development. In particular, the Swiss entrepreneurial ecosystem in general is a great example to learn from: 41% of Swiss start-ups yearly collect more than €500,000 in revenue, while only 15.4% of Dutch start-ups fall into this category. Switzerland also has the highest share of university spin-offs (18.1%) in Europe (ESM, 2016). The Swedish ecosystem is considered as a best practice as well since not only does it have a higher job creation rate than the EU average start-ups (European Commission, 2018), it also leads globally in terms of its R&D investments that constitute more than 3% of the country's GDP. This exceeds the R&D expenditure of comparable countries as well as other big players such as the United States (Sweden.se, 2018). Finally, Israel's ecosystem is also interesting to consider since it built a strong reputation as one of the leading countries in producing successful (high-tech) start-ups (Barnea, 2018). The country has also been cited as a best practice for promoting entrepreneurial thinking and acting (ESM, 2016).

It is important to keep in mind that there notably exists other countries representing best-practices for university entrepreneurship and provide ASOs with a conducive ecosystem to flourish, but are excluded for the sake of comparison. For instance, universities in the United States dominate the number of spinoff deals and make up half of the Top 10 universities for spinout capital raised (Global University Venturing, 2018). This is not surprising given the overall consensus of the interview respondents revealing a preference for the less risk adverse venture capital structure in the US. The other half of the Top 10 universities are from the United Kingdom, with the University of Cambridge topping the list of capital raised (from 2013-2017) by their ASOs (Global University Venturing, 2018). Arguably, the largest TTO in Europe is Isis

Innovation (University of Oxford's wholly-owned subsidiary) with "a strong track record in creating spin-outs with staying power. (...) The most common method for commercialising research is through licensing patents to existing businesses, says Andrea Alunni, seed investment manager at the company – and Isis Innovation currently manages a portfolio of 1,500 patents" (Thomas, 2014). South Korea is another noteworthy global player in terms of having universities with high impact on fostering innovation and serving the needs of industry. This is exemplified by the fact that half of the Top 10 universities based on the "Industry, Innovation and Infrastructure SDG" category are South Korean universities (Times Higher Education, 2019).

5.2 ETH Transfer — ETH Zürich (Switzerland)

The Swiss Federal Institute of Technology (ETH Zürich) is Switzerland's highest-ranked university as well as the only non-UK European university to rank within the global top ten and a well-established leader in scientific and technical fields.[25] Since the 1990s, ETH Zürich has been supporting the foundation of companies based on its research achievements, with the aim to turn research results into marketable products and to create qualified jobs. ETH Zürich supports the incorporation of spinoff companies based on the translation of research results into products. 437 spinoffs have been founded at ETH Zürich since 1996 (ETH Zürich, 2020). See Figure 9 for an overview of the growth in spinoff companies founded at ETH Zürich over the past decade.

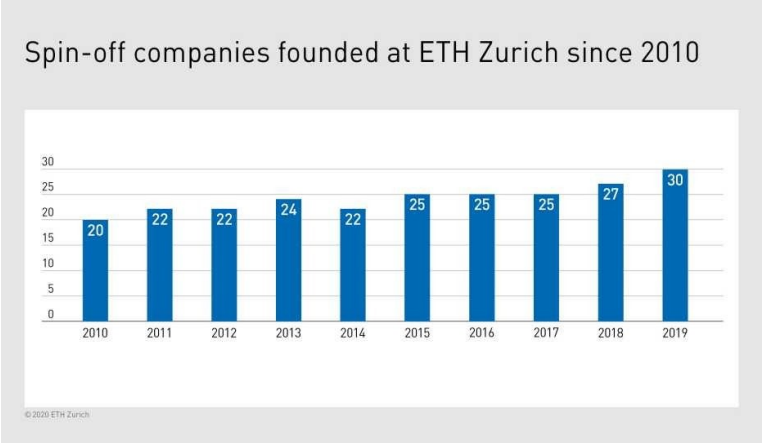

Figure 9: Growth in spinoff companies founded at ETH Zürich. Source: ETH Zürich (2020).

The extensive entrepreneurial ecosystem, depicted in Figure 10, brings together the relevant entities, associated groups and student organisations at ETH Zürich. In this way, ETH Zürich clearly leverages the critical factors found at all levels in the entrepreneurial ecosystem, from micro to meso. Not only is there an emphasis in the early stage to provide entrepreneurial skills and incentives in the ecosystem (such as via focus projects or ETH Entrepreneurial Club), there

[25] Based on QS World University Rankings 2019: https://www.topuniversities.com/university-rankings/world-university-rankings/2019

are also links with the external environment including (international) institutional support from the European Union (such as via the European Institute of Innovation & Technology and the ESA business incubation centre).

Figure 10: Entrepreneurship Ecosystem at ETH Zürich: From Idea to Market. Source: ETH Zürich (2020).

This extensive support (as depicted above in Figure 10) could also explain why the spinoffs produced by ETH seem to be relatively more successful, with the five year survival rate of ETH spinoffs (2003-2007) reaching 92% compared to 50% for Swiss start-ups in general and with each spinoff creating twenty new jobs on average (ETH transfer, 2015). A potential explanation for the success of ETH spinoffs could also be the direct and proactive support of the parent organisation, as revealed in the literature review as a critical factor for the development of knowledge intensive start-ups. However, it seems like ETH provides direct and proactive support only up to three years after the establishment of the ASO[26], probably with the intention to prevent the risks associated with conflicting goals and strategy at a later stage of the spinoff's lifecycle. Indeed, ETH Zürich has a detailed policy on division of tasks, role and ownership of the intellectual property used by the spinoff company[27], especially when university staff and PhD candidates are employed at both the university and the academic spinoff. However, it remains unclear whether some type of "softer" or informal support is still provided after the first 3 years.

The ETH transfer was appointed as a specialised group to support the commercialisation of research results and technologies from ETH Zürich, which includes supporting spinoff creation among other activities (ETH transfer, 2015). They offer ETH Advice to prospective founders and award the 'ETH spinoff' label to start-ups providing innovative solutions for relevant problems by applying state-of-the-art research and technology. Detlef Günther, Vice President Research and Corporate relations, mentions that the "prospects for starting a company at ETH

[26] For the resources, check: https://ethz.ch/content/dam/ethz/main/industry-and-society/entrepreneurship/ETH-spin-offs/dokumente/spin-off_guidelines_2019_EN.pdf
[27] See note above

Zürich are excellent, as a central concern of the university is to bring innovations to society swiftly." (ETH Zürich, 2020). ETH Transfer supports young entrepreneurs in the early stage of founding their own companies. ETH Transfer coordinates various support programmes, such as:

- ETH Pioneer Fellowships: awarded to one or two individuals intending to independently develop a highly innovative product or service to be exploited commercially and/or for the benefit of society. Pioneer Fellows receive 150k CHF over 12-18 months along with an extensive mentoring and training programme;
- ieLab: as ETH's deep science accelerator, the Innovation & Entrepreneurship Lab encourages and challenge bright, talented entrepreneurs and support them along their path to success creating their own start-up.

5.3 KTH Innovation - KTH Royal Institute of Technology (Sweden)

KTH is the largest technical university in Sweden and represents a third of all Swedish technical research and engineering education at university level. KTH has an outstanding number of spinoffs, which translates into a higher ratio of spinoffs produced per SEK invested in research at the university when compared to MIT, Stanford or Cambridge. The number of patents per SEK invested in research at KTH is comparable to other top-level universities globally (KTH Innovation, 2015). In 2017, the university established KTH Innovation as a centre to support students, researchers or employees at KTH with developing tech-based start-ups or commercialising their research results. They offer a diverse range of programmes to those with ideas at different stages of development, examples are:

- The Bicky Chakraborty Entrepreneur Program: involving four full-day training and education sessions over a period of nine months. Accepted projects into one of their programmes (even comes with 70 000 SEK proof-of-concept funding);
- KTH Innovation pre-incubator programme: 12-month support for early-stage, tech-based KTH projects with the potential of becoming viable companies. Over 70% of the 159 projects so far accepted to the programme have been considered successful at exit (KTH Innovation, 2019);
- Test Drive Deeptech: helps researchers find a working business model and develop the necessary tools to bring their research to the market;
- KTH Innovation Brighter Program: an immersion, inspiration and internationalisation programme, aimed for early stage start-up projects or research commercialization projects that have the potential of reaching a global market.

All programmes offered are free of charge (besides the travel costs involved with the KTH Innovation Brighter Program) and KTH Innovation explicitly mentions under the costs of each programme that they "take no ownership" of ideas. This alleviates the conflict that arrives at the meso level between knowledge intensive start-ups and their parent organisations as revealed in both the literature review and the interview findings.

The inaugural Times Higher Education (THE) University Impact Rankings for 2019 placed KTH Royal Institute of Technology at third place (after Yonsei University, Seoul and the University of Tokyo) for the "Industry, Innovation and Infrastructure SDG" category. This ranking focuses on universities' role of fostering innovation and serving the needs of industry. It explores institutions' research on industry and innovation, their number of patents and spinoff companies and their research income from industry. Despite the relatively younger age of KTH Innovation, the university was able to achieve such a high ranking. As revealed in the literature, direct and proactive support forms a critical factor for the development and success of knowledge intensive start-ups. Therefore, the optimal performance of KTH in this category could possibly be attributed to the extensive support that KTH offers at various stages of development. The KTH Innovation Panel, a unique web-based market research tool, is an example of support that KTH provides to entrepreneurs at a very early stage of development. This panel provides a way for potential clients, users and other stakeholders to share crucial feedback at the early stages. By sharing their knowledge and experience, the panel plays an important part in determining how ideas are developed, which applications are worth investing in and whether it is worth pursuing some ideas by creating a spinoff company (KTH Innovation, 2018).

5.4 Yissum - The Hebrew University of Jerusalem

The Hebrew University of Jerusalem (HUJI) has Israel's largest TTO in terms of industry output and diversity (Leichman, 2018). Since its inception in 1964 and being the third private company dedicated to technology transfer of its kind ever created, Yissum has created a rich tradition of innovation and commercialisation. It has registered more than 10,750 patents (that cover more than 3,030 inventions), licensed more than 1,050 technologies and produced more than 170 spinoff companies so far. Within its expansive ecosystem, Yissum offers access to entrepreneurial support for researchers from a variety of faculties with their (early stage) ideas. A few examples are: [28]

[28] These examples are retrieved from: http://www.yissum.co.il/overview

- Spark HUJI: a biotechnology accelerator focussed on personalised medicine, digital health, drug repurposing, and drug reformulations. In partnership with the Hebrew University Faculty of Medicine, it aims to increase the chances of project commercialization through a global mentorship program, and by leveraging a unique partnership between university and industry experts to create successful product concepts and business models.
- HUGROW: an acceleration track of HUstart supporting the development of ground-breaking early stage food, agricultural and environmental research into valuable technological innovations with significant commercial potential. HUGROW prepares entrepreneurs with the necessary material to seek investments for their early stage innovations.
- Labs/02: a Jerusalem based value-added incubator committed to investing in early stage start-ups in the AI, computer vision, deep learning, autonomic transportation and smart city sectors is backed by OurCrowd, Motorola Solutions, Reliance Industries, Israel Innovation Authority, and Yissum.
- BioDesign: a HU medical innovation accelerator is a partnership between Yissum, the Grass Center for Bioengineering, the Jerusalem School of Business Administration and the Hadassah Medical Center. The programme creates multidisciplinary groups of medical, engineering and business fellows, providing clinical immersion, market analysis, intellectual property support, prototyping and business plan backing with the intent of guiding the groups to bring medical innovation to the market. BioDesign has launched 7 spinoffs since its inception in 2013, raising over $3 million in investment.

Furthermore, Yissum proactively supports their spinoffs with the establishment of three venture funds:[29]

- Integra Holdings: a unique holding company founded in 2012 that exclusively focuses on a selection of Yissum biotech technologies including therapeutics. Medical devices and diagnostics with propriety solutions and a competitive advantage in their respective fields. Integra Holdings' portfolio is comprised of companies operating in the fields of cancer therapy, Alzheimer's disease, infectious diseases, inflammatory diseases and bipolar disorder.
- Agrinnovation: founded in 2015 as an investment partnership focused on nurturing agricultural inventions originating from the HU's Robert H. Smith Faculty of Agriculture Food and Environment. The partnership focuses on technologies, plant protection, animal sciences, as well as veterinary and food technologies.
- Racah Nanotech Fund: launched in 2018 to serve as an investment vehicle for HU technologies that are focused on advanced materials and nanotechnology. The fund considers technologies related to integrated solutions using performance materials such as 3D printing, quantum materials, and solar cells.

[29] http://www.yissum.co.il/Venture-Funds

The network and knowledge of the parent organisation the meso level, as demonstrated in the literature review, therefore proves helpful in establishing a conducive environment for knowledge intensive start-ups in various types of sectors to flourish. In addition to that, HUJI innovate[30] provides mentorship and support to students, alumni, faculty members and staff to develop and launch start up ideas. By guiding aspiring entrepreneurs in the basics of translating innovation into commercial ideas, the entrepreneurial skills gap identified in both the literature and the interview findings at the micro level has been partially filled. For more advanced entrepreneurial teams, HUJI Innovate also provides mentoring for product launch, funding and growth issues. Tackling the scaling up of knowledge intensive start-ups is therefore also being taken into consideration.

Yissum's CEO, Yaron Daniely, emphasises that today's TTOs must do much more than protect IP. They need to share information among one another and, most importantly, build bridges facilitating the free transfer of ideas and opportunities between the academic world and the outside world of entrepreneurs, investors, industries and communities (Leichman, 2018). This explains the partnerships that Yissum has with large corporates such as J&J, Novartis, Merck and Google. Furthermore, Israeli universities are distinct in the way they encourage innovation within the university environment even for those entrepreneurs planning to retain their IP. HUStart, HUJI's entrepreneurship centre, for instance opened the IP-free zone BioGiv[31] as an "excubator"[32] for these purposes (Leichman, 2018). The barrier identified in the literature review relating to the conflicting goals of the parent organisation is therefore already in the process of being overcome by HUJI's UCEE.

5.5 Wrap-up: potential for the Netherlands

It is clear from the best practices that these UCEEs all provide comprehensive support of spinoffs through their entire commercialisation process, from idea to market and, in the case of HUJI and KTH, even to scale. Support to scale up after entering the market is rarely found in Dutch UCEEs and thus represents a potential area of improvement. Furthermore, the extensive network of these UCEEs with partners from the business world, other knowledge-institutions and finance seems to also benefit ASOs, which was identified as a critical factor in both the literature review as well as the interviews. However, there was no clear consensus from the interview respondents whether the network from their parent organisations really benefitted them.

[30] The Hebrew University Entrepreneurship Center, a partnership between Yissum, the Hebrew University Faculty of Science, and the University Daniel and Raphael Recanti Jerusalem School of Business Administration

[31] This IP-free zone provides access to shared equipment and tissue culture facilities, research service centers and experts and provides, among others, support in accessing non-dilutive funding (any kind of fundraising that does not require you to give up ownership of your company). See https://biogiv.huji.ac.il/ for more details.

[32] An excubator is designed to support startups from the very beginning with ideation to the very end of what hopes to be a successful exit (http://blacklinereview.com/the-excubator-a-new-kind-of-incubator/).

Although all these best practice UCEEs emerge within technically and scientifically oriented environments, they offer aspiring entrepreneurs the tools (e.g. via incubation programmes) and business skills to start up overcoming one of the most important bottlenecks identified in this study – the lack of entrepreneurial skills at the micro level. The interview results revealed that not all founders made use of the incubation programmes offered at their knowledge institutions to overcome the barrier of the lack of entrepreneurial skills. The Netherlands therefore still has room for improvement when it comes to promoting entrepreneurial behaviour.

Nevertheless, it seems that the Dutch education system is doing a relatively good job at promoting entrepreneurial thinking and acting with a score of (3.0 out of 6), which is higher than the ranking of the overall European education system (2.7 out of 6) but just below the score for Israel (3.1), which represents a best practice example for promoting an entrepreneurial environment (ESM, 2016). The Dutch mentality revealed (from the in-depth interviews) that knowledge institutions would rather focus on the **quality over quantity** of spinoffs produced. This may account for why universities in Netherlands seem to produce a smaller number of spinoffs when compared to other best practices from abroad (e.g. KTH in Sweden).

Another major bottleneck revealed in the Dutch ecosystem from the literature as well as the interviews is related to ownership and IP issues resulting in conflicting interests. Since all these best practice cases present a lower barrier to entry and **minimal interference in terms of ownership and IP**, there is room to state with a certain degree of confidence that knowledge-intensive start-ups in the Netherlands could benefit from more freedom to operate from their parent organisation, without taking a major stake in the spinoffs/spinouts. See **Table 3** below for a selection of best practice examples that could overcome the bottlenecks related to the critical factors extracted from the literature review.

Table 3: Critical Factors for Knowledge-Intensive Start-ups in Best Practices

Levels in the Entrepreneurial Ecosystem	Critical factors	Best practice examples
Micro: founding team	Scientific orientation Market experience and knowledge	ETH & KTH KTH Innovation Panel
Meso: parent organisation	Direct and proactive support Conflicting strategy and goals Network and knowledge	ETH Pioneer fellowship BioGiv Programmes offered by ETH, KTH and Yissum
Macro: external environment	Entrepreneurial infrastructure Industry influence	Yissum's Venture Funds Yissum: support for different types of industries

6. Conclusions

This section describes the main conclusions drawn from this study in order to answer the research questions as described in the introduction. First, the performance of Dutch knowledge-intensive start-ups is discussed, followed by conclusions about the Dutch university-centred entrepreneurial ecosystems in comparison to the learnings with best practices of (university-centred) entrepreneurial ecosystems abroad.

Dutch Knowledge-intensive start-ups

From the analysis of knowledge-intensive start-ups in the Netherlands, it is clear that their performance (when compared to regular start-ups) is not straightforward from the two variables that were analysed. It can nevertheless be concluded that **Dutch knowledge-intensive start-ups face difficulties in maintaining a sustainable (employment) growth path and generating sales** when compared to regular start-ups.[33]

Dutch (university-centred) entrepreneurial ecosystems

The main conclusions that can be drawn from the study are as follows, for each level in the entrepreneurial ecosystem:

Micro level: the founding team

- There is a strong **scientific orientation** within the founding teams of Dutch ASOs and CSOs, which is a result of the high quality of education and research provided by Dutch knowledge institutions;
- As expected from the literature, the success of Dutch knowledge-intensive start-ups is found to be highly dependent on **market experience and knowledge,** i.e. the relevant market expertise and entrepreneurial skills to run a successful business. This often contrasts with the strong scientific and academic orientation of ASOs and CSOs and it appears to be useful when TTOs offer trainings of entrepreneurial skills to their knowledge-intensive start-ups;
- In terms of talent that is external to the founding team, the difficulty faced when **finding the right technical labour force** (beta talent), as reported by Technopolis (2015), seems to be overcome due to (helpful) connections built within the parent organisation. The only exception is represented by firms operating in the field of Artificial Intelligence, where labour seems to be more difficult to source. Quite surprisingly, though, more issues are encountered with finding the right sales candidates who also have an understanding of the highly technical product they have to market.

[33] It is important to note that, due to limited data availability, this conclusion is drawn from an analysis of a *sample* of knowledge-intensive start-ups and therefore is not fully representative of the whole population of knowledge-intensive start-ups in the Netherlands.

Meso level: the parent organisation

- Dutch knowledge-intensive start-ups demonstrate an ambiguous relationship with their parent organisations — some consider it helpful while others report no active contact. Parent organisations, especially TTOs, do offer **direct and proactive support,** especially at an early stage when ASOs and CSOs need support to overcome the first bottlenecks to start up;
- Most knowledge-intensive start-ups (particularly ASOs) report **conflicting strategy and goals** with their parent organisation, as expected from the literature. This is especially relevant when parent organisations act as majority shareholders and when IP is involved. This conflict is not restricted to knowledge-intensive start-ups and their parent organisations and extends to conflicts with shareholders in general (e.g. corporate venture capital);
- It is not clear whether the **network and knowledge** of parent organisations are actually beneficial for Dutch knowledge-intensive start-ups, although there is a general recognition that there is an extensive network at their disposal.
- The **reputation** of the knowledge institutions helps with building the credibility of the product behind the academic spinoff, especially in the eyes of a particular segment of tech-driven investors.

Macro level: the socio-economic environment

- The Dutch ecosystem indeed offers knowledge-intensive start-ups the necessary **entrepreneurial infrastructure** to enter the market. There is an encouraging entrepreneurial spirit throughout the country that provides the basis for knowledge-intensive ventures to start up. However, there is a pressing need for a revision of the Dutch (venture capital) funding structure, which seems to be too conservative to foster the growth of knowledge-intensive start-ups to eventually scale up;
- The funding structure and general entrepreneurial infrastructure seem to be industry-dependent. It is clear that there is a significant **industry influence** that comes into play in the establishment and subsequent growth of knowledge-intensive start-ups, with the healthcare sector standing out to be more protective of their IP and requiring more support systems in place.

Best practices of University-Centred Entrepreneurial Ecosystems (UCEEs) from abroad

What stands out from the most relevant best practices abroad is that all three TTOs offer extensive support at *every* stage of the spinoff/out development, while Dutch organisations seem to be supportive *primarily at the early stages*. Although incubation programmes seem to be a norm among all entrepreneurial ecosystems (including the Dutch ecosystem), the best practices offer such programmes either without any costs to aspiring entrepreneurs or without any prior intention of ownership. This lower barrier to entry and lack of interference could explain why these best practices are so successful in technology transfer and producing a larger volume of knowledge-intensive start-ups. Nevertheless, the Dutch entrepreneurial mentality revealed a value in quality over quantity. As such, the Netherlands is able to produce

high quality knowledge-intensive start-ups with a strong scientific orientation. With more extensive support systems in place, these Dutch knowledge-intensive start-ups could therefore have a better chance in scaling up.

Overall, the Netherlands provides a supportive and conducive environment for the emergence of knowledge-intensive start-ups. Being so resource-intensive, such start-ups need a large(r) investment in terms of knowledge and finances to successfully gain a position in the market. The Dutch environment seems to offer enough support for market entry, yet the resources (including knowledge, network connections and, most importantly, financial) seem to be scarce (or misallocated) when it comes to scaling up. When comparing to the foreign best practices, there is clearly room for growth and important learnings for relevant actors in the Netherlands to further foster the development of knowledge-intensive start-ups.

7. Appendices

7.1. Glossary of terms

Knowledge intensive start-up: Spinoffs and spinouts that are formed as a result of an investment in knowledge-intensive activities by existing organisations (a knowledge institution, e.g. university, for ASOs or another enterprise for CSOs) and that entertain a formal or an informal relationship with the parent organisation.

Corporate spinout (CSO): A new venture/start-up originating from R&D (or other business) activities of an existing company that are isolated into formally independent and semi-autonomous organisations that maintain a formal or an informal link with the parent organisation.

Academic spinoff (ASO): A new venture/start-up originating from a core technology or technology-based idea generated within a university or similar knowledge institution and that maintain a formal or an informal link with the knowledge institution. The Dutch Ministry of Economic Affairs and Climate (EZK) defines them as "start-ups that are primarily based on a recent discovery resulting from a scientific research of Dutch Universities, Medical Centres and institutes of NWO and KNAW".

Entrepreneurial Ecosystem: The combination of social, political, economic, and cultural elements within a region that support the development and growth of (innovative) start-ups.

Corporate entrepreneurial ecosystems (CCEE): An entrepreneurial ecosystem that is centred around a corporate and the support provided by the private sector (or corporate sphere).

University-centred entrepreneurial ecosystem (UCEE): An entrepreneurial ecosystem that is centred around the support provided by an academic institution.

Technology transfer office (TTO): Dedicated office in universities and other knowledge institutions to manage links with industry, licensing, patenting, spinoff creation, contract research and consulting activity.

7.2. Profiles of interviewees

N	Role	Organisation Type	Parent Organisation	Sector
1	CSO	ASO	Maastricht University	Engineering
2	Founder/ CEO	ASO	University of Amsterdam	Artificial Intelligence
3	COO	ASO	University of Amsterdam	Microbiology
4	CEO	ASO	TNO	Health
5	CEO	ASO	KNAW	Health
6	CEO	ASO	TU Delft	Microelectronics
7	CEO	ASO	WUR	Food Tech
8	Founder	CSO	Philips	Engineering
9	Founder	ASO	Utrecht University	Biochemical
10	Founder	ASO	TU/e	Engineering
11	University Employee	TTO	Erasmus MC	Health
12	University Employee	TTO	WUR	Food Tech
13	University Employee	TTO	TU/e	Engineering

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