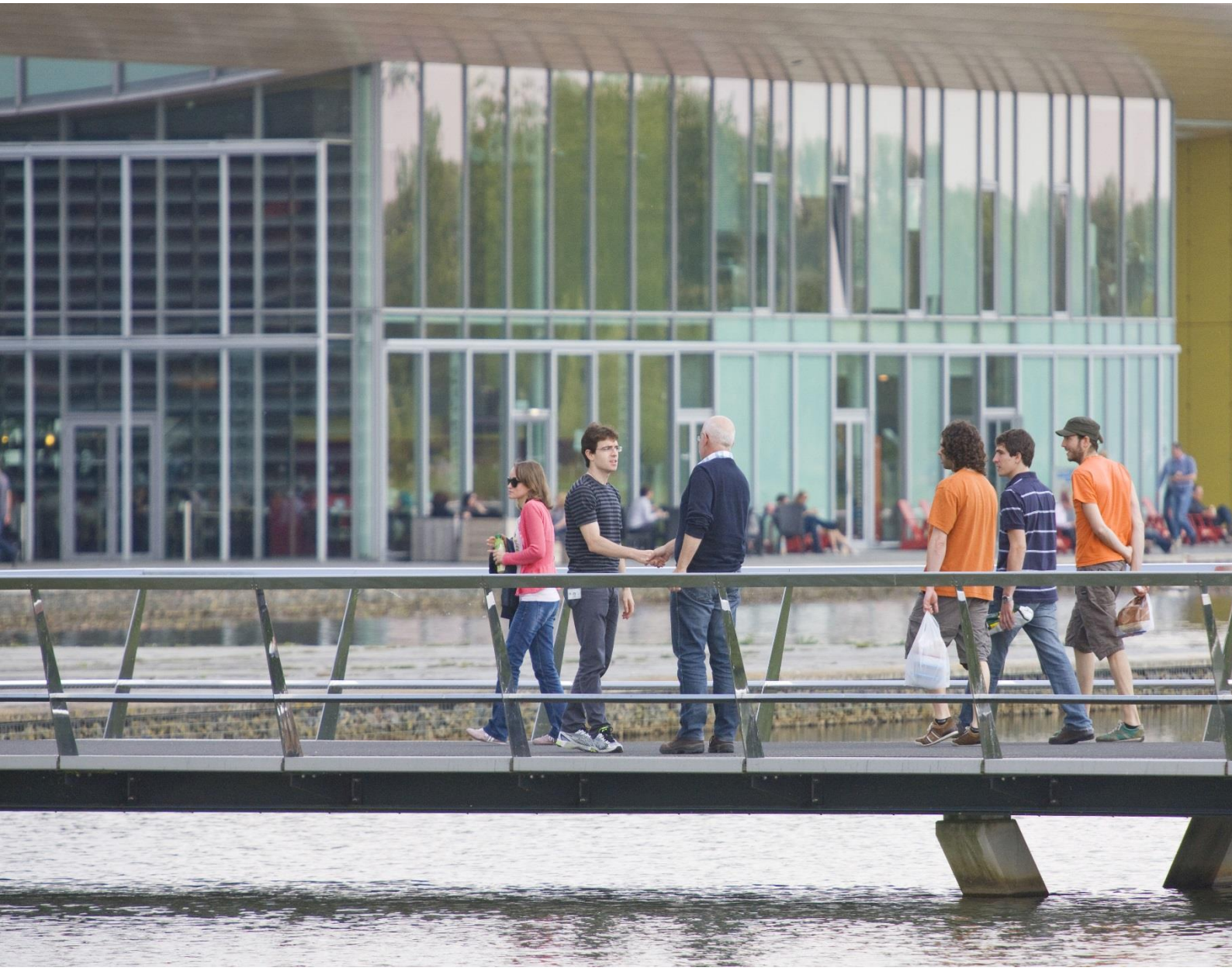
Industry seeking university

The emergence of strategic public-private research partnerships



Report

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Encounter on Eindhoven's High Tech Campus. Photo: Norbert van Onna - Hollandse Hoogte

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* (table 1 en figure 4)

Preface

Large high-tech enterprises such as Microsoft, Intel, Philips, ASML and Siemens are developing new methods for effective and efficient collaboration with higher education. Recently, they have also been entering into long-term partnerships with carefully selected universities. Dutch universities are following this trend and are successfully locking in global firms worldwide. Multiple Dutch universities are now home to joint laboratories or research centres.

In this report, we look at how strategic research partnerships differ from other forms of cooperation between universities and industry. We do that by reviewing both theory and practice, studying the literature, interviewing stakeholders, and examining case studies. Our aim is to understand the emergence of strategic research partnerships and identify the new opportunities that close cooperation affords the partners.

At the same time, this is a trend that calls for critical reflection. What considerations and trade-offs does a university face when a multinational wants to work with one of its professors or research groups? The world of open science does not necessarily fit in with the world of commercial innovation. Who ensures that there is no conflict between public and private interests? Strategic research partnerships appear to be suitable mainly for large multinationals. What does that mean for SMEs or public-sector parties that have less financial clout? How does incoming knowledge and talent compare with outgoing knowledge and talent abroad when universities collaborate with foreign firms? Such questions make strategic research partnerships an important topic of political debate and, consequently, an important topic for our institute.

It is time to develop an integrated assessment framework that will help stakeholders at universities, in industry and in government to size up the various interests, opportunities and risks when deciding whether or not to enter into or support a strategic research partnership.

Dr Melanie Peters
Director Rathenau Instituut

Summary

Large firms tend to organise their research and innovation activities on a global scale. They seek to cooperate with the best universities in Europe, the US and Asia. A recent trend is that they enter into strategic partnerships with a select number of carefully chosen universities. Such partnerships allow them to develop joint programmes in which they work closely with researchers over a lengthy period. In many cases they invest in a joint laboratory and/or in setting up their own research centre on a campus. Universities are receptive to such strategic partnerships and are themselves actively seeking out financially robust and knowledge-intensive partners.

The Rathenau Institute has investigated the emergence of strategic public-private research partnerships. How do they differ from other forms of public-private cooperation in research? What new opportunities do they offer the partners on both sides? What societal issues and ensuing trade-offs do they entail for the firms and universities involved? And what are the political and policy implications with regard to science, innovation and regional development?

A new type of public-private research partnership
Strategic research partnerships are more selective and exclusive, closer and longer lasting than other types of public-private cooperation in research. What typifies the strategic nature of such partnerships is the involvement of senior management at both the universities and the firm in the decision-making process. The partners want to build a relationship with each other, a necessity if they are to cooperate closely and trust each other enough to share knowledge, data, systems and facilities. The aim is to reduce or bridge the gap (geographical, cognitive, social, organisational) between university and industry in a variety of ways, for example through frequent personal contact between academic and industry researchers.

New opportunities for partners
This strategic type of public-private partnership creates new opportunities for the partners. For example, it allows industry researchers to get closely involved in innovative research and puts them in close contact with top researchers and talented PhD students. Strategic partnerships also open up new opportunities for universities in all three of their core tasks, i.e. education, research and valorisation. Close cooperation with industry researchers and developers, for example, allows PhD candidates to receive a broader training. University researchers can benefit from access to the firm’s expertise, knowledge of technology and markets, data and facilities. By attracting large firms to its campus, the university can contribute to regional economic development.

Considerations and trade-offs for partners

These new opportunities also give rise to new considerations and trade-offs. Strategic partnerships serve both public and private interests. It is precisely because the partners pursue ‘border crossings’ so vigorously that they must keep each other at an appropriate arm’s length and avoid conflicts of interest. The partners must get to know and guard their own and each other’s boundaries. In fact, strategic partnerships call for a new way of working and a research culture in which both partners share responsibility for striking the right balance between academic and commercial interests.

Strategic partnerships not only impact the research groups involved but also the rest of the faculty and university. A strategic partnership with a multinational must therefore be consistent with the university’s long-term perspective on the type of knowledge institution it wants to be, and for which stakeholders. Possible criteria for engaging or not engaging with industry include: whether the firm will contribute to boosting knowledge ecosystems on or around the campus (in the longer term); the risk of an exodus of strategic knowledge and world-class talent to other countries, particularly outside the EU; and the firm’s reputation in terms of responsible business conduct.

Towards an assessment framework

All sorts of public and private interests converge in strategic partnerships. They not only bring together the interests of public and private researchers and the organisations they work for, but also those of public policymakers in different domains and tiers of government. Their importance for the Dutch Ministry of Economic Affairs and Climate Policy lies in the contribution strategic partnerships make to the primary aim of the government’s enterprise and innovation policy: to work towards a competitive business and business location climate that incentivises firms to do business in the Netherlands in a way that is both sustainable and innovative. The (potential) importance of strategic partnerships for the Dutch Ministry of Education, Culture and Science and the Netherlands Organisation for Scientific Research (NWO) lies in their contribution to the general aim of science policy: to create an internationally competitive research environment that challenges researchers to work to the best of their ability and that is closely attuned to the needs of society. Strategic partnerships are also important for provincial and municipal authorities because they contribute to the regional or urban economy. They can help to bring large enterprises to the region and boost regional innovation ecosystems.

Strategic partnerships are still in the throes of development. Now is a good time to devise an integrated assessment framework that will allow stakeholders to weigh up the various public and private interests, opportunities and risks involved. That will help them take an informed decision as to whether they want to enter into or

support a strategic partnership, and on which conditions. A sound assessment framework should in any event address the following issues:

- How does a strategic partnership impact the access to public knowledge and researchers of firms outside the partnership?
- How does a strategic partnership impact research agendas and the balance between the various academic, social and economic agendas that mobilise science?
- Geopolitical considerations. Knowledge generation and technological advances are pawns in the battle for economic and military power. Does a strategic partnership help to strengthen the regional / Dutch / European economy or does it boost the economy of global competitors? Is it contributing to the outflow of knowledge and (top-class) researchers to other countries, or is it in fact bringing about an influx of knowledge and talent?
- How does a strategic partnership fit in with the university' s long-term perspective on the knowledge institution that it wants to be for stakeholders (and which ones)? How does it fit in with the government's long-term outlook on the research and science system?
- How does a strategic partnership tie in with the regional development strategy? How does a strategic partnership impact the dynamism and vitality of regional ecosystems for R&D and innovation?

This report is based on a study of the literature, three case studies (Chemelot InSciTe, DELTA Lab and ARCNL) and interviews with experts and stakeholders.

Contents

1 Introduction

Public-private research partnerships between universities and industry have become commonplace in the Netherlands in recent decades. Since the 1980s, the Dutch government has also explicitly encouraged cooperation across successive generations of innovation policy, currently in the form of a public-private partnership allowance (the PPP allowance).[1] A key policy rationale is that PPPs help science to contribute to industry innovation and competitiveness. Wide-ranging consortia, virtual research institutes and individual projects illustrate how varied PPPs are. In recent years, however, there has been a new trend in PPPs in which large firms and universities enter into *strategic* research partnerships. There are some interesting examples of this in the Netherlands. For example, Delft University of Technology and the Netherlands Organisation for Applied Scientific Research (TNO) are conducting research into quantum computing in the QuTech research centre with such industrial partners as Microsoft and Intel. Philips, Eindhoven University of Technology and three regional hospitals are collaborating on research into healthcare innovations at the Eindhoven MedTech Innovation Center (e/MTIC). Examples abroad include the Volkswagen Automotive Innovation Laboratory (VAIL) for automotive technology research at Stanford University School of Engineering, and the biotechnology research partnership between the University of Basel and the Friedrich Miescher Institute for Biomedical Research, which is funded largely by pharmaceutical company Novartis.

In these examples, public and private partners collaborate closely and for lengthy periods of time in large-scale research programmes. Strategic partnerships go farther and deeper in many respects than the more customary public-private partnerships that focus on individual research projects or take the form of broad research consortia. Are the ‘border crossings’ between the world of public science and the world of private innovation in strategic research partnerships becoming so extreme that they could cause boundaries to blur? Does the emergence of strategic research partnerships mark a new phase in the way universities and (large) firms collaborate?

These questions inspired us to study this new form of cooperation. We have done so based on the Rathenau Instituut’s mission, which is to analyse and interpret trends and developments in knowledge ecosystems in an effort to encourage the formation of public and political opinion about the social aspects of science and innovation. We need a close analysis of the phenomenon of strategic public-private

1 The Ministry of Economic Affairs’ ‘Top Sector’ policy, for example, supported more than a thousand public-private partnership projects between 2013 and 2016. (See the factsheet Stimulering publiek-private samenwerking via de PPS-toeslag. Onderzoek en Innovatie by the Rathenau Instituut, 11 February 2018, https://www.rathenau.nl/nl/wetenschap-cijfers/het-geld/stimulering-publiek-private-samenwerking-de-pps-toeslag-onderzoek-en).

research partnerships because there is some controversy surrounding cooperation between universities and industry.

Cooperation between university and industry controversial

Opinions differ as to the desirability of public-private partnerships in scientific research. Evidence for this can be found in the Rathenau Instituut's report *Trust in Science in the Netherlands – Survey Monitor 2018*, which shows that in the Netherlands, public trust in science declines when industry pays for research. Doubts about the integrity of scientists increase as soon as they work for industry (and government). Almost half (41%) of the Dutch believe that scientists will modify their research data to get the results that the contracting firm wants. The Dutch also do not have a positive view of government and industry within the context of contract research: a large majority think that firms will make use of research results only if those results support their own ideas, and about 60% believe that government and industry will try to obstruct unwanted results. On the other hand, many Dutch people also believe that it is acceptable for scientists to let their choice of research topic be guided by the interests of business (Van den Broek-Honingh & de Jonge, 2018). The varying views of the Dutch on university-industry relationships have been echoed in the Dutch House of Representatives, where a recent debate showed that MPs too have differing opinions on the subject.[2]

An article in a recent three-part series in *NRC Handelsblad* about the influence of funding bodies on scientific research also clearly shows that there are questions surrounding private-sector funding of research.[3] For a pittance, firms can leverage considerable influence on research. A reconstruction of the ARCNL strategic partnership shows how diverging interests, corporate cultures and expectations cause inherent tensions in public-private partnerships.

Strategic partnerships in knowledge ecosystems

In this study, we regard strategic public-private research partnerships as a new phenomenon in knowledge ecosystems. We define knowledge ecosystems as the totality of producers and users of knowledge that are organised around a joint knowledge search (Järvi, Almpanopoulou, & Ritala, 2018).

Knowledge ecosystems are dynamic: they emerge, they grow, and they shrink. Actors join; they flourish or disappear. In knowledge ecosystems, universities, public knowledge organisations, industry and government depend on one another to generate new knowledge. They influence one another, they compete and they collaborate. Knowledge ecosystems can develop around specific research themes or technological or societal challenges. Geographical hotspots often emerge within knowledge ecosystems because actors seek others nearby to promote more

2 Dutch House of Representatives, Debate on links between fossil fuel industry and universities, 7 September 2017, see: Handelingen II, 2016/2017.

3 NRC Handelsblad, 6 September 2018, p. 10-11.

effective collaboration and to benefit from clustering advantages, for example a concentration of knowledge workers.

The actors in knowledge ecosystems focus on generating new knowledge in a pre-competitive setting. They therefore differ from innovation ecosystems in which the actors work mainly on knowledge exploitation. In innovation ecosystems, the point is to use knowledge to create value for the economy or society, for example through start-ups that commercialise that knowledge. PPPs forge a link between knowledge and innovation ecosystems that connects R&D to innovation processes.

Strategic partnerships change how knowledge ecosystems function. They offer the partners alternative courses of action and frameworks, both in the lab and in the corporate and faculty/university boardrooms. They change the research agenda and the way research is programmed, funded and carried out. The same holds true for the way in which knowledge is disseminated, transferred and valorised. In addition, when a select group of parties enter into a strategic partnership, that partnership changes the rest of the relevant knowledge ecosystem, if only because others then have fewer opportunities for cooperation or because there are changes in the way knowledge and staff circulate in the knowledge ecosystem.

For the strategic partners themselves, the alternative courses of action are accompanied by new responsibilities and new considerations and trade-offs. For example: who should be allowed to leverage how much influence on research agendas, and who should be given which type of access to researchers and (interim) research results? How can a strategic partnership serve both academic and commercial interests at one and the same time? What do strategic partnerships mean for the role that universities play in society? To what extent do they help to make the Netherlands an attractive research hub?

1.1 Aim, questions and method

The aim of this study is to gain more insight into the phenomenon of strategic public-private research partnerships between universities and industry, and their potential impact on the functioning of knowledge ecosystems. Such insight can help politicians, policymakers and other decision-makers in knowledge ecosystems to respond (more effectively) to this trend.

The Rathenau Instituut has undertaken this study to answer the following questions:

1. Are strategic public-private research partnerships a new type of public-private research partnership? If so, what are the distinguishing features of strategic partnerships?[4]

4 In this report, we refer to ‘strategic public-private research partnerships’ simply as ‘strategic partnerships’.

2. How can we understand the emergence of strategic partnerships?
3. What do strategic partnerships mean for the functioning of knowledge ecosystems? What new opportunities does a strategic partnership offer firms and universities?
4. What new questions and trade-offs do such partnerships entail, both for the stakeholders themselves and for government's science, innovation and regional policy? What are the implications for society and, consequently, for science, innovation and regional policy?

To find answers to these questions, we started by carrying out a conceptual study of public-private research partnerships based on the academic literature and other publications. We then conducted an empirical study by examining three cases of strategic partnerships in the Netherlands. They are:

- Chemelot InSciTe (Institute for Science and Technology)
  Partners: Province of Limburg, DSM, Eindhoven University of Technology, Maastricht University and Maastricht Universiteit Medical Centre+
  Theme: Biomedical and biobased materials
- DELTA Lab (Deep Learning Technologies Amsterdam)
  Partners: Bosch, University of Amsterdam
  Theme: Artificial intelligence
- ARCNL (Advanced Research Center for Nanolithography)
  Partners: Netherlands Organisation for Scientific Research (NWO), University of Amsterdam, VU Amsterdam, ASML
  Theme: Nanolithography

We conducted desk research and interviews with stakeholders from the partner organisations in these case studies. We also interviewed other individuals (outside these organisations) about their expertise and experience. We further discussed interim research results during a liaison meeting and a meeting with experts and stakeholders.[5]

1.2 Reader's guide

Chapter 2 presents the findings of our conceptual study of strategic partnerships as a new type of public-private research partnership. We describe what is new or different about this strategic version of the PPP. Chapter 2 also explains how the emergence of strategic partnerships relates to the changing strategies of firms, universities and governments in recent decades.

Chapter 3 sets out the results of our empirical study of strategic partnerships based on three case studies. We show why partners seek one another out in strategic

5 See Appendix 1 for a list of persons involved and Appendix 2 for additional information on the research approach.

partnerships, which agreements they then make entering the partnership, and how they give shape and substance to their relationship in practical terms.

Chapter 4 combines the findings from the conceptual and empirical studies to arrive at a typology of the strategic partnership phenomenon. We identify typical university, industry and government motives for establishing strategic partnerships, the typical agreements they make when entering into a partnership, and typical ways in which partners maintain their strategic relationship.

Chapter 5 considers what strategic partnerships mean for the dynamism of knowledge ecosystems and their impact on society. We then look at the alternative courses of action this creates for firms, universities and governments, and the questions it raises for them and society.

We summarise the findings of this report in Chapter 6.

2 A conceptual study of strategic partnerships

What is new or different about strategic public-private research partnerships compared to existing forms of public-private partnership (PPP) or university-industry collaboration? Why have strategic partnerships emerged in recent years? How can we explain their emergence? This chapter presents the results of a conceptual study of strategic partnerships. Section 2.1 produces a typology of PPPs in which strategic partnerships exemplify the closest form of collaboration. Sections 2.2 and 2.3 explain the emergence of strategic partnerships from a theoretical and historical perspective. Section 2.4 summarises the chapter.

2.1 A new type of public-private research partnership

To gain a better understanding of what strategic partnerships are and how they differ from existing forms of research PPPs, we conducted a literature study. One good starting point for a conceptual study of strategic partnerships is the general definition used by the OECD.[6] In the domain of science, technology and innovation a PPP may be defined as:

> 'any formal relationship or arrangement over fixed-term/indefinite period of time, between public and private actors, where both sides interact in the decision-making process, and co-invest scarce resources such as money, personnel, facility, and information in order to achieve specific objectives in the area of science, technology, and innovation' (OECD, 2005).

Defining elements of a PPP are joint decision-making and co-investment in research by public and private parties.

From the perspective of firms, the research PPP is an intermediate form that lies halfway between in-house research and outsourcing research to third parties (contract research). From the perspective of universities, it is an intermediate form that lies halfway between publicly funded research and contract research funded by industry (KNAW-werkgroep opdrachtonderzoek, 2005).

6 The Organisation for Economic Cooperation and Development (OECD) has 36 member countries and was founded to foster discussion, study and coordination of social and economic policy.

These intermediate forms can also be observed in the type of research associated with PPPs. PPP research combines an interest in basic research with a focus on potential applications in innovative solutions. In terms of Pasteur's quadrant (Stokes, 1997), it is 'use-inspired basic research' (see Figure 1).[7] It differs in that sense from pure basic research (the Bohr cell) and pure applied research (the Edison cell), making it interesting to both academic researchers and industry researchers and developers.

Figure 1 Pasteur's quadrant: Classification of scientific research

		Considerations of use?	
		No	Yes
Quest for fundamental understanding?	Yes	Pure basic research *Bohr*	Use-inspired basic research *Pasteur*
	No		Pure applied researach *Edison*

Source: Stokes, 1997

The research PPP can serve a broad range of purposes for the various participants. Not all of them necessarily consider the actual research results equally important. Firms often regard the access that a PPP gives it to students, researchers and professors – and their research networks – as an important reason to participate, especially when talent is scarce. Universities may regard access to private research funding and expert knowledge of high-tech markets as important motives.

Because research PPPs can serve different purposes, they take many different forms. The size of the PPP structures varies from small-scale, temporary projects to permanent, large-scale organisations with hundreds of industry partners (Perkmann & Walsh, 2007). Corporate involvement ranges from funding and guiding research to collaboration in the lab.

In 2014, the OECD Working Party on Innovation and Technology Policy (2014) noted that research PPPs were becoming increasingly strategic in nature, i.e. more focused on achieving real and specific innovation targets. In strategic PPPs, all the partners have the same primary goal: to generate the new (high-tech) knowledge that they need to attain their own strategic goals. In other words, what distinguishes a strategic from a non-strategic PPP is the huge importance that both the public and the private parties attach to the actual research results of the partnership.

As yet, there is no extensive academic literature on the phenomenon of strategic public-private partnerships. A few years ago, the Centre for Science, Technology &

7 This type of research is also known as strategic basic research or strategic science.

Innovation Policy (CSTI) at the University of Cambridge organised a workshop on 'Building Long Term Strategic University-Industry Partnerships' (Coates Ulrichsen & O'Sullivan, 2014). The researchers attribute the recent emergence of these partnerships – specifically in the United States and the United Kingdom – to the fact that large R&D-intensive multinationals have been rationalising their investment in universities and increasingly limiting such alliances to a small number of strategic, longer-term partnerships with a select group of universities. They are better able to absorb and utilise knowledge in this way. According to the researchers, strategic partnerships with large multinationals can unlock significant added value for universities by enabling them to gain access to more diverse sources of funding and to use basic research to meet technological challenges. Universities in the United States and the United Kingdom are actively seeking partners with which they can build strong, deep and enduring relationships.

Of note is that the CSTI report refers to two models that position strategic research partnerships as the closest form of cooperation on a 'continuum' or 'stairway':

1. The *Partnership Continuum* model developed by the University-Industry Demonstration Partnership (2012) in the United States places strategic partnerships at one end of a continuum characterised by an increasing degree of engagement, from 'transactional' to 'collaborative' to 'alliance'.[8] The model is broad in scope and considers not only cooperation in research but also in education, research facilities and valorisation. 'Transactional' cooperation focuses on sharing materials, software and hardware, consulting and advising, giving lectures and organising seminars and workshops. A more far-reaching form of 'cooperation' involves sponsoring research projects and clinical trials, as well as sabbaticals, emeritus professors and gifts. The closest form of cooperation in this model is 'alliance' (what we refer to as the strategic partnership). Alliances are long-term in nature, involve a substantial commitment (and sometimes sacrifices) that need to be made by the partners, the alignment of aspirations and objectives, and the development of deep, trust-based relationships.

2. The *Stairway* model developed by the Münster University of Applied Sciences in Germany, combines the institutional level at which the commitment is made and at which coordination takes place with the strategic relevance of the relationship (Davey, Baaken, Golan Muros, & Meerman, 2011). The stairs of the model are tied to the number of joint projects (from a few irregular projects to several and regular joint activities), the length of the collaboration (from short- to long-term), the number of people involved (few to multiple) and the management level (from individual researcher or professor to faculty (dean) and university management). The highest step is the strategic partnership.[9]

8 The model distinguishes between five stages in the relationship: Awareness, Involvement, Support, Sponsorship and Strategic Partner.

9 The four stairs are Formation, Basic Collaboration, Joint Collaboration and Strategic Partnership.

Yet another study of university-industry partnerships is by Casper & Miozzo (2013), who focused on the pharmaceutical industry, where research PPPs have been common for decades. They noted a new trend in the way in which large pharmaceuticals and universities engaged with one another. In the 1980s, 'rights-oriented partnerships' were customary between pharmaceutical firms and university researchers. The firms were mainly interested in gaining a 'window on science' and concluded multi-year contracts with universities for this reason, paying considerable amounts in upfront funding in exchange for access to intellectual property developed at the university. Part of the funding was often 'unrestricted' while other components were limited to supporting collaborative, more application-driven projects between university and industry researchers. In reality, these partnerships were unable to live up to the firms' expectations and also proved difficult to manage. In the 1990s, 'tapping-in' partnerships emerged. Firms would establish a research centre on the university campus to 'tap into' local university research projects and networks. Partnerships were subject to a legal framework in the form of a 'master agreement' that the firms concluded with the entire university. Specific partnership projects would come from the bottom up, often as a result of interactions between university and industry researchers. The firm would make a contribution in kind. Intellectual property (IP) rights were based on co-ownership of patents. In practice, this model did not lure many top researchers at US universities to enter into collaborations, mainly owing to IP issues.[10] Entrepreneurial professors who wanted to set up their own spin-offs found it particularly constraining. That is why a new partnership model has emerged in recent years, referred to as 'contracting for innovation', which is inspired by the research and innovation partnerships that have developed in the biotechnology industry. In this model, the goal of the pharmaceutical firm is not so much to gain a 'window on science' or to 'tap into' research projects and networks but to involve university researchers in drug development; it facilitates close collaboration by establishing an R&D centre on campus. 'Contracting for innovation' differs from previous partnership models in that industry ties its funding to drug discovery and development milestones on the path towards commercialisation. This allows university researchers to share in the commercial profits, incentivising them to commit to innovation-driven research. The main goal of the partnership is to build a good relationship in which the parties (learn to) trust one another. One example is the joint steering committee, in which the firm and the university have an equal say in the selection of projects for funding. Research proposals are usually initiated by university researchers and then – after selection – developed into full proposals in collaboration with industry researchers.

10 American universities reward their researchers financially for their (patented) inventions, for example by paying them a percentage of the royalties or by investing in a researcher's start-up firm. It is therefore less interesting for more enterprising researchers to cooperate with industry because their intellectual property rights to inventions are transferred to the firm. In the Netherlands, the law regards the university (as the researcher's employer) as the owner of the intellectual property. The law also stipulates that employees must receive 'fair compensation' if their employer makes use of their invention. Delft University of Technology has implemented a '1/3rd scheme' in this regard; inventors are entitled to a third of the profits accruing from the invention. Source: http://www.delftenterprises.nl/kennisvalorisatie/beloning-uitvinders/

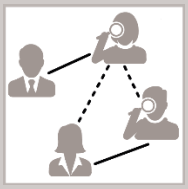
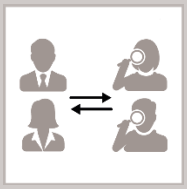
The study carried out by Casper & Miozzo (2013) shows how large pharmaceutical firms are always seeking effective ways to access (tacit) knowledge held by top scientists, steer research into areas that align with their business strategy, promote innovation, and reduce conflicts about IP rights. The trick is to make the partnerships interesting for all the partners and keep them that way.

A typology of research PPPs

Drawing on the various studies, we can distinguish three types of research PPPs (see Table 1).[11] We have also noted a more basic type of cooperation (type 0), but this is not a PPP in the formal sense because there is no joint decision-making. The typology shows that the various types of PPP serve different aims and interests, depending on the partner, and also have different functions in knowledge ecosystems. Type 0 consists of networks between academic and industry researchers. Type 1 prioritises coordination between academic research and commercial innovation. A group of firms active in a specific area of innovation may help determine academic research agendas in relevant fields of research. This is referred to in policymaking as 'demand-driven cooperation'. In type 2, demand-driven academic research agendas transition into collaboration based on a joint research programme. In type 3, collaboration transitions into a strategic partnership between a select group of universities and firms that wish to cooperate closely in research. This is the closest form of cooperation and can be regarded as a response to the changing goals and strategies of firms, universities and government, as the table shows. We describe the four types in more detail below.

11 See also: Curley & Salmelin, 2018; Davey et al., 2011; Frølund, Murray, & Riedel, 2017; Hagedoorn, Link, & Vonortas, 2000; Hessels & Deuten, 2013; Koschatzky, 2017; Mowery, 1998; Savage, 2017.

Table 1 Typology of public-private research partnerships

	 **Type 0 Networking**	 **Type 1 Coordination**	 **Type 2 Collaboration**	 **Type 3 Strategic partnership**
Function in knowledge ecosystem	Building and maintaining networks between academic and industry researchers	Coordinating academic research agendas with commercial innovation targets	Cooperation based on a joint research programme	Joint programming of knowledge generation geared to strategic business interests
Composition /size	Individual projects based on personal contacts	Broad programme consortia, smaller project consortia	Broad programme consortia, smaller project consortia	Exclusive collaboration between select groups of partners
Involvement of industry	Ad hoc, e.g. participation in supervisory committee for graduation project	Making suggestions and co-decision-making about programme; project supervision	Co-decision-making about programme; participation in projects	Close collaboration in programmes and projects
What the firm wants	To stay abreast, to gain access to students, graduates and researchers	To steer scientific research towards topics relevant to the firm	To participate in scientific research that is relevant to the firm	To jointly build a strategic knowledge base
What the university wants	To connect students, PhD candidates and researchers to firms as knowledge users and potential employers	To benefit from demand-driven cooperation and access to funding	To exploit opportunities for use-inspired research (and funding); use firms' knowledge and skills.	To benefit from various advantages: use-inspired research, funding, access to knowledge and facilities, personnel policy, etc.
What government wants	N/A	To close the 'gap' between scientific research and commercial innovation by 'demand-driven' cooperation	To get firms to make better use of public knowledge institutions	To encourage science with impact, boost the innovative capacity of industry and the (regional) economy
Financial contribution by firms	Small-scale *(*in kind*)*	Modest (e.g. 10-20%)	Significant (e.g. 20-30%)	Substantial (e.g. 30-80%)

Source: Rathenau Instituut

Type 0: Networking
In the ‘networking’ type, universities and firms are primarily interested in building and maintaining networks between academic and industry researchers. Firms want to cooperate with university researchers to stay abreast of developments relevant to their field, to gain access to experts (professors) and their networks, and to scout and recruit talented students and PhD candidates. University researchers seek to cooperate with firms to tap into an important source of jobs for their students and PhD candidates, to arrange traineeships, and to keep up with commercial and technological advances in the field.

This is a bilateral, small-scale, ad hoc form of cooperation, often based on personal contacts between university and industry researchers. For example, professors network with former students and PhDs who have gone to work in industry. Firms often make no more than a small contribution (often in kind) to the cooperation (e.g. a graduation project). Their involvement in the university’s research agendas and in the research itself is usually limited to making suggestions, for example as a member of a committee supervising a student’s or PhD candidate’s research project. It is not the actual results (of the traineeship or graduation project) that matter, but the networking.

Type 1: Coordination
In the ‘coordination’ type, the aim of the PPP is to align university research more closely with industry innovation activities. By cooperating in programmes, university research groups can bring their research agendas into line with the knowledge requirements of industry in key areas of innovation. Firms active in that area thus encourage scientific research in fields that have relevance for them. The parties coordinate with each other on a specific innovation theme or area of technology, usually by cooperating in programmes as members of a broad consortium. Firms influence research agendas and programmes only in a general sense and their financial contribution is therefore relatively modest. They may, for example, have a seat on the programme council and project supervisory committee.

Government plays an important role in establishing PPPs of this kind. It tempts public and private parties to participate by making funding available and gears its policy towards resolving ‘system failure’: when universities and industry fail to connect, opportunities for innovation are lost.

Example of type 1: Coordination

The Netherlands’ Innovation-oriented Research Programmes (IOPs) were a good example of the coordination-type PPP. The first IOP began in 1979 and

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last few ended in 2010. The main purpose of the IOPs was to coordinate scientific research in emerging fields of technology with the demand for innovation in Dutch industry. Firms actively influenced research programmes, while researchers took the lead in projects. They drafted research proposals in response to programme-led calls for proposals.

Type 2: Collaboration

In this type of PPP, cooperation focuses on the joint execution of PPP projects within the context of an overall research programme. The programme is often set up and managed by a broad consortium of knowledge institutions and firms. The projects that fall under the programme are developed and carried out by individual groups within the broader consortium. Firms make a larger contribution than in the foregoing PPP types. Collaboration requires firm agreements about IP rights and the publication of the research results, as they can or will have a direct impact on the participating firms' innovation agendas.

Government plays an important role as a facilitator. By making grants available, it creates leverage that makes it attractive for public and private parties to participate and contribute themselves. Its intervention goes a step further than merely getting the two worlds of R&D to cooperate, however. Its aim is also to get firms to make better use of knowledge institutions – and vice versa – in order to arrive at specific innovations.

Example of type 2: Collaboration

The Top Technology Institutes (TTIs), first established in the mid-1990s, were a good example of the collaboration-type PPP. The aim of the TTI scheme (cancelled in 2010) was to get firms and publicly funded knowledge institutions to enter into in multi-year cooperation agreements on research topics important to the Dutch economy. They were meant to generate knowledge in a specific area of research that would provide answers to basic strategic questions in industry. They undertook basic and applied research and pre-competitive development activities. Industry co-financed the research programmes (25%). Firms were involved not only in programme development, project selection and funding but also in carrying out research projects, for example by contributing equipment and expertise. One explicit aim was to translate research results into actual innovations. A TTI functioned as a joint

virtual research institute in which the research was carried out mainly by the participating knowledge institutions.

Type 3: Strategic partnership

In this type of PPP, a select group of public and private parties cooperate in a multi-year research programme. They choose one another with great care and intend to undertake joint activities for a longer period of time and build a good relationship with one another. The research programme is geared to strategic business interests. Researchers in strategic partnerships benefit from several advantages through their participation in a multi-year agreement with an R&D-intensive firm, for example the possibility of conducting advanced, use-inspired basic research or of undertaking research activities that enable new technologies. Such partnerships provide access to extra research funding and to the firm's data, knowledge and facilities. The advantages, for example being able to recruit good researchers and offer them attractive career prospects, accrue to the university as a whole. By working closely with university researchers, firms can gain access to new knowledge and work with them on building a strategic knowledge base.

Unlike types 1 (cooperation) and 2 (collaboration), strategic partnerships are not about broad consortia in which competing firms also participate, but rather about exclusive (sometimes bilateral) cooperation in which a select group of partners make a long-term commitment to one another. The partners make a substantial investment *(*in cash and in kind*)* and take considerable risks. If academic and commercial aims and interests are to be combined productively in the partnership, the partners much make firm agreements about IP rights and publications.

Examples of type 3: Strategic partnership

Two examples of strategic partnership are the Advanced Research Center Chemical Building Blocks Consortium (ARC CBBC) and Eindhoven MedTech Innovation Center (e/MTIC).

The ARC CBBC was set up to implement a long-term, large-scale use-inspired basic research programme. It investigates energy carriers, functional materials and coatings that will promote clean energy, the circular economy and sustainable chemical processes. Knowledge-building is of strategic importance for industry partners AkzoNobel, BASF and Shell. Their strategic partners are

Utrecht University, Eindhoven University of Technology and the University of Groningen.[12] The firms make a substantial investment in the research programme (at least 30%). Public funding is provided by the universities, both as cash in hand and in kind, and by the other founding partners, i.e. NWO, the Dutch Ministry of Economic Affairs and Climate Policy, and the Top Consortium for Knowledge and Innovation in the Chemicals Industry. The firms are closely involved in formulating the research questions. While the research is being carried out, they are updated regularly on progress and also take a strong interest in the research itself.

In the e/MTIC, set up by Philips, Eindhoven University of Technology, Máxima Medical Centre, Kempenhaeghe Epilepsy and Sleep Center and Catharina Hospital, the partners' researchers work together on one another's sites in the Eindhoven region. The e/MTIC was founded in 2014 to develop and implement healthcare innovations based on sensors, artificial intelligence and data science. It focuses on common cardiovascular complaints, sleep disorders and perinatal issues treated at non-university hospitals. The researchers work with patients. Philips regards the e/MTIC as a means to accelerate innovations in healthcare. The partnership offers the universities interesting research projects and the possibility of valorisation and allows the hospitals to work on efficiency and improvements in patient care. The partners exchange staff. All partners support the partnership financially. New partners may only join with the consent of the existing partners.

2.2 Theoretical perspectives on the emergence of strategic partnerships

The literature offers different theories that can explain why companies enter into strategic partnerships (Koschatzky, 2017). Below, we look at three: transaction cost theory, innovation economics and economic geography.

Transaction cost theory

Transaction cost theory suggests that strategic partnerships arise because the actors want to keep their transaction costs as low as possible. In other words, a strategic partnership will emerge when it is the most cost-effective way for the actors to achieve their goals. A firm that needs knowledge can obtain it in different ways. It can develop it in-house. It can procure it from external knowledge suppliers

12 ARC CBBC consists of three bilateral partnerships to foster more strategic research projects (one bilateral partnership per industry partner, with the private partner providing two-thirds of the funding and the public partner one-third) and a joint multilateral research programme (with the private partners providing one-third of the funding and the public partners two-thirds) (ARC CBBC, 2017).

through contract research, or it can acquire it through a PPP. Each type of coordination has its own transaction costs. According to the theory, strategic partnerships emerge when it is costlier, more difficult or riskier for firms to organise research in-house or outsource individual research projects to external parties (Hagedoorn et al., 2000). At the moment, many firms are pursuing an 'open' innovation strategy precisely because they find it too expensive and risky to organise research in-house. However, contract research is not always an effective (or cost-effective) way of gaining knowledge either. The transaction costs involved in outsourcing, for example, include the cost of searching for and selecting suitable researchers, drawing up contracts, overseeing compliance with agreements, and so on. Once the firm has entered into a certain number of individual 'transactions', it becomes interesting to concentrate them into a formal type of cooperation because that lowers the transaction costs. Broad and open PPP consortia are unsuitable for addressing firms' complex and strategic knowledge demands because the transaction costs of keeping strategic business information confidential are very high. In addition, firms are not prepared to run the risk (of incurring extra costs) posed by possible conflicts with competitors about IP and decision-making (Hagedoorn et al., 2000). It is therefore worth their while to invest in a close relationship with a knowledge partner and create the sort of mutual trust that can reduce transaction costs.

Innovation economics

According to innovation economics, knowledge is the main driver of economic growth because entrepreneurs innovate through acquired knowledge. Innovation systems play an important role in this theory because public and private parties need each other in such systems to innovate. Innovation is a non-linear process in which basic and applied research, technological advances and commercialisation constantly feed into one another. Interaction and knowledge exchange are crucial for innovation. Public-private research partnerships arise when firms and universities need each other to produce and apply knowledge. The more complex the innovation challenge is, the more knowledge has to be accumulated from multiple sources, and the more the parties prefer using PPPs to coordinate research and innovation (Chesbrough, 2003; Koschatzky, 2017). Strategic industry-university partnerships emerge because the actors need to organise research and innovation in 'ecosystems' in which they can cooperate effectively.

Economic geography

Economic geography suggests that proximity between cooperating parties is beneficial and to some extent even necessary for effective research cooperation. Parties who are located near to one another, for example on a campus, can work together more effectively because personal interactions are easier and occur more frequently. Proximity need not be of the geographical kind; there are other forms of proximity as well, such as cognitive proximity (the degree to which the partners understand each other's work), organisational proximity (the degree to which the

partners' standards, values and practices are a good fit) and social proximity (the degree to which individuals know, understand and trust each other because they are part of the same networks or have worked together before, for example) (Boschma, 2005; Heringa, 2014).

Viewed from this perspective, PPP offers firms and universities a way to increase their cognitive and social proximity and therefore build mutual understanding and trust. Strategic research partnerships are a variation on this idea in which firms maximise the geographical, cognitive, organisational and social dimensions of proximity to universities.

2.3 Emergence of strategic partnerships: historical background

To help readers understand the emergence of strategic partnerships, we briefly review how firms, universities and governments developed their strategies and the role that public-private research partnerships played in that context. We see examples of the various types of PPPs in our outline history of public-private partnerships.[13]

A brief history of PPPs

Public-private research partnerships first emerged in the 1980s and have taken a variety of different forms since then. Universities and industry interacted and formed alliances before the 1980s, of course, but they rarely established formal public-private partnerships 'where both sides interact in the decision-making process, and co-invest scarce resources such as money, personnel, facility, and information in order to achieve specific objectives in the area of science, technology, and innovation' (OECD, 2005). The main purpose of their interaction and cooperation was to build and maintain networks. Firms that wanted to involve universities in actual research did so through consultancy or contract research arrangements.

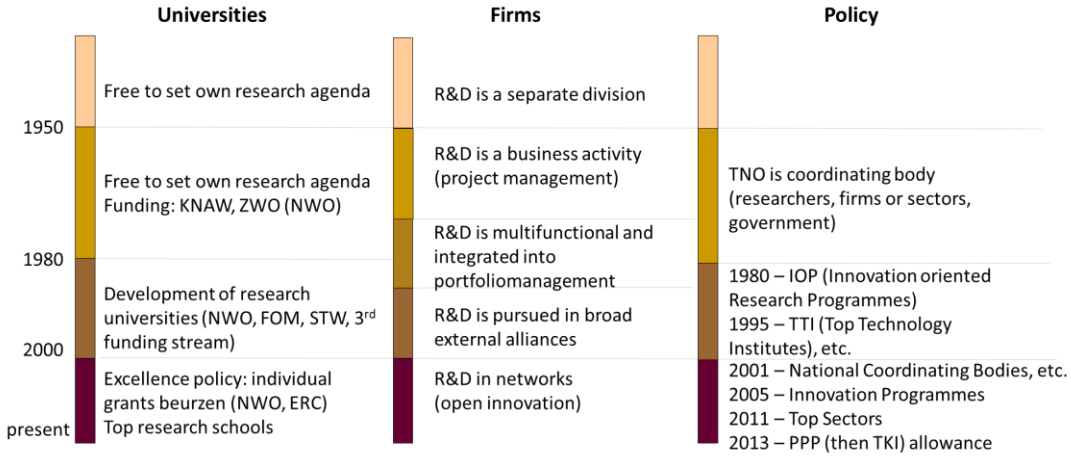
Large industrial research labs

In the post-war period, large firms often set up their own research labs to meet most of their demand for basic or applied research in-house. Until the 1960s, industry research labs were patterned on the linear model that dominated after the Second World War: groundbreaking basic research would eventually lead to new insights that could then be translated into innovations by means of applied research and technological advances. Corporate management therefore gave their private research labs considerable scope to put more basic research on the agenda. Researchers working in these labs also had the leeway to maintain close ties with

13 This historical account is based on: Curley & Salmelin, 2018; Dorsman & Knegtmans, 2007; Faasse, 2018; Hessels & Deuten, 2013; Homburg, 2003; Knegtmans, 2000; Lintsen & Velzing, 2012; Shapin, 2010.

the academic community, for example by attending conferences, publishing in scientific journals, participating in working groups and supervisory committees, accepting part-time appointments at a university, and so on. Industry researchers often had one foot in the academic world. It was important for firms to create a research environment that would attract and retain good researchers. By maintaining networks with academia, they also had the opportunity to scout and recruit talented students and researchers. During this period, formal public-private partnerships in broad consortia were not really conducive to the R&D strategies typically pursued by large firms. That strategy was aimed at gaining a competitive knowledge advantage by doing research mainly in their own labs, in some specific instances supplemented by bilateral contract research carried out by third parties.

Figure 2 History: universities, firms and PPP policy



Based on: Curley & Salmelin, 2018; Faasse, 2018; Lintsen & Velzing, 2012; Niosi, 1999; Nobelius, 2004; van der Zee, Goetheer, & Gijsbers. 2016

Autonomy of university research agendas

University research groups also enjoyed a large measure of freedom to set their own research agenda in the post-war period. ‘Pure’ science was regarded as the core task of universities, an attitude somewhat at loggerheads with the idea of public-private partnerships. There was a huge gap between basic and applied research. Cooperation with industry and alignment with its needs were much more common in applied research. The Netherlands Organisation for Applied Research (TNO) functioned as the organising and coordinating body for applied technical research. Research was also coordinated on a national scale in the agricultural sciences.

Business-driven industrial research

From the late 1960s onwards, firms began to focus more on their own innovation needs in their in-house research. Corporate research labs were reorganised and a considerable number of them became separate business units. It turned out to be quite expensive to maintain large research labs, and not always the most effective

way to generate innovations. Portfolio management became popular in the 1970s (i.e. managing all projects centrally in a portfolio to achieve strategic goals), with firms looking to lower risk and cut costs by balancing innovative basic research and more applied research. The more firms cut back on their own research capacity, the more leeway there was for university groups to address specific research questions through contract research.

Academic research of relevance to society
It was in the same period that the Dutch government launched its own research policy. The national budget could not keep pace with the growth of the universities, forcing the government to make choices. In 1974 it drew up its first Science Policy document. One of the four main points that it addressed was closer coordination between academic research and the priorities and knowledge requirements of society. From the 1970s onwards, the Ministry of Education, Culture and Science used various measures to coordinate scientific research and the needs of society, including sector councils, foresight committees and national research programmes (Faasse, 2018).

University researchers seeking funding
By the end of the 1970s, university research groups were actively seeking additional sources of funding. The growing scarcity of government funding made industry more attractive as a paying knowledge user. At the same time, universities increasingly emphasised their research tasks.

Industrial research in product development
In the 1980s, industrial research came to be dominated by such notions as integrated product development and became an integral part of new product design. Researchers joined cross-functional teams, working with engineers, designers, production experts, marketing professionals and regulatory and public affairs specialists. It became attractive for firms to cooperate with universities (and other firms with similar knowledge needs) on maintaining their strategic knowledge base for the longer term.

Encouraging demand-driven research
It was during this period that the national government developed its innovation policy. It issued its first innovation policy document in 1979, part of efforts to address the Netherlands' lengthy economic recession and high unemployment rate. Two key aims were to boost the innovativeness of industry and to support efforts by research institutions to integrate technological innovation into society and industry (Hessels & Deuten, 2013).

An analysis had revealed that publicly funded research was not sufficiently responsive to the needs of industry and society. The government's innovation policy therefore introduced a new measure to stimulate demand-driven research:

Innovation-oriented Research Programmes (IOPs) The IOPs were meant as a mechanism through which the research community, industry and government would jointly define research topics that could lead to industrial applications. In an IOP, firms would be actively involved in setting the research agenda and programme and in supervising PhD research in areas relevant to industry. These broad PPP consortia were meant to better align academic research agendas with the knowledge requirements of innovative firms, particularly in emerging technologies.

Exchange of knowledge between engineering sciences and industry
From 1981 onwards, Technology Foundation STW encouraged close cooperation between the engineering sciences and industry. STW (which became the NWO Domain Applied and Engineering Sciences or AES in 2017) received funding from the Ministry of Economic Affairs and NWO. Research proposals were assessed both for their scientific quality and for the likelihood of results being applied. Projects were assigned a user committee with seats held by potential users (representatives of firms and other organisations), ensuring that knowledge was exchanged and allowing some researchers to make use of facilities in industry and vice versa (Veen, Boots, & Boontje, 1990).

Sharing the costs and risks of knowledge generation
After the fall of the Berlin Wall and the opening up of China in the 1990s, markets and suppliers began to globalise. At the same time, the rise of the Asian tigers (Singapore, South Korea, Taiwan, Hong Kong) intensified worldwide competition. To survive, firms needed to quicken the pace and lower the cost of innovation. Many large firms adopted ‘open innovation’ strategies in which they deployed external sources of knowledge and expertise to achieve innovation. Research PPPs complemented the open innovation approach. The 1990s saw steady growth in the number of public-private research consortia, whose aim was to boost the international innovativeness of industry. Dutch examples included the Top Technology Institutes and ICES/KIS consortia. In the new forms of PPP, the purpose was not merely to better align public knowledge agendas with private innovation goals but also to share the costs and risks of pre-competitive knowledge generation with knowledge institutions, governments and other firms.

Firms seeking proximity to universities
This trend continued in the 2000s, with firms organising (or reorganising) their research and innovation activities to optimise cooperation with external knowledge partners.

R&D-intensive multinationals were especially keen to seek proximity to public and private knowledge partners and increasingly clustered their activities in one or a few R&D centres, many of them close to carefully vetted university or technology campuses. In addition, they often had multiple small R&D centres around the world or in nearby knowledge ecosystems to support interesting developments. Firms

developed a global R&D footprint in this way that included one or more strategic global R&D hubs embedded in local knowledge and innovation ecosystems, supplemented by smaller R&D centres that could be used to gain (temporary) access to other knowledge ecosystems offering special expertise on specific subjects (Deuten, 2015). Strategic partnerships with select groups of universities suited this approach.

Universities expanding relationships

In the same period, universities were looking for new sources of research funding and new ways to perform their valorisation task (for social impact of knowledge). Public-private research partnerships were a good fit because they offered both substantial co-financing from firms (and other partners) and interesting research programmes. Before the millennium, universities mainly used PPPs as a new way to set the research agenda and fund their research. Gradually, PPPs also offered universities a new way of organising research, for example within multidisciplinary research projects or in interfaculty (or even interuniversity) research groups. Universities also began promoting themselves as entrepreneurial institutions and members of regional innovation systems.

Use-inspired basic research

Parallel to the universities' growing interest in PPPs, Dutch national research policy increasingly came to focus on strategic PPPs in which a select group of firms and universities cooperated on research, such as the Industrial Partnership Programmes (IPPs) run by the Foundation for Fundamental Research on Matter (FOM) (now part of NWO) (de Witte, 2012). The introduction of IPPs in 2004 illustrates the change in the scientific community's attitude towards cooperating with industry. In FOM's analysis, the worlds of industrial R&D and academic research had grown too far apart; both sides had lost interest in each other. In its strategic plan, its stated aim was to turn the culture around towards innovation.[14] In an effort to bridge the gap, it rejected the disparity between basic research (interesting for universities) and applied research (interesting for industry) as unproductive and instead proposed the notion of use-inspired basic research. Viewing things from this perspective would create new opportunities for cooperation in strategic public-private partnerships.

Regional expectations of strategic partnerships

14 FOM was a forerunner in this way. From 2012 on, NWO has also sought closer cooperation with industry after part of its budget was earmarked for research in the 'top sectors' of Dutch industry, as part of the government's innovation policy. This new focus was further embedded in NWO's 2015-2018 strategy, with the organisation aiming to encourage collaboration and interconnectivity in research 'even more than in previous years', and with public-private partnerships being given an important role in this regard (NWO, 2015). In its new strategy for 2019-2022, which bears the revealing title Connecting Science and Society, NWO writes that it 'will continue to make public-private and public-public partnerships in research possible. Various possibilities will be made available to participate with money, expertise or knowledge. (…) In recent years, several institutional forms of collaboration have been started in which NWO collaborates with other parties over a period of many years. [Examples include the strategic partnerships ARCNL, ARC CBBC and QuTech.] In the next strategy period, NWO will evaluate these relatively new forms of collaboration so that the experiences acquired can be used to further improve the concepts.' (p. 75).

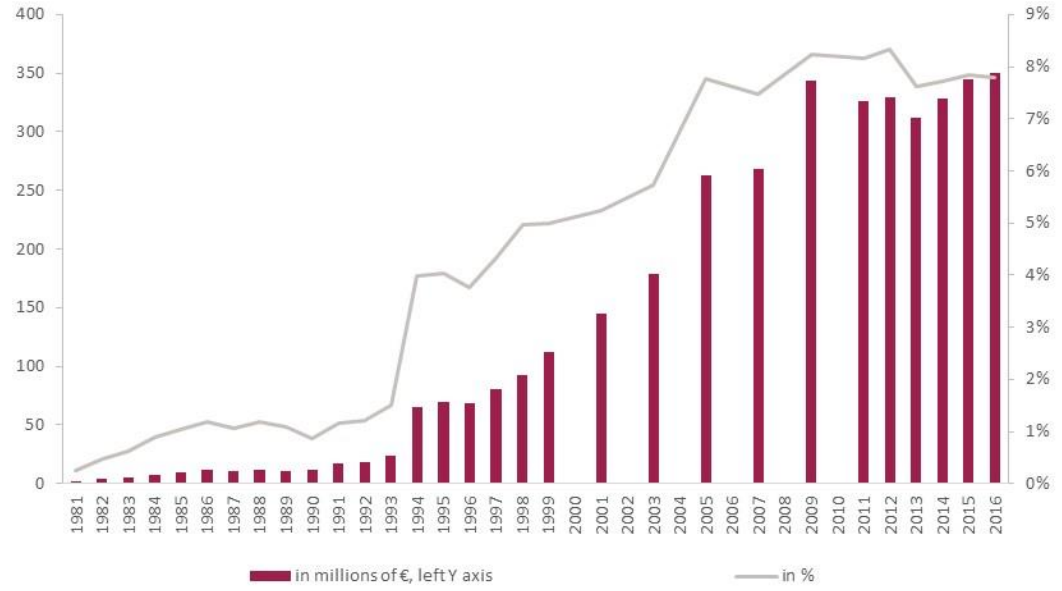
Regional governments became more aware of the contribution that knowledge institutions and ecosystems could make to regional economic development. Municipal and provincial authorities began to co-finance PPPs because they expected them to boost the local or regional economy. Strategic partnerships complemented local and regional development strategies because they took the form of multi-year agreements in which firms committed themselves to local knowledge institutions.

Emergence of strategic partnerships
From the 2010s on, a growing number of strategic university-industry partnerships have emerged as a new form of PPP alongside the existing forms. Universities, industry and governments each have their own reasons for participating in or supporting these partnerships. Strategic partnerships offer universities a way to (continue to) conduct leading research in emerging and fast-growing fields, such as artificial intelligence, with sufficient critical mass to benefit from the knowledge, expertise, data, investments and other advantages of private partners. Strategic partnerships give firms a new way to use external sources of knowledge for research that has so much strategic value that they do not want to organise it in broad, open public-private consortia. Strategic partnerships are also suitable for knowledge requirements that are too complex and multidisciplinary to be organised through bilateral contract research. Firms have a major say in determining the research programmes undertaken by strategic partnerships.

Partnerships suit policy
Strategic partnerships are well suited to the current policy context, both in industry (where the aim is to make better use of public knowledge institutions) and at universities (where researchers are urged to actively pursue knowledge valorisation). The Dutch government encourages strategic partnerships mainly through the PPP allowance and in some cases by means of direct funding. Depending on their financial robustness, regional governments make smaller or larger investments in such partnerships with a view to boosting the regional economy.

Industry increasingly funding university research
The emergence of PPPs is part of a trend that sees firms and universities in the Netherlands increasingly cooperating in research. Figure 3 shows that firms began contributing significantly to university research in the 1990s, when PPPs started to emerge. While their contribution was still very modest in the 1980s, in recent years it has fluctuated at around 8% of the total R&D expenditure of universities and other higher education institutions. This increase has coincided with a changing set of policy measures in the Netherlands that through IOPs and TTIs increasingly channel universities towards PPPs and private co-funding of research.

Figure 3 R&D expenditure by Dutch institutions of higher education funded by industry (in millions of € and %)



Source: Eurostat and OECD

2.4 In summary

We began this chapter by asking how strategic research partnerships between universities and industry differ from existing forms of public-private partnerships in research. We also asked why these strategic partnerships have emerged in recent years. How can we explain their emergence?

Strategic partnerships are a new type of PPP
Based on our conceptual analysis, we can conclude that strategic partnerships are a new type of PPP. The cooperation in strategic partnerships is lengthier, more intimate and more selective than in other types of PPP, and it is aimed at building a close relationship that nurtures the mutual trust required for intensive cooperation.

A continuum, from 'networking' to 'strategic partnership'
We can position strategic partnerships on one end of a PPP continuum that runs from 'networking' to 'coordination' and from 'collaboration' to 'strategic partnership'.

In the 'loosest' configuration, cooperation is about maintaining networks between university and industry researchers, offering benefits to both parties. These are small-scale, often ad hoc research projects by students or PhD candidates where firms offer ideas, provide guidance, arrange internships and so on. The second type of PPP prioritises coordination. The primary goal is to better align academic research agendas with industry innovation agendas in broad public-private

consortia. The third type of PPP, collaboration, sets the bar higher; industry no longer merely offers programme guidance but becomes actively involved in specific projects. In the fourth type of PPP, cooperation is transformed into a strategic partnership. It is not only more selective but also more intense.

Three theories to explain strategic partnerships

We can explain the emergence of strategic partnerships by combining three theories: transaction cost theory, innovation economics and economic geography. Transaction cost theory demonstrates that strategic partnerships allow firms to reduce their transaction costs. Strategic partnerships come about when it is more cost-effective to build a close relationship with a well-chosen strategic partner than to find new project partners time and again. Innovation economics emphasises that innovations come about by combining differing public and private parties. PPPs allow firms to coordinate and organise the interaction; strategic partnerships arise when the challenge of coordination becomes complex. Economic geography emphasises the importance of 'proximity' in cooperation. Strategic partnerships allow firms to increase the various dimensions of proximity (geographical, cognitive, organisational and social) so that they can cooperate effectively in research.

Strategic partnership as a response to changing strategies

The emergence of strategic partnerships may also be a response to the changing strategies of industry, universities and governments. Large R&D-intensive firms increasingly favour 'open innovation', bidding farewell to their large-scale in-house research labs and relying more heavily on cooperation with external knowledge partners. Influenced in part by the globalisation of R&D, they are changing the locus of their R&D as well as their partners and method of cooperation. The growing focus on strategic partnerships complements the rationalisation they have pursued in their alliances with external partners and the rearrangement of their global R&D footprints into one or more large-scale strategic R&D centres *('*global hubs*')* that are firmly embedded in the surrounding knowledge and innovation ecosystems, supplemented by smaller R&D teams that are able to tap into interesting knowledge ecosystems *('*knowledge hotspots*')* worldwide.

Universities have come to rely increasingly on the third funding stream in recent decades, and government policy has also challenged and encouraged them to cooperate with industry. After several decades of PPP, university research groups are much better able to find partners in industry with which to cooperate on research questions. Regional governments have also become more involved in research and innovation PPPs in recent years in a bid to boost their regional economies. Because strategic partnerships support longer-term cooperation, they appear to offer additional opportunities for regional development, especially when firms locate their R&D centres near universities.

3 An empirical study of strategic partnerships

After our conceptual study in the previous chapter, in this chapter we describe the results of our empirical study of strategic public-private research partnerships. We look at three different strategic partnerships between universities and firms: Chemelot InSciTe, DELTA Lab and ARCNL. In our review of each case study, we examine (a) what motives the partners have to engage in a strategic partnership, (b) what agreements the partners make with each other, and (c) how the partners have experienced the reality of their strategic partnership.[15] In the next chapter, we combine the findings of our conceptual and empirical studies to create a typology of strategic public-private research partnerships.

3.1 Chemelot InSciTe

The Chemelot Institute for Science and Technology (InSciTe) was founded in 2014 by the Province of Limburg, chemicals giant DSM, Eindhoven University of Technology (TU/e), Maastricht University (UM) and Maastricht University Medical Centre+ (MUMC+). The institute brings the universities and DSM together to cooperate on research and innovations in two areas: biomedical materials and biobased materials.

InSciTe's activities cover about 80 FTEs with a budget of € 60 million over a six-year period. The Province of Limburg contributes € 30 million through its subsidiary Chemelot Scientific Participations, while the other founding partners each contribute € 10 million.[16] The province has also made a further € 20 million available through another subsidiary, Chemelot Research Facilities, to finance facilities on the host campus. InSciTe also makes use of the PPP allowance scheme run by the Ministry of Economic Affairs and Climate Policy.[17] InSciTe is located on the Brightlands Chemelot Campus, a former DSM location in Sittard-Geleen. In addition to its own facilities, InSciTe uses other laboratory and cleanroom facilities on the Chemelot campus as well as its partners' facilities.[18] The Chemelot facilities are managed by

15 For more information on the research approach, see Appendix 2.
16 Chemelot Scientific Participations and Chemelot Research Facilities are investment organisations that are wholly owned by the Province of Limburg. UM and MUMC+ have joined forces and participate as one partner.
17 For every euro of private R&D funding that a firm gives a research organisation, the Dutch Ministry of Economic Affairs and Climate Change adds € 0.25 to the PPP allowance. The allowance was increased to € 0,30 in 2018. Source: https://www.rvo.nl/subsidies-regelingen/pps-toeslag-onderzoek-en-innovatie, Staatscourant 11 May 2018.
18 InSciTe has founding partners and partners (other participating companies, knowledge institutions). To avoid confusion with the other case studies that have only one type of partner, we use the terms founding partners and participants (or project partners) as much as possible.

the campus organisation and can also accommodate projects undertaken by external firms and knowledge institutions.

3.1.1 History

DSM's Central Laboratory began its transformation into the Chemelot campus in 2005. From that point on, a number of parties, including DSM, UM and the Province of Limburg, promoted the idea of expanding the campus into an open innovation campus, similar to Philips NatLab's transformation into the High Tech Campus. The idea complemented the Province of Limburg's evolving clustering and campus development policy, meant to boost the knowledge-intensity of the regional economy to drive future job growth. It was against this background that UM and MUMC+ joined forces with Zuyd University in 2013 to form the Limburg Knowledge Axis. The Knowledge Axis is a decade-long strategic programme geared towards enhancing the socio-economic structure of the province. The plan encompasses four campuses, the Brightlands Chemelot campus in Sittard-Geleen being one of them.[19] The Chemelot campus organisation, set up to make strategic investments on the campus appealing, noted a gap in the knowledge component of the Chemelot campus. That gap could be filled by establishing several research institutes, and InSciTe was suggested as one of them.

InSciTe was founded in 2014 for a six-year period by the Province of Limburg, DSM, TU/e, UM and MUMC+. Its purpose is to translate academic knowledge into innovative biomedical and biobased applications.

Each of the founding partners has its own motives for participating in InSciTe. The Province of Limburg wants InSciTe to support the Chemelot campus in its efforts to boost the knowledge intensity of the regional economy and Limburg's business climate. Job preservation and job creation play an important role. DSM's participation is important to the province because it allows the open innovation campus to build on DSM's experience in scaling up and commercialising technologies.

Participating in InSciTe appeals to DSM because it can work with universities and MUMC+ on research and innovation in domains that it considers strategically important. InSciTe can also spur the growth of the campus ecosystem, leading to a broader regional labour market that will attract talented employees. Thanks to InSciTe, DSM can easily keep track of interesting spin-offs and start-ups. This model, in which firms closely monitor, nurture and in some cases participate in start-ups, follows a trend pioneered in the pharmaceutical industry, where large

19 There are now four Brightlands campuses: the Chemelot Campus in Sittard-Geleen, the Maastricht Health Campus, the Greenport Venlo Campus and the Smart Services Campus in Heerlen. Source: https://www.brightlands.com/.

firms outsourcing some of their R&D to smaller firms and then absorb successful ones through participations or acquisitions. DSM and the Province of Limburg share a strategic interest in supporting a thriving ecosystem on the Chemelot campus.

InSciTe appeals to MUMC+ because it supports the practical usefulness of new findings; by participating in projects, it can scale up research and shorten the time to clinical use. InSciTe gives UM and TU/e an interesting and attractive way to perform their valorisation task.

The facilities make it possible to scale up research from small laboratory set-ups investigating materials measuring only a few grams to testing and demonstration facilities that can handle a few kilograms' worth. InSciTe is therefore attractive to the universities because it helps (future) application of the results of their research. InSciTe also functions as a network organisation for universities in linking the dispersed facilities and knowledge required for valorisation.

At the outset, InSciTe focused on two topics: biomedical materials and biobased materials. These topics parallel DSM's strategic investment domains and also reflect the interests of research groups active at the universities and MUMC+. The two topics were also identified in the Limburg Knowledge Axis programme. In terms of biomedical materials, the partners were able to build on a long-standing partnership in the Top Technology Institute for Biomedical Materials (TTI BMM) (which was winding down at the time).[20] There was no such history for biobased materials, and so the partnership still had to get off the ground. The focus was on close cooperation between TU/e and DSM.

3.1.2 Agreements

The founding partners of InSciTe have made various working arrangements about governance and decision-making, how projects will fit into the programmes, how much authority the participants will have, and how IP rights and scientific publications are to be handled.

InSciTe has a board whose members represent the founding partners. The number of votes are keyed to each partner's financial contribution, which means that Chemelot Scientific Participations has a major say in any decisions about the institute and the projects that it undertakes. The researchers select the PhD candidates and engineers-in-training to work on the projects.[21]

20 The managing director of BMM at the time has now become the managing director of InSciTe.

21 Research at InSciTe is closely aligned with university engineering programmes (leading to the degree PDEng or 'professional doctorate in engineering'). Students must complete a two-year, paid programme in which they train to become engineers. During training, they improve their knowledge of technology and learn to apply that knowledge in practice. They also develop their professional skills to improve their career opportunities in industry.

The two research domains, biomedical materials and biobased materials, are each headed by a programme director seconded from DSM. The programme directors propose new projects to the board and report to the board on the progress of current projects. Projects must be initiated by one of the founding partners. If at least three of the four founding partners are interested in the project, it can be undertaken as an InSciTe project. The three founding partners then become project partners. Other parties may also join projects. Firms and knowledge institutions participating in projects may use the InSciTe facilities.[22]

The founding partners put the available funds into a single 'InSciTe piggy bank' that is managed by the InSciTe board. That means that the founding partners cannot decide for themselves how their share of the funding will be spent. The board assesses and selects projects on predefined criteria. Because of the way the votes are distributed, Chemelot Scientific Participations casts the decisive vote in this form of shared agenda-setting. At the same time, the province's subsidiary relies on the expertise of the other board members when it comes to research-related decisions.

One of InSciTe's aims is to attract additional funding. It has therefore been agreed that InSciTe and its partners will also participate in EU programmes (such as Horizon 2020, ERDF and Interreg) and national programmes. That means that other – external – organisations such as TNO may act as project managers.

In addition to a project partner that coordinates the project, another project partner is responsible for valorisation. That project partner can be a public or a private party. This role, which is more commercial and entrepreneurial in nature, requires an extra financial investment, with the valorisation partner shouldering the task of filing for patents and covering the associated costs. There are therefore certain obligations associated with starting up a project, since one of the project partners must be prepared to take on this role and make the necessary investment. If there are any proceeds, however, they will go to that project partner first, to reimburse the cost of filing and maintaining the patent.

To safeguard the interests of all participants, InSciTe has an IP framework agreement that covers all projects.[23] The guiding principle is that in the event of publication, the knowledge institutions must allow for the patent application timeframe and the interests of industry. The IP rights are held by the project partner that employs the inventor(s)/researcher(s).

The valorisation partner is responsible for the patent filing process and the related costs. This partner also issues licences and is authorised by the other project

22 Alongside projects undertaken with UM, MUMC+ and TU/e.
23 See Appendix 3 for an explanation of IP rights and publications arrangements.

partners to negotiate with interested parties about the type of licence and the relevant terms and conditions. If the valorisation partner is interested in taking out a licence itself, then another project partner assumes this role.

After the valorisation partner's costs are reimbursed, the proceeds from patents are distributed among the project partners in proportion to each one's contribution. The founding partners deposit their share of the proceeds in the 'InSciTe piggy bank'. This system means that the benefits of what are ultimately commercially successful innovations also accrue to the Province of Limburg through its subsidiary Chemelot Scientific Participations.

3.1.3 Experiences

With respect to biomedical materials, the university and industry researchers have been able to build on prior partnership projects, specifically within the Top Technology Institute for Biomedical Materials (TTI BMM), which had been located on the Chemelot campus some years previously.[24] Many of them got to know one another through previous alliances and have learned how best to work together building mutual trust and organisational capacity in the process. According to the stakeholders, that is largely why new projects are able to get off the ground quickly. That ability has already led to a start-up and the development of several new products. Another contributing factor is that biomedical materials are an important growth market for DSM. Thanks to InSciTe, DSM researchers and staff are in close contact with doctors and academic researchers, allowing them to improve their knowledge of the market and immediately roll out experiments to see what works. Conversely, the physician researchers at MUMC+ benefit from DSM's efforts and experience, for example when filing for patents, ensuring quick and effective protection of IP. InSciTe's internal IP agreements are also helpful because they offer clarity in advance, with no need for discussion among project partners.

InSciTe helps researchers learn what is important for commercialisation (at a later stage). For example, medical applications require accurate experiments based on generally accepted and accredited methods. Academics, however, are more interested in the science and therefore prefer to work with cutting-edge methods. That can lead to tension between their academic curiosity and the need to comply with the customary testing methods for future certification. What the project teams do, for example, is to apply the generally accepted testing method first and try the newer method later. Researchers also learn how DSM markets a new product and attempts to meet market demand.

24 The Top Technology Institute for Biomedical Materials (TTI BMM) was founded in 2007. In 2010, it merged with the Center for Translational Molecular Medicine (CTMM) and in 2014, CTMM merged with Top Pharma Institute, now called Lygature (van der Zee et al., 2016). TTI BMM was originally located on the Chemelot campus. CTMM was in Leiden and moved to Utrecht after the merger. Source: https://www.tipharma.com/about-our-institute/history/# and https://www.lygature.org.

Examples of InSciTe projects

InSciTe works on projects in two domains that parallel DSM's strategic technology priorities: biomedical materials and biobased materials.

Biomedical materials
Projects focusing on biomedical materials include research on materials for vascular prostheses, materials that support self-repair in cartilage and stimulate its ingrowth, and the development of an ocular coil that serves as a drug-delivery system for the eye. One project team made up of TU/e, UM and MUMC+, DSM and Xilloc Medical are working on a new treatment for severe scoliosis (Patient Specific Scoliosis Treatment or PoSTuRe). Scoliosis patients have a deformed spinal column. In severe cases, surgery is required to straighten the spine with metal wires and rods. Young patients must undergo the procedure several times to allow for growth. In the elderly, who often have less bone strength, the procedure may cause bone fractures, necessitating more surgery. The project team is developing a new procedure in which the metal wires are replaced by broad, woven polyethylene cables that slide over bars. Screws are no longer needed because the cables are wound around the bone, preventing fractures of the vertebrae. The project consists of clinical trials of the procedure. The expectation is that the new procedure will lead to a dramatic reduction in the number of repeat operations.

Biobased materials
The projects exploring biobased materials focus on sustainable processes and materials that support the circular economy. Researchers are developing new chemical feedstock made of biomass that can replace fossil feedstock in industrial materials and chemicals production processes. The feedstock consists of second-generation biomass that does not compete with the food chain. As yet, the processes are still too energy-intensive and their yields do not always make them marketable.

Lignin refinery for marine fuel
In one of InSciTe's biobased projects, TU/e researchers are working to scale up a chemical biobased process that transforms lignin into lignin crude oil on a commercial scale. Lignin is a by-product of second-generation bio-ethanol. Lignin crude oil is more sustainable and environmentally friendlier than current marine fuels. The researchers are cooperating with a shipping company and a marine engine manufacturer. A multifunctional pilot plant has now been set up that can produce approximately 160 litres a day, allowing the partners to test the fuel samples. In 2017, the TU/e spin-off Vertoro was founded to commercialise the process.

The partners working on biobased materials had to get to know one another and figure out how to leverage their competences and interests to mutual advantage. In addition, shortly after the start of InSciTe, the market for biobased materials collapsed in response to falling oil prices. That made it much less interesting to DSM to involve itself in this area. In the ensuing discussion, it became clear that the other partners could offer limited support for a shift in research focus, so that research could proceed. Since then, there is more emphasis on sustainable process technology.

In practical terms, the founding partners of InSciTe always weigh up the various interests – academic, commercial, and public – as a group. For example, they do so when distributing the project funding and if one partner turns out to be contributing bigger projects than the other partners. Although they have agreed to put all the funding into a single piggy bank, it seems that they also consider whether an investment is sufficiently advantageous for their own organisations. In addition, they look at how InSciTe's facilities complement their own. For example, because MUMC+ has excellent facilities in Maastricht for preclinical trials and evaluations, they are performed there and not on the Chemelot campus. On the other hand, the campus has a pilot plant for biobased materials that offers many more options than the TU/e's campus facilities.

DSM is finding that long-term partnerships have both advantages and disadvantages. Close cooperation on biomedical materials is producing rapid results, but the long-term commitment in the area of biobased materials is making it difficult for the company to respond quickly to changing market circumstances. DSM believes that the solution may lie in its being one of the participating firms rather than a founding partner. It will then have the flexibility that the founding partners of InSciTe sometimes lack.

InSciTe offers university researchers new opportunities to work on valorisation. As a result, they spend a lot of time during InSciTe projects on research leading to new knowledge that accelerates product development. This type of research is less suited to producing scientific publications in prestigious journals, however. The faculties and board of MUMC+ recognise the importance of InSciTe's activities and they are therefore experimenting with a new researcher assessment method that will consider more than number of publications and impact scores. At the same time, MUMC+ has noted that not everyone is suited to working with industry, nor is that a requirement. MUMC+ wants to differentiate researcher assessment and in that way come up with an appropriate method for encouraging achievements in both applied and basic research.

The Province of Limburg has a vested interest in a regional economy that creates and can offer employees knowledge-intensive jobs. In the province's view, InSciTe

should support an open innovation campus that will drive the knowledge-intensive economy that it has envisaged. The province regards the Chemelot campus (along with the other Brightlands campuses) as 'an economic and spatial driver' for the South Limburg region, but considers it too soon to judge whether InSciTe will have the desired impact.

Although DSM is now only one of many firms with a presence on the campus, the chemicals giant is also a defining factor in InSciTe's image and therefore influences which new firms the partnership can attract. Formally, InSciTe welcomes all and sundry (as project participants), even DSM's competitors and counterparts in the industry, provided one of the founding partners sponsors the project. In reality, however, it has turned out to be difficult to attract new partners because InSciTe is viewed as a partnership between DSM, knowledge institutions and the Province of Limburg. That is why in the next phase, InSciTe is considering making DSM one of the participating firms rather than a founding partner with a seat on the board that decides on projects. At the same time, all the partners acknowledge that DSM's participation as founding partner has been a key success factor. It would have been difficult if not impossible to get InSciTe off the ground without the firm's commercial experience and familiarity with the scaling-up process. None of the other founding partners had expertise in these areas.

3.2 DELTA Lab

The Deep Learning Technologies Amsterdam (DELTA) Lab was founded in April 2017 by Bosch and the University of Amsterdam (UvA).[25] DELTA Lab conducts use-inspired basic research: it develops models and algorithms that enable machines to learn from data and experience. The research laboratory is integrated into the Informatics Institute (IvI) at Amsterdam Science Park.

Nine PhD students and one postdoc work in DELTA Lab. Bosch is contributing € 3 million over its four-year term. The lab has been awarded a PPP allowance (€ 0.75 million) by the Ministry of Economic Affairs and Climate Policy. The IvI contributes in kind by supervising PhD students. It also houses the QUVA Lab (14 FTEs), a strategic partnership with chip manufacturer Qualcomm.

25 The German multinational Bosch is best known in the Netherlands as a manufacturer of refrigerators, washing machines and drills, which it started producing in the 1930s to cope with a downward trend in the automotive industry. Founded in 1886, the firm has nevertheless become well known as a manufacturer of electrical components and systems for cars, including drive systems, starter motors and generators, and steering and braking systems.

3.2.1 History

DELTA Lab came about because Bosch needed expertise in artificial intelligence (AI) and talented AI researchers and wanted access to the crème de la crème of the scientific community in this field. An automotive industry supplier, Bosch was aiming to deliver intelligent software systems for self-driving cars. More generally, it wanted to transform itself from a hardware manufacturer into a supplier of software, plant data-gathering services, and software services. It was also keen to use AI in products other than cars and in its own production and testing facilities. AI therefore had to become one of its core technologies.

To effectuate this transformation, Bosch sought to cooperate with several different public knowledge institutions and firms. In 2016, it established the Cyber Valley consortium with its partners the German federal state of Baden-Württemberg, the Max Planck Institute for Intelligent Systems (Tübingen and Stuttgart), the University of Tübingen, the University of Stuttgart, BMW, Facebook, IAV, Daimler, Porsche and ZF Friedrichshaven. Amazon joined the consortium in October 2017. The consortium aims to create an 'ecosystem for technology transfer in the field of Artificial Intelligence through a new model of cooperation between science and industry'. It consists of five Max-Planck research groups, four university research groups, about ten new chairs, and a research school that will train one hundred PhD students in six years' time.

Deep Learning

DELTA Lab performs research on deep learning. Raw data (e.g. texts, medical scans) are used to attain a 'digital target' (e.g. a diagnosis advising a particular therapy). Using large amounts of raw data, a deep learning model can itself derive the best estimate of the digital target. That estimate is not based on predetermined hypotheses or facts (e.g. certain physical traits) but on the model's ability to recognise patterns. The focus of research is the development of effective, fast and reliable models. Computer labelling of data, possibly with external assistance, plays an important role. Not all models are equally successful across all applications: in medical applications, what matters is the ability to distinguish between details; in traffic applications, image contrast is important. Deep learning applications include speech recognition in smartphones and recognition of road signs by automobiles.

To build its internal knowledge and knowledge absorption capacity, Bosch established the Bosch Center for Artificial Intelligence (BCAI) in 2017. BCAI employs about 100 FTEs divided between an academic research group in Renningen (Germany) and two applied research groups in Bangalore (India) and Palo Alto (USA). The externally recruited BCAI director brought Bosch special knowledge of and experience working with AI. Bosch also used BCAI to gain access to the academic world; its aim was to boost its knowledge base in AI by collaborating with leading research groups.

It was in that context that Bosch approached UvA professors Max Welling and Arnold Smeulders. Welling's machine learning research group and Smeulder's computer vision group work on the cutting edge of science. Bosch proposed funding a joint laboratory in deep learning with UvA. Its reasoning was that basic research on deep learning would ultimately produce answers to a number of questions in which it had a critical interest, such as how deep learning works and how reliable it is. The professors would select the research topics. The proposal was an appealing one for Welling and Smeulders because it allowed them to attract large numbers of PhD students to work on their research agendas. They would no longer have to seek project funding by competing for public research grants. A further factor was that public funding of AI research had not kept pace with the enormous growth and progress in AI in recent years.[26] The private sector had therefore become an important source of funding for the researchers.

The university takes a positive view of public-private partnerships, provided that both the university and industry benefit; partnerships have little chance of success otherwise. The university feels it is important for the proposed research programme to be compatible with the research group's existing programme. A partnership makes additional industry funding available and helps to build research capacity. It also helps the university fulfil its knowledge valorisation task. Because university research is generally not suited to solving short-term problems, the university board wants to be sure that the suggested research programme addresses longer-term business interests, for example its strategic business plans. The board also reviews the proposed arrangements, which it insists must comply with requirements imposed by the academic world and government, such as publication rights.

26 In April 2018, the EU urged public and private sectors to increase their research and innovation budgets in the field of artificial intelligence by at least € 20 billion between April 2018 and the end of 2020. The European Commission has raised the amount earmarked for artificial intelligence in the Horizon 2020 programme to € 1.5 billion (https://ec. uropa.eu/growth/content/commission-outlines-european-approach-artificial-intelligence_en).The International Center for Artificial Intelligence (ICAI), established in April 2018 by UvA and VU (see the report text below), has joined five other institutes in the European Lab for Learning and Intelligent Systems (ELLIS). Source://www.theguardian.com/science/2018/apr/23/scientists-plan-huge-european-ai-hub-to-compete-with-us

There were no other parties or public partners involving in establishing DELTA Lab. The lab would welcome other partners subject to the approval of both UvA and Bosch.

IvI – the institute that houses DELTA Lab – had already established a similar public-private partnership in 2015 when an academic spin-off (EUVision) was sold to US chip manufacturer Qualcomm.[27] When Qualcomm wanted to work with UvA researchers on basic research projects, it joined forces with IvI in setting up the QUVA Lab, whose research programme is determined in the same way as that of DELTA Lab. Qualcomm has a vested interest in the patents produced by QUVA Lab, and the lab also gives the firm access to the academic world, knowledge and talent.

3.2.2 Agreements

Bosch and the UvA negotiated the research programme, the duration of the partnership, the financing, the working arrangements, and the intellectual property and publication rights. DELTA Lab's research programme was the focal point of their cooperation. Bosch asked professors Welling and Smeulders to draw up a proposal describing the overall research topics. After a brief discussion, Bosch approved the proposal, making minimal changes. The professors then got to work defining the specific projects that would be carried out under each topic and recruiting and selecting researchers (most of them PhD candidates).

DELTA Lab was established for a four-year period (the length of time a PhD candidate needs to complete his or her doctoral research). The contract does not include a renewal option. When the time comes, the partners will decide whether or not to continue their partnership, depending on their experiences, options and plans. The DELTA Lab partners (the professors and BCAI director) have a management meeting once every six months. The lab draws up quarterly updates and an annual financial report.

The partners make work arrangements to facilitate efficient knowledge exchange. Each research project is assigned to a Bosch employee from BCAI who is in regular touch with the DELTA Lab researchers. BCAI staff members are researchers themselves who publish in the same journals as the UvA group. Frequent meetings allow them to track the progress and substance of the research. The employees of DELTA Lab's partner organisations are also getting to know one another better in

27 15% of EUVision's shares were held by UvA (part of the proceeds went to the faculty), and the other shares (approximately 20%) were held by the spin-off's employees and owners. Smeulders was one of its co-founders. The value of the acquisition has not been disclosed. An NRC article refers to 'millions'. Source: https://www.nrc.nl/nieuws/2014/10/10/hoe-het-grote-qualcomm-een-kleine-universitaire-startup-uit-amsterdam-kocht-a1499572

other ways. The PhD students spend about a month at Bosch in Renningen every year while BCAI staff work in the DELTA Lab for short periods. These exchanges have benefits on both sides: PhD students gain business experience and expertise, while BCAI staff brush up their research skills.

The partners have agreed that the IP rights to the research results will be transferred from DELTA Lab to Bosch. This agreement follows the rules drawn up in the Netherlands for PPPs (see Appendix 3), which state that if a firm finances (almost) all of a lab's work, it is entitled to the IP rights – and that is certainly the arrangement in the case of DELTA Lab. This agreement allows Bosch to protect its commercial interests.[28]

It is important to the university researchers to be able to publish their results. The agreement with Bosch stipulates that they may do so. Bosch does check the articles beforehand for any patentable information and to ensure that they do not inadvertently disclose confidential information.

The partners have also agreed on the open-source software used by DELTA Lab. The software is available to non-profit organisations (such as universities) free of charge, but not always to commercial parties. In some instances firms must pay to use this software or are obliged to disclose any programmes and applications that they have developed with it. The agreement makes it easier for Bosch to continue developing DELTA Lab's results later.

3.2.3 Experiences

DELTA Lab was still in its start-up phase in late 2017. Both UvA and Bosch regard the initial experiences as positive. BCAI is happy about the quality of the research and the expertise available in Amsterdam.

The UvA's lab directors appreciate the involvement of the BCAI directors and staff and the freedom that they are given to set the research programme and select projects. BCAI staff are involved in the research projects (meetings) but do not interfere in their management. According to the lab's directors, they are very knowledgeable about the science itself, and because they limit themselves to asking interesting questions and making suggestions, the lab directors feel that they respect their academic freedom.

Cooperation between the university and Bosch is smooth in part because the latter has allowed its research staff at BCAI the necessary discretion to do basic research. The firm's corporate culture supports taking a longer view by investing in

28 Bosch has already filed for patents.

staff and knowledge. One plus point is that Bosch is not a listed company and is therefore not subject to share price fluctuations and shareholders who want to see a short-term return on their investment. Even so, Bosch does expect short-term results from its investment in AI research. The purpose of BCAI is to see that a certain percentage of Bosch's revenue and cost savings are derived from AI-related applications by 2021. BCAI has established applied research groups to work towards meeting that aim. Its academic research group functions as a bridge between basic and applied research.

For the lab directors, close cooperation with Bosch means that PhD researchers can take on teaching tasks as part of their academic training, helping the staff bear some of the teaching load. That load has become considerable thanks to the popularity of AI, which attracts 160 Bachelor's students and 100 Master's students to the programme every year.

The lab directors have also noted the enormous popularity of research places in the DELTA Lab.[29] The lab received more than 450 applications from around the world for ten places. The candidates, both Dutch and foreign, are of exceptional quality. Many of them previously studied at prestigious universities or were working for leading high-tech firms. Candidates find the laboratory attractive because it is partnered with a renowned firm, Bosch, and gives them access to leading scientists.

Professors Welling and Smeulders have also positioned the DELTA Lab as part of the Amsterdam AI Ecosystem. They have two reasons for doing so. First of all, they want to attract and retain talent in the face of global competition for talented researchers and research investment in AI. High-tech firms such as Google (which acquired Deepmind in 2014) can recruit AI researchers by offering them high salaries and allowing them to continue their research work in-house. That makes it challenging for the UvA to hang on to AI research staff. Welling and Smeulders and other AI professors working in Amsterdam are therefore promoting the use of AI in local companies – including start-ups. Sometimes the UvA is involved in founding spin-offs, either by providing co-financing (UvA Holding) or because its own staff members work there.[30]

AI researchers find it appealing to work in an environment where business activities take place alongside scientific research. Local businesses retain research staff but also graduates for the region. The majority of PhD candidates come from abroad. About half will remain in the Netherlands after receiving their doctorates to work for

29 The lab directors refers to the two directors (professors Welling and Smeulders) and the scientific manager Zeynep Akata.

30 UvA researchers can also set up their own start-up or spin-off, albeit subject to certain rules. For example, the business activities must be appropriate and not compete with the UvA's other activities. If permission is granted, limits are set on the amount of time that the researcher may spend on the spin-off, the amount of time that he or she may devote to it outside working hours, and the facilities or knowledge that he or she may use.

spin-offs specialising in image recognition, giving rise to a local network of specialists in these firms. The professors believe that this concentration of knowledge will attract even more talent, fuelling the growth of the Amsterdam AI Ecosystem.

Another reason for developing an Amsterdam AI Ecosystem is that the professors want to help embed an advanced knowledge of AI in the Dutch economy. Together with other UvA and VU colleagues, they invited the CEOs of Dutch companies for a meeting to persuade them of the importance of partnerships such as those with Qualcomm and Bosch. Their message was that, if Dutch industry is to remain competitive, it needs AI-related knowledge generated in the Netherlands and based on Dutch data. One recent development is the International Center for Artificial Intelligence (ICAI), launched by the UvA and the VU in April 2018 and dedicated to driving innovation in AI public-private partnerships. After the joint labs with Qualcomm and Bosch, this is the third university-industry lab, this time involving a PPP with Ahold-Delhaize (AIRLAB); its researchers focus on studying AI for retail applications. The UvA and the City of Amsterdam are planning to build a new AI facility in the Amsterdam Science Park to house new and existing ICAI Labs, for teaching purposes, and to support cooperation with other faculties, SMEs and civil society partners.

The UvA and DELTA Lab researchers do not feel that their academic freedom has been restricted. They can share all their discoveries and ideas openly within the IvI, the organisation to which they officially belong. They can also interact normally with the wider academic community. There is one proviso, however: researchers must not obstruct patent applications and must therefore observe secrecy prior to publishing their results.

3.3 ARCNL

The Advanced Research Center for Nanolithography (ARCNL) was founded in 2014 by the Foundation for Fundamental Research on Matter or FOM (which became part of NWO in 2017), the University of Amsterdam (UvA), VU Amsterdam (VU) and ASML, the world leader in the production of lithography machines that define the structures of processor and memory chips. The Province of Noord-Holland and the City of Amsterdam supported the initiative by providing joint start-up funding. ARCNL conducts basic research in the fields of physics and chemistry, inspired by current and future key technologies in nanolithography; the current focus of research is the production and use of extreme ultraviolet (EUV) light.

ARCNL currently has about 70 FTEs on staff, with plans to expand to 100 FTEs. Its ten-year budget amounts to € 100 million, with NWO providing € 22.5 million, the universities € 12.5 million each, ASML € 35 million and the Province of Noord-

Holland and the City of Amsterdam € 5 million in start-up funding. The Ministry of Economic Affairs and Climate Policy has awarded ARCNL a PPP project allowance tied to ASML's contribution. The remainder of the budget is derived from research grants and projects undertaken with other partners. The institute has its own building in Amsterdam Science Park, next door to AMOLF, a Dutch research institute that studies the physics of complex matter.[31] ARCNL shares a number of research activities, advanced facilities and support staff with AMOLF. In organisational terms, ARCNL is one of NWO's research institutes.

3.3.1 History

ARCNL came about because ASML wanted to find a new way to mobilise academic knowledge for the development of a new generation of machines to manufacture microchips. Until then, it had mainly done so by funding PhD researchers at various universities and research institutes. There were limits to this approach, however, because individual PhD researchers could only work on a small part of a problem, whereas the complex technological challenges that the firm was facing required answers to larger, multidisciplinary questions. It also proved difficult to retain the knowledge it had acquired from the academic world, and to ensure continuity in its research. ASML therefore needed to set up its own research institute in which a large number of researchers would investigate several interrelated topics over a longer period.

To achieve this, ASML issued a call for the founding of a research institute that would undertake large-scale basic research into the physics and chemistry of nanolithography, starting with EUV nanolithography. ASML wanted to use EUV in the latest generation of lithography machines to produce microchips that would offer more functionality for computers and electronic equipment. The firm invited four parties to submit proposals (giving them only six weeks to do so): FOM Institute AMOLF, Radboud Universiteit, Eindhoven University of Technology, and Rheinisch-Westfalische Technische Hochschule in Aachen, Germany. ASML asked the parties to come up with a proposal that addressed not only the science but also the funding and governance aspects of the new institute.

FOM indicated its interest in participation by promising equal support for the three Dutch proposals. ASML's call fit in well with FOM's own Industrial Partnership Programme (IPP), set up in 2004 to encourage research alliances between science and industry. The IPP promotes advanced physics research to drive innovation in

31 AMOLF scientists are continuously searching for the fundamental relationship between the architecture and interactions of complex matter and material systems and their purpose and function. Such a 'system' can be a complex of biomolecules with properties that make life possible. It can be a nanostructure of a semiconductor with metal particles that capture light. Or a newly designed material with very different mechanical properties than you might expect. What exactly is happening at the macro-, micro- or nanoscales and how can this be explained?' (https://amolf.nl/about/about-amolf)

firms; it not only supports the generation of new knowledge but also helps build relationships between academic researchers and industry. Between 2009 and 2014, ASML had itself been involved in a FOM IPP with Twente University and printing and copying equipment manufacturer Océ.

ASML ultimately selected the proposal that AMOLF, the UvA and the VU had put together, and that would eventually be known as ARCNL. As a team, they offered wide-ranging expertise. The Amsterdam proposal convincingly linked ASML's questions to existing scientific expertise at universities and institutes by indicating which professors and researchers would be appointed as group leaders. This made for a very solid proposal. In addition, ARCNL's proposed research groups lined up with ASML's own research topics. The ARCNL organisation could be set up without delay with AMOLF's technical and administrative support and taking AMOLF's structure as its basis. The siting of the research centre also made the proposal appealing. ASML had relatively little experience working with researchers in Amsterdam, and ARCNL gave it access to an entirely new group. That would allow ASML to acquaint itself with talented young researchers who might later work for the firm.

Once the Amsterdam proposal was selected, the stage was set for FOM, UvA, VU and ASML to establish ARCNL in 2013. The institute began operating officially on 1 January 2014, initially as an AMOLF unit. During the start-up phase, it hired some 50 staff members. In September 2015, it became an independent NWO institute.

The new institute appealed to the research group leaders invited to join for different reasons. They would be able to concentrate entirely on research within the context of a large, coherent programme, a more attractive proposition than combining various small projects under different programmes. Also appealing was the fixed nature of much of the funding, as it guaranteed a basic budget for PhD researchers and postdocs (approximately two per research group). In addition, the institute made it possible to gain experience in basic research in an area in which an industrial user had expressed interest.

The Amsterdam proposal also had the support of the City of Amsterdam and the Province of Noord-Holland. In addition to the funding provided by FOM, the universities and ASML, the new institute also received € 5 million worth of start-up funding from the province and the city jointly. Their purpose was to support Amsterdam Science Park and the Amsterdam region as a high-tech hub in a broader sense. ARCNL would connect Amsterdam more solidly to the Brainport region around Eindhoven. It was also expected to lead to spin-offs and new business in the Amsterdam region. The other parties looked favourably upon the involvement of the provincial and the municipal authorities not only because they offered financial support but also because they would cooperate on or facilitate permits and other official matters.

3.3.2 Agreements

ARCNL's partnership agreement sets out arrangements regarding a number of different subjects. Below, we review the usual items: the term of the agreement, provisions regarding parties that wish to withdraw, decision-making about the research programme, intellectual property and publications, support for researchers' careers, and location.

The institute is to operate for a minimum period of ten years. The partnership agreement stipulates how the partnership can be renewed or terminated. As of the end of 2018, each party can decide, at a given moment, whether or not it wishes to proceed. Parties may withdraw with due observance of a five-year notice period. This allows PhD candidates to complete their research and gives the other partners time to find replacements and to reorganise the institute.

The board of the ARCNL is the most important joint decision-making body for the partners (NWO, the universities and ASML). One of its tasks is to make changes in the focus of research where necessary. ARCNL's initial research topics and choices were based on the original proposal. To ensure that the research programmes reflect the changing interests of the stakeholders, the board decided to make changes, at the director's proposal. As a result, the new strategic plan (2017-2022), sets out plans to expand ARCNL by adding a number of new research groups. In addition, one of the present lines of research will be wound down over the next few years. The board must approve the appointment of research group leaders. It has no say over appointments and other research-related matters *within* the groups. That responsibility lies with the research group leaders. To ensure the quality of the research, a scientific advisory committee has been appointed and meets once a year.

In terms of IP rights, the partners have agreed that all research results generated by ARCNL may be published and presented, but that ASML is entitled to file patents (a 'right of first refusal'); in return, it will pay a pre-determined, market-compliant fee (see Appendix 3). Draft publications must be submitted to ASML first so that it can check for confidential or patentable information. Publication may be held up for a maximum of thirty days (researchers in fact usually receive an answer within two weeks and the total delay is not more than about four weeks). Under certain circumstances, publication may be postponed twice more for a maximum of two months. In reality, a postponement need not be an obstacle, since the route to publication in an academic journal generally takes longer than the initial stages of the patent filing procedure.

ARCNL wants to attract researchers who aspire to a scientific career. That is why it was set up as an NWO research institute and why most of its research staff are seconded from the universities. In addition, it has been agreed that individual

researchers may apply for funding and personal grants for their ARCN work from such sources as NWO and the European Research Council. Funding of this kind is of huge importance for their research careers.

To help ARCNL attain its scientific aims, the partners decided to house all researchers in the same building. Occupying temporary premises close to its final location has allowed the institute to make a quick start. It will move into the new Matrix VII Building as soon as it is ready. Several different organisations will use the new building's laboratories and offices, with ARCNL leasing approximately a third of the available space.

3.3.3 Experiences

ARCNL was able to get off the ground fairly quickly in 2014 thanks to its close organisational relationship with and proximity to AMOLF. Initially, ARCNL was an AMOLF unit, which allowed it to use the research institute's facilities and support staff. The cooperation between the two organisations continued even after ARCNL became an independent entity. ARCNL pays prearranged fees to borrow AMOLF's support staff (technical, human resources, financial). AMOLF and ARCNL also engage in several joint research activities. AMOLF has influenced ARCNL in other ways; for example, ARCNL has adopted a number of its customs, including a daily coffee break attended by the entire staff, as at AMOLF, that is an effective and informal way of sharing information.

ARCNL research group: atomic and plasma physics

The tinier the circuit elements on a silicon chip, the more functionalities can be crammed on it and the more smartphones can do. The latest microchip-making machines (known as wafer steppers) therefore use light of increasingly narrower wavelengths to 'etch' even more lines on chips. ASML's latest generation of wafer steppers uses extreme ultraviolet (EUV) light with a wavelength of 13.5 nanometres, a factor of fourteen times narrower than in the previous generation of devices. EUV light is generated by firing two rounds of microscopic laser pulses at a droplet of tin. The first pulse accelerates and deforms the droplet into a pancake shape. The second, more powerful pulse turns the droplet into a plasma that emits EUV light.

Although ASML is already building machines using EUV light sources, ARCNL researchers in the EUV Plasma Processes research group focus on answering fundamental questions about this process. How do the droplets of tin become

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deformed? How does the plasma emit light? How do the atoms behave in the plasma? Their research provides a better understanding of why atoms emit light at certain wavelengths and the conditions that can alter this spectrum. The research makes a contribution to atomic and plasma physics. Research on plasma light sources is also useful in microscopy, for example. For ASML, the research can help improve the efficiency of EUV light sources.

ARCNL's EUV Plasma Processes group often collaborates with its EUV Generation and Imaging group, which studies laser systems. Besides being in frequent touch with ASML in Veldhoven, the group's PhD candidates spend a number of weeks at the firm's manufacturing plant in San Diego to get better acquainted with the practical side of the business. The research group also shares its results and experiences with other science institutes, for example the Los Alamos National Laboratory and the Max Planck Institute for Nuclear Physics in Heidelberg.

The ARCNL partners are learning to deal with the differences in one another's time scales. ASML tends to scale up, make changes or terminate projects quickly. The academic world is used to the notion that research takes time to get started and that it can take a year to deliver initial results. These differences can be attributed to the different priorities of the two worlds. At ASML, commercial interests take precedence, whereas at the university, the researchers' academic interests and their reputations are a priority.

When it comes to the research programme and how they carry out their research, ARCNL researchers face the challenge of combining their academic interests and working methods with the firm's commercial interests and practices. If ASML sees an opportunity to valorise anticipated results in the short term, it immediately assigns its own researchers to the task and carries out the research itself. In reality, the combination works best when research projects are defined such that the anticipated results match ASML's interests but are only of interest to the firm in the longer term.

ASML's challenge is to bear in mind the academic time scale and culture when dealing with ARCNL researchers. It also needs to be more patient than it usually is about potential results. ARCNL is interesting to ASML because it represents a new way to acquire knowledge and because it focuses on basic research and the longer term.

Research planning at ARCNL complements both worlds. The research is performed primarily by PhD candidates and postdocs, so that the subjects of individual

research projects are fixed for a period of approximately four years (two years for postdocs). By setting up subsidiary projects that take about a year to complete (a single chapter or publication), the research satisfies both the academic requirements and the firm's need for shorter-term results.

Recently, the institute introduced an annual 'ARCNL Strategy Day'. ASML, NWO, UvA and VU representatives meet to hammer out the research plans. In the run-up to the meeting, each of the ARCNL research groups goes through a rigorous coordination phase. Researchers discuss every aspect of their research with the partners involved so that they can arrive at detailed plans for the coming year as well as longer-term prospects.

ARCNL researchers are actively involved in the process related to ASML's intellectual property. If they come up with ideas during their research that might be interesting to ASML, they fill in an 'Invention Disclosure Form' that closely resembles a form used at ASML. The firm then scans the forms for patentable concepts.

It is crucial for the partners to build mutual trust and understanding so that they can allow for one another's differences. That is why ARCNL researchers and research group leaders are regularly in touch with their contact persons at ASML. In addition to telephone calls and e-mail exchanges, they also have scheduled face-to-face meetings. ARCNL encourages this by coordinating its main research topics with the research categories at ASML itself.

How much contact there is depends on the line of research and also on the extent to which the 'academic' part of the research is user-relevant. Other methods of promoting cooperation are co-location (temporary) and staff exchanges. ASML's director of physics and chemistry research spends a day at ARCNL every other week. ASML has also seconded one of its working group leaders to ARCNL. ASML researchers can also work at ARCNL for a period of time (and vice versa), although so far this has been a fairly rare event.

ASML staff are closely involved in the research, not only to monitor progress but also to share knowledge. Thanks to this relationship, ASML staff can internalise new information more rapidly, ensuring that ARCNL's research results help ASML more forward with the technology. On the other hand, ARCNL researchers are discovering just how advanced and deep the firm's knowledge base is. The company's experience, test results and any new questions that it is addressing all serve as input for ARCNL's research.

ARCNL has impacted its environment in a number of ways. One effect relates to the way that university funding is arranged. The relevant faculties mainly contribute in kind by seconding researchers to ARCNL. This makes the institute something of

an oddity within the faculties: although it puts long-term pressure on the budget, the faculty has limited control over it. In addition, faculty researchers who are seconded to the institute have less time for normal faculty activities, such as general teaching. On the other hand, ARCNL researchers give lectures on the science & technology of nanolithography to physics students, introducing them to the possibility of combining research and business applications.

The partners have had to set aside time and effort to get to know and understand one another. A recent evaluation of ARCNL and other NWO institutes has revealed that ARCNL initially experienced some 'growing pains'. As a result, progress was uneven and stresses arose, mainly in terms of burdens on the scientific staff and interactions between ARCNL and its partner organisations. The Evaluation Committee concluded that ARCNL 'will need several more years of focused effort to bring all its research areas up to their full potential, [and to] fully realise the mutual benefits of its relationship with ASML' (Evaluation Committee, 2017).

3.4 In summary

The three case studies offer us a multifaceted picture of strategic public-private research partnerships. In the next chapter, we combine our empirical and conceptual studies to identify a number of features typical of strategic partnerships. We conclude this chapter with several observations about the case studies.

In the *Chemelot InSciTe* case, the founding partners share the same aim: to use the research institute to help build the Province of Limburg's regional innovation system. The public-private institute stimulates the mobilisation of scientific knowledge to attain innovation targets and to drive new business activity by DSM and other firms. Notable in this case study is the major role that the Province of Limburg is playing, making regional development a priority. InSciTe is therefore structured to enable the original founding partners to actively recruit new partners as project participants. The case study reveals the inherent tension that arises in multi-year partnerships between commitment (necessary for building trust and close cooperation) and flexibility (necessary for responding to changing market and other circumstances). The case study also illustrates that the exclusiveness or selectiveness of a strategic partnership does not always combine well with a desire to work with all sorts of other partners too.

In the *DELTA Lab* case study, academic and industrial partners have joined forces in use-inspired basic research that addresses a topic of strategic importance to both sides. Bilateral programme-based cooperation offers opportunities for extensive public-private 'border crossings', allowing PhD researchers to gain business experience and Bosch to build its knowledge base. The professors involved believe that this is how to get commitments from differing business partners in a bid to

promote Amsterdam (Science Park) as a knowledge and innovation hotspot in the field of artificial intelligence. Bosch sees this as a way to tap into precisely this type of hotspot worldwide, in addition to its own R&D activities and the public-private Cyber Valley consortium in Germany. The case study shows that this type of PPP gives both partners new opportunities to pursue their academic and industrial research agendas. A requirement for an effective partnership is that the firm must invest in enough knowledge absorption capacity to allow for close cooperation with university researchers.

In the *ARCNL* case study, the partners share the aim of building a fundamental knowledge base for nanolithography technologies. ARCNL makes it possible for researchers from multiple disciplines to work together on a joint research programme under one roof. Programme-based cooperation provides critical mass and facilitates extensive ‘border crossings’ between scientific disciplines and between academic research and industrial R&D. The Province of Noord-Holland and the City of Amsterdam want to boost the knowledge economy in Amsterdam and solidify its connection with the Eindhoven region, where ASML is located. By supporting the establishment of ARCNL, they are driving the growth of an urban network that will help them attract foreign investment and talent. This case study clearly shows that the parties in a strategic partnership must learn to deal with the inherent differences between academic and commercial interests and cultures.

4 Typology of strategic partnerships

What do our conceptual and empirical studies tell us about strategic public-private research partnerships as a new phenomenon? This chapter reveals how strategic partnerships differ from other PPP types. We start with a general description of strategic partnerships in section 4.1. Section 4.2 then describes typical motives of firms and universities for choosing this new type of relationship. Section 4.3 discusses typical agreements made by the partners to facilitate close and lasting cooperation. As a relationship type, strategic partnerships are still evolving and partners are gradually learning what that relationship requires to be and remain effective. Section 4.4 shows that the partners maintain their relationship by deliberately investing time and energy in maximising various dimensions of proximity. We conclude this chapter in section 4.5 by summarising the most important features of strategic partnerships.

4.1 What are strategic public-private research partnerships?

In general terms, strategic research partnerships between universities and industry are arrangements in which a select group of partners work together on a scientific research programme aligned with strategic corporate interests. The partners cooperate closely in programmes and on projects under a multi-annual, exclusive agreement.

Strategic partnerships are bespoke affairs. The specific format chosen by the partners depends on their precise intentions and what they can offer each other. Another important factor is how national (or regional) government is involved in the partnership, i.e. as a funding body or as a partner. Model PPP contracts offer a basis for the legal substance of the agreement. Subjects such as the term and scope of the research programme depend on what the parties are willing and able to contribute. The partners may make significant investments in the relationship, for example by making their own facilities or a building available or by establishing an industry research centre on a university campus. They make agreements specifying topics for joint decision-making, associated procedures, and the latitude for change.

4.2 Typical motives for entering into strategic partnerships

Public and private parties each have their own reasons for choosing a strategic partnership rather than a 'lighter' form of PPP or contract research. Below we describe typical motives that we have observed at firms and universities. In the case of universities, we distinguish between the motives of researchers and those of the university as an organisation. Universities are less hierarchical than firms, and the motives of professors and their research groups do not always coincide with the motives of the faculty or university board. We also show why governments support strategic partnerships and (sometimes) actively participate in them.

Firms' motives

Firms use a range of PPP arrangements (and contract research) to 'tap into' knowledge, ideas, networks, talent and spin-offs from universities. The strategic partnership is another step in an historical evolution that sees firms continuously seeking effective (and cost-effective) ways to align external knowledge sources with their innovation strategies. Establishing a close relationship with universities is consistent with industry's current open innovation strategies, in which it seeks to exploit various external sources of knowledge, including university research groups, to achieve its innovation goals. One example is DSM, which casts its net far and wide 'to capture the best science has to offer'.[32] Cooperation with external partners is attractive because it can share costs, risks and the investment in expertise and facilities. Firms are seeking to 'leverage' their investments. Those that operate in knowledge-intensive science-based sectors view universities as key sources of knowledge. A strategic partnership with one or multiple university research groups is the most far-reaching type of PPP. Why do firms choose to enter into these partnerships? The case studies and our conceptual study have led us to identify the following motives.

To build a strategic knowledge base with a university partner

A strategic partnership is suitable for firms with a complex knowledge requirement that they cannot meet through individual and changing (contract) relationships. They need a select group of university partners with whom they can carry out innovation-oriented (often multidisciplinary) research programmes over a period of several years. Through a strategic partnership, the firm can involve itself directly in the research programme and in specific research projects. The alternative, which involves concluding a series of individual contracts or undertaking individual PPP projects with different partners in different locations, requires a considerable degree

32 DSM participates in more than fifty PPP programmes that allow it to 'plug in' to more than forty academic research groups. Such a multitude of alliances also requires a certain corporate strategy and organisation and a certain level of absorption capacity to benefit from the knowledge. Source: https://www.dsm.com/corporate/science/collaboration.html

of coordination and make it difficult to work consistently on building the necessary strategic knowledge base.

Combining individual projects with various partners into a single integrated programme involving a select group of strategic partners is consistent with a trend in which firms are starting to think more strategically about the way in which they involve external knowledge parties in their own innovation strategy (Deuten, 2015). The firm wants to build a close relationship with a select group of universities (or university research groups). The partners are strategically selected with approval from senior management. The ARCNL case study is an example of strategic knowledge-building as motive. In addition to research in strategic partnerships, firms continue to conduct research in individual PPP projects with university research groups that do not have the status of strategic partners.

University partners on three levels

Philips' innovation strategy differentiates between three levels of cooperation with universities. The first level consists of a large number of universities that perform contract research and also deliver the associated intellectual property rights. The second level involves Philips having relationships with various partner universities and jointly executing programmes or projects with them on specific topics. On the third level, Philips has a limited number of strategic partners with which it builds close relationships to implement multiple broad research programmes. One example of a relationship on the third level is the Eindhoven MedTech Innovation Center (e/MTIC), in which Philips conducts research into healthcare innovations with the TU/e and three regional hospitals. Source: *Overview of flagship collaboration, Regional Eindhoven Ecosystem,* November 2017.

Rapid and productive knowledge absorption

A strategic partnership offers the firm excellent opportunities to quickly and effectively absorb researchers' knowledge and (interim) research results. Building a close relationship with a strategic partner is beneficial to this process. More than other PPP types, strategic partnerships allow the partners to become well acquainted with each other and to build mutual trust. Close personal contact between university and industry researchers and developers improves knowledge sharing, especially when it comes to new and tacit knowledge. Wherever possible, firms seek to establish a co-location, bringing together academic and industry researchers in one building or on a campus to encourage researcher exchanges and interactions. In all three case studies, knowledge absorption is a key motive for

choosing to enter into a strategic partnership rather than a regular PPP arrangement.

To develop an innovation ecosystem
Strategic partnerships allow large enterprises to integrate universities into the innovation ecosystem that is important to them. Strategic partnerships function as building blocks in the innovation ecosystems they need to implement their long-term innovation strategy. Multinational enterprises build their ecosystems in two ways. In the first place, they seek to embed their strategic research centres firmly into a surrounding innovation ecosystem, often on or near a (university) campus. They are not only interested in building knowledge with a university, but also in gaining access to other firms that they can work with, to start-ups that they can invest in, to talented researchers that they can recruit, and so on. In addition, they use strategic partnerships to connect with hotspots worldwide where they themselves do not have a research centre. If this long-distance relationship is to work, they need to have their own researchers on the spot. The desire to develop an innovation ecosystem is particularly relevant in the InSciTe case study, in which DSM is working actively to establish an open innovation campus around its strategic R&D centre in the province of Limburg. The same motive plays a role in the ARCNL case study, in which ASML is looking to expand its innovation ecosystem, which is clustered around Veldhoven. In the DELTA Lab case study, the firm is using a partnership to gain access to leading scientists and research groups outside its own Bosch research campus in Renningen.

Universities' motives
Universities can use various PPP arrangements (and contract research) to involve firms in their research. What makes a strategic partnership more attractive to them than other PPP types? Why is it so interesting to undertake research with a firm as a strategic partner?

Research funding
A strategic partnership often consists of an extensive research programme involving several PhD students who are funded largely by the private partner. Attracting this form of research funding is naturally an important reason for university researchers to enter into a partnership. Nowadays, having a (financial) commitment from a private party is often one of the prerequisites to qualify for public research grants. A research group that receives corporate funding will, for example, also receive a PPP allowance under the Dutch government's 'top sectors' strategy. It is important for the faculty and university boards to ensure that this funding stream does not have (unintended) adverse consequences for the rest of the faculty or university, for example through their internal distribution models.

An appealing research programme
A strategic partnership offers university researchers the opportunity to do interesting research within the scope of a multi-year research programme. This may involve high-quality use-inspired basic research, or translational research in which the results of basic research are translated into practical applications. In the first case, the research is in line with academic incentives meant to promote 'excellent' research suitable for publication in high-impact scientific journals. In the latter case, the research is aligned with the valorisation aims of the researchers and the faculty or university as a whole.

Besides focusing efforts on a particular research question, a strategic partnership also creates critical mass because it has several PhD students, postdocs and other researchers working together for several years in a large-scale (multidisciplinary) programme. In addition, the very scale of the programme offers more opportunities for cross-fertilisation and synergy than a series of individual PPP projects with different private partners. DELTA Lab and ARCNL are examples of this.

Extensive interaction with knowledge-intensive firm
In a strategic partnership, academic and industry researchers cooperate closely, with bi-directional knowledge-sharing and cross-fertilisation. Academic researchers gain access to corporate facilities and corporate knowledge of technological applications and market trends.

It is helpful and sometimes even crucial for academic researchers to gain access to firms' (real-world) knowledge, data and systems as input for their own research. The same is true when it comes to the insights that academic researchers can gain into the way industry researchers and developers think and work. Academic researchers in emerging fields such as nanotechnology and quantum computing may require access to high-cost (corporate) facilities to be able to do their research. In addition, interacting with firms helps university research groups to make decisions about their research agendas. Bi-directional knowledge-sharing and cross-fertilisation play a role in all three case studies.

Relevance to society
Strategic partnerships are also attractive to university research groups because extensive interaction with industry during all phases of research contributes to knowledge valorisation and the societal impact of the research. Societal impact is becoming an increasingly important factor in assessments of research proposals and research groups. When competing for public funding in which 'relevance' is one of the selection criteria, research groups can point to a good track record in knowledge valorisation as evidence that they are capable of conducting research of relevance to society. Participating in a strategic partnership can enhance the status and positioning not only of the research group (and faculty) within the university and the academic world, but also of the university in society. Societal relevance made

manifest in a university-industry partnership and visibility drawn from the firm's reputation play a role in all three case studies.

Human capital
Strategic partnerships can help a research group recruit students and researchers, as evidenced by the large number of applicants for research positions in the DELTA Lab. Many young researchers find it appealing to cooperate closely on research with a large, technologically advanced firm and to gain a realistic perspective on possible applications. A glimpse of the business world can be instructive, which is why strategic partnerships also help to broaden the horizons of PhD students during their training. Their employment opportunities improve, especially outside the academic community, where most PhD students end up finding jobs. Strategic partnerships are interesting to research groups, faculties and universities as a whole because they boost their ability to recruit students and researchers at home and abroad and broaden the scope of training.

Developing a campus and knowledge ecosystem
Strategic partnerships are attractive to a university because they can drive the development of the university's campus and/or the local innovation ecosystem in which the university wants to play a pivotal role. Universities are investing heavily in their campuses and science parks. Strategic partnerships can help them to do this, not least because they gain status by partnering with a leading firm. Amsterdam Science Park is planning a new co-creation building for DELTA Lab and other public-private research laboratories. ARCNL is housed in temporary premises on the same site until the new Matrix VII building is ready for occupation.

Governments' motives
Governments do not participate in strategic partnerships as an actual *knowledge partner* themselves because they are not the intended users of the research results. They have only limited input into the subject matter of the research programme.[33]

Strategic partnerships receive support in different policy areas for different reasons. We list three motives below. They apply not only to government ministries at national level but also to regional and local authorities.

Governments are involved in strategic partnerships in different ways. The Province of Limburg was an active party when InSciTe was established. FOM (now part of NWO) was one of the founding partners of ARCNL.[34] In addition, governments may be asked to provide financial or other support while the strategic partnership is being established and afterwards, for example because it is in the national or regional interest to accommodate a large multinational's strategic R&D site.

33 In fact we are now seeing the emergence of strategic public-public partnerships in which governments do act as knowledge partners, for example the Amsterdam Institute for Advanced Metropolitan Solutions.
34 Formally, NWO is an Autonomous Administrative Body ('ZBO') with a statutory mission and tasks. It is the responsibility of the Ministry of Education, Culture and Science.

Government can also be involved in a strategic partnership more remotely, through a grant scheme.

High-value research with societal impact
In its science policy, the national government uses strategic partnerships as a tool for boosting both 'excellent' research and the societal impact of publicly funded research. This is NWO's main motive as a public research funding body that supports strategic partnerships.[35] ARCNL is important to NWO because it connects basic research to innovation in the Netherlands.

Innovativeness of firms
The government's innovation policy encourages strategic partnerships because they improve the innovativeness of firms, particularly in priority areas such as the country's top economic sectors. This is an important motive in the national government's 'top sectors' strategy. The Ministry of Economic Affairs and Climate Policy pays a PPP allowance over the financial contribution of corporate partners to encourage public-private research partnerships in top sectors. InSciTe, DELTA Lab and ARCNL all make use of this scheme.

Improving the economic structure
Economic and spatial economic policy promotes strategic partnerships to improve the regional (and national) economic structure. The underlying idea is that strategic partnerships can help to attract multinationals and connect them to local universities. They can be important building blocks in regional innovation ecosystems, especially if the strategic partnership leads to the co-location of industrial research activities on a campus or science park. Because strategic partnerships are long-term, large-scale arrangements involving large multinationals, governments see them as an opportunity to drive the development of innovation campuses, science parks and the like. The Province of Limburg sees InSciTe on the Chemelot campus as a means of promoting regional economic growth. The same is true for the City of Amsterdam and the Province of Noord-Holland with respect to ARCNL at Amsterdam Science Park.

4.3 Typical agreements in strategic partnerships

A strategic partnership is established under a formal partnership agreement in which the partners make various arrangements in advance, for example concerning the governance (management and supervision) and organisation of the partnership, the budget and method of financing, rights and obligations with regard to knowledge

35 NWO's mission is to advance 'world-class scientific research. This research has scientific and societal impact' (NWO, 2018, p. 19). 'Connecting science and society is one of the focal points in the vision of NWO. Knowledge from scientific research forms the breeding ground for the societal and economic innovation that is necessary for the well-being of Dutch society' (NWO, 2018, p. 3).

delivery and intellectual property, liability, compensation and confidentiality, as well as the term of the partnership, its termination, communication, applicable law and settlement of internal disputes.

A public-private partnership is inherently difficult because universities and firms differ in their missions, organisational objectives, management styles, decision-making processes, organisational cultures, incentive structures, and so on. They must find a way that is workable for both sides. What typical agreements do the partners in a strategic partnership make?

Commitment and exclusiveness
The time horizon of a strategic partnership is often longer than that of other PPP types. The aim is to build and maintain a close relationship and that is why the partners often do not want to limit themselves to the customary four or five years needed to complete a PhD research project. Since many things can change during the term of the agreement, it is all the more important for the partners to make arrangements about (interim) accession and withdrawal.

Under what conditions can a partner withdraw from the agreement? The changing market environment in which firms operate requires a type of relationship that leaves room for adjustments and modifications. Changes in the market can lead to changes in strategy that emphasise other aspects of research or chart an entirely new course. Transitional provisions are needed to cover situations in which a firm wants to leave the partnership, for example to allow the remaining partners to find replacements or to reorganise the public-private lab. Provisions are also needed to guarantee that PhD students can complete their research, for example if the firm loses interest in the subject matter due to major market changes.

It is also important to make arrangements about the accession of new partners. Clear-cut agreements are needed about the conditions under which other parties may participate in the research programme.

Joint choices regarding subject matter
Both public and private partners in a strategic partnership make a substantial contribution to the actual research and the funding. This means that all partners have a say when it comes to the research programme and the composition of the project portfolio. Partners must agree on the choice of subject matter, with due regard for each other’s interests. It is particularly important to make explicit agreements about this in a strategic partnership because the private partners may have a major strategic (commercial) interest in the research results. The partners need firm agreements to fall back on if commercial and academic interests conflict or if one interest threatens to overrule the other, for example, if the firm wants to shift the research focus to questions that are less interesting from an academic viewpoint.

Intellectual property and scientific publications

In view of their differing requirements and goals, the partners need to make transparent agreements about their rights and obligations in respect of the intellectual property (IP) that they contribute and develop (jointly). To do so, they must reconcile a commercial interest in protecting IP with an academic interest in sharing and disseminating knowledge. Industry is eager to work with leading researchers. Without the prospect of publication or a doctorate, however, top researchers are not likely to be tempted to work with a firm. Industry partners therefore understand that it is in their own interest to offer academic partners opportunities to publish and award doctorates, as well as the necessary academic freedom. At the same time, the agreements must also anticipate situations in which private and public interests might clash. There are now standard models that serve as templates for arranging IP rights in specific cases.[36]

The general principle underpinning these models is that private partners in PPPs should be licensed to use research results on a non-exclusive basis, as this increases the likelihood of valorisation and innovation. As a rule of thumb, the more a firm contributes to a PPP as a percentage of the whole (in money, background knowledge, human and other resources), and the fewer other private partners participate, the more likely it is that the firm will acquire (exclusive) ownership of the intellectual property. The public knowledge institution transfers the IP rights to the private partner in that case. If the public party or parties contribute (as well), then there are two options under EU rules. The first is that IP rights are assigned in a way that appropriately reflects the private partner's contributions to the partnership. The second is for the private partner to pay the public partner or partners a market-compliant fee for the IP rights, deducting its own contributions to the research from this amount. In addition, publication of (unprotected) results must always remain possible, even if IP rights are transferred.[37]

A typical option well suited to strategic partnerships is to agree that the private partner will own the IP and that the knowledge institution will retain the right to use the results for purposes of academic teaching and research. The basic premise here is that university researchers must be able to publish all their research results and also use them to obtain a doctorate. If the firm provides commercially sensitive background material, the partners will also make agreements governing confidentiality.

36 For the Netherlands, see Appendix 3 with relevant information provided by Regiegroep Spelregels (2013). For the United Kingdom, see https://www.gov.uk/guidance/university-and-business-collaboration-agreements-lambert-toolkit.

37 The transfer of IP to the private party is standard in contract research. Where this is the case, the knowledge institution is also not entitled to use the results for other academic or research purposes. Scientific publications are also not permitted, unless the firm has granted its consent.

Close cooperation
The partners state their expectations regarding effective methods of cooperation, bearing in mind each other's differences. A distinctive feature of strategic partnerships is that partners expect to invest time, money and energy in narrowing or bridging the gap between industry and university, thereby encouraging 'border crossings'. That is why they make agreements about their cooperation and prepare their own organisations to facilitate an effective partnership, making it possible to maximise the 'proximity' between them, both geographically (co-location and mutual visits) and cognitively (knowledge and expertise), organisationally (organisational goals and research cultures) and socially (networks and relationships). This allows the partners to genuinely get closer to each other and work on building the mutual trust necessary for effective knowledge-sharing.

To maximise proximity, the partners make agreements about how, where, how often and for how long academic and industry researchers (and their group leaders or managers) will meet. They can agree on the amount of time that researchers spend at each other's locations or in shared facilities. For example, researchers at one partner organisation may be seconded temporarily to the other partner. In some cases, researchers are employed by both the university and the firm.

4.4 Maintaining the relationship

In strategic partnerships, parties typically commit to actively managing and maintaining mutual exchanges or 'border crossings' between university and industry. They do this to build and maintain a close relationship that promotes the effective (and cost-effective) generation and exchange of knowledge based on mutual trust. The challenge is to keep the relationship interesting and workable for all the partners, even in changing circumstances.

Working on geographical proximity
For a strategic partnership to function properly, it is important for researchers from both partners to meet and talk to each other regularly on location. That is why the partners invest in geographical proximity by offering researchers time and leeway for mutual visits and/or by investing in a shared physical location. Co-locations on a campus or science park are often the most visible signs of a strategic partnership.

Working on cognitive proximity
There is often a considerable cognitive gap between the partners in a strategic partnership. For the relationship to function properly, it is important for both partners to work on narrowing that gap. Both partners need sufficient absorption capacity to appreciate and master each other's knowledge. A firm cannot simply 'tap into' knowledge but needs its own research capacity to appreciate and utilise the research results of its university partner. Bosch, for example, is investing in its own

research group so that it can work strategically with academic researchers. Bosch has also invited a DELTA Lab professor to give a presentation at a corporate conference. ASML and DSM employ R&D managers and researchers who are also professors and are therefore familiar with both worlds. Researchers at ARCNL give and take courses at ASML. We see that universities also contribute to narrowing the cognitive gap, for example by structuring and organising the research programme in such a way that it corresponds as closely as possible to the firm's organisational structures and innovation needs.

Working on organisational proximity

A university and a multinational enterprise are completely different organisations in many ways. They differ, for example, in the way decisions are taken, in their organisational culture, in their management philosophy, and so forth. In an academic culture, researchers are accustomed to open exchanges of ideas and research results. In a commercial culture, the appropriation and use of research results are important. To ensure that a strategic partnership functions properly, the partners must be willing to familiarise themselves with each other's organisations, whether they be researchers, board members or managers. This helps them to develop a collaborative approach that does justice to both organisational worlds.

Firms cannot manage a public-private lab in the same way as they manage their own industrial laboratories. For example, a line of research cannot be discontinued suddenly when market conditions change, because this would put PhD research projects at risk. Firms must therefore learn to deal with the time horizons and interests of the academic world. ARCNL has found a practical solution by organising PhD research into shorter sub-studies instead of one four-year PhD project. In defining their projects, ARCNL researchers consider the time horizons of both academia and ASML.

Universities cannot manage a public-private lab as if it were a regular university lab. As a strategic partner, for example, the firm wants regular and detailed progress updates. This means that university researchers may have to prepare formal, written progress reports more often than they are accustomed to doing.

If the partners succeed in maximising their organisational proximity, the academic partner will become more entrepreneurial and flexible in certain respects, while the commercial partner will be (more) aware of the importance of maintaining a long-term outlook in research. Academic researchers will be more inclined to view their studies in the light of later stages of research, development and commercialisation (and the associated requirements). A good example is how researchers at InSciTe bear in mind the test requirements for drug authorisation in the medical sector when choosing their testing methods, and how they take pains to carry out those tests consistently.

Close cooperation with industry partners also affects the relevant faculty and university boards. For example, MUMC+ is now considering a method of assessing researchers that not only factors in their scientific publications and impact but also recognises the type of research activities undertaken at InSciTe. Inspired by DELTA Lab and others, the UvA is now planning a new building in Amsterdam Science Park that will house new public-private artificial intelligence research labs.

Working on social proximity
Strategic partnerships that function properly maximise the social proximity of academic and industry researchers. The same can be said of the relevant board members and managers. They start moving in the same circles, meet in the same places, learn what they can offer each other, and so on. Conversely, partnerships are also more likely to emerge if the social gap between the partners is relatively narrow, for example because they have a history of public-private partnerships that have built mutual trust.

One striking difference with the 'lighter' types of PPP is that social proximity plays a role not only for the researchers, but also for the board members and managers. After all, the parties in strategic partnerships have strategic reasons for choosing the partners with which they will enter into a multi-year commitment.

The InSciTe case study illustrates that social proximity facilitates and accelerates further and subsequent cooperation. The partners in one InSciTe programme are building on previous networks (e.g. in a Top Technology Institute), while the partners in another InSciTe programme are starting to become acquainted. A large social gap means that it takes longer to get cooperation up and running.

Strategic partnerships change
A typical feature of strategic partnerships is that partners must devote sufficient time and energy to maintaining their cooperative relationship. It is a challenge to keep the partnership interesting for all partners, especially if market or other circumstances change or a partner sees new opportunities elsewhere. An illustrative example is the InSciTe case study, in which the commercial outlook for biobased materials collapsed and the partners had to adapt their partnership. After some consultation, the focus shifted to more generic technology for sustainable processes. The ARCNL case study is an example of how a partner's changing interests can lead to changes in the research programme.

4.5 In summary

Strategic public-private research partnerships are bespoke affairs. The specific format chosen by the partners depends on their precise intentions and what they can offer each other. Another important factor is how national or regional

government is involved in the partnership, as a funding body or even as a partner. Model PPP contracts offer a basis for the legal substance of the agreement.

Strategic partnerships differ from other PPP types with regard to the partners' motives. Typically, both academic and industry partners are mainly interested in the actual results of the joint research programme. Industry partners are also more interested in building their knowledge of the subject matter than is the case in other types of PPP. Both partners therefore attach great importance to extensive 'border crossings' and to investing in a close, long-term relationship. A partnership offers excellent opportunities for academic and industry researchers to engage with one another extensively and to share (interim) research results.

Partnerships offer large enterprises a platform for boosting the innovation ecosystems that surround their strategic R&D centres. They also offer them a means of gaining access to relevant knowledge ecosystems worldwide.

Partnerships offer university researchers the opportunity to undertake an attractive research programme in close cooperation with a knowledge-intensive firm. Their involvement gives them access to the knowledge and expertise, data and facilities of their industry partner. Partnerships are also interesting because they appeal to talented researchers and broaden the scope of PhD training. They furthermore help the research groups and the university as a whole to fulfil their valorisation mission. An underlying strategic motive is the development of the campus or science park into an attractive site for research and innovation.

Governments have a variety of motives for supporting strategic partnerships. Spatial economic development is an important motive for local and regional authorities. They see strategic partnerships as a way to boost the regional economy. In some cases, they even involve themselves in the partnership as an active partner. Strategic partnerships are promoted in both innovation and science policy, the former because they contribute to innovativeness in firms and the latter in the interests of high-value research with impact.

What sets strategic partnerships apart from other PPP types is that the partners must be prepared to invest in the relationship and to narrow and bridge the inevitable gap between the world of academia and the commercial world. This not only means maximising geographical proximity (co-location, frequent visits), but also cognitive proximity (shared knowledge base), organisational proximity (hybrid organisational culture) and social proximity (good relationships and shared networks). The partners cannot remove the inherent differences between their worlds, but they can learn to understand and trust each other better by cooperating closely, so that their strategic partnership remains effective and interesting. For example, it may be necessary to change the research programme midway through in response to unforeseen developments in the ecosystem or at one of the partner

organisations. Extensive ‘border crossings’ also allow the partners to get to know each other’s boundaries so that they can maintain an appropriate distance where necessary.

5 New options and trade-offs

Strategic public-private research partnerships are a relatively new phenomenon. The previous chapters have shown how these partnerships differ from other types of PPPs. A key factor is that academic and industry partners commit to collaborating for a longer period in order to research a topic relevant to all partners. They deliberately seek to enhance their cooperation by narrowing or bridging the geographical, cognitive, organisational and social gaps between them. In doing so, strategic partnerships in fact create a new research practice that combines elements of academia and industry.

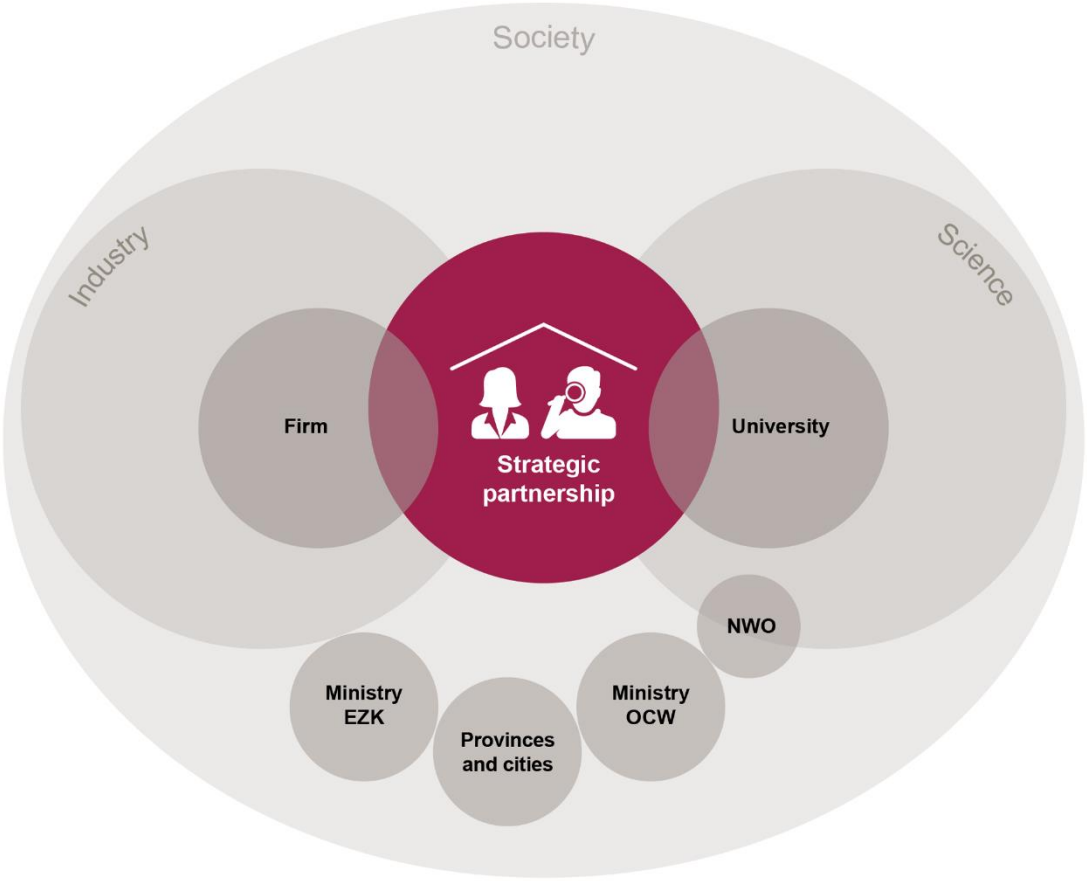
It is precisely because a strategic partnership facilitates intensive 'border crossings' between academia and industry that the partners can and indeed must become more familiar with each other's boundaries. Strategic research partnerships are also interesting to various public authorities for a variety of reasons, particularly at regional and local level –so much so that governments sometimes actively participate in them.

In this chapter, we explore the impact of strategic partnerships – as a new practice of joint knowledge generation – on the functioning of knowledge ecosystems and its dynamism. How do strategic partnerships influence the options and choices available to firms, universities and governments to develop and implement their strategies? And what new questions and trade-offs do these options and choices entail? Which aspects of society are at stake? Figure 4 visualises strategic partnerships and actors in society. In addition to the strategic partners themselves, these are actors in industry and science, NWO, the Ministry of Economic Affairs and Climate Policy, the Ministry of Education, Culture and Science, and regional and local authorities. We asked stakeholders attending one of our meetings to comment on our interim results and we reflect on their responses in this chapter.[38]

The aim of this chapter is to take the first step towards creating an assessment framework that allows universities, firms, governments, politicians and civil society organisations to make a balanced appraisal of strategic partnerships.

38 See Appendix 2 for more information on the research approach.

Figure 4 Strategic partnerships and actors in society



Notes: Ministry EZK refers to Ministry of Economic Affairs and Climate Policy, Ministry OCW: Ministry of Education, Culture and Science, NWO: Netherlands Organisation for Scientific Resarch

5.1 Industry: options and trade-offs

Strategic partnerships offer industry a new way of working with universities. What new opportunities does this create for firms, and what do they need to consider in this context?

New opportunities

Strategic partnerships give firms the opportunity to be closely involved in innovative scientific research allowing them to carve out a new position for themselves in a knowledge ecosystem that is important for their R&D strategy.

From the firm's perspective, this means connecting the public world of academic research more closely to the private world of industrial R&D. As a university's strategic partner, the firm has direct access to scientific knowledge and university researchers, and can play an active role in setting the research agenda, defining the research programme and executing the research. Industry researchers can

work side by side with university researchers. Personal and frequent interaction between them is the most effective and efficient way to transfer and share knowledge. A strategic partnership differs from a client-contractor relationship in critical respects. In contract research, cooperation is based on transactions. In a strategic partnership, it is the relationship itself that is important. The firm wants to build a relationship with university researchers (and their directors or board) that fosters the mutual trust needed to cooperate closely.

A partnership also offers the firm ample opportunities to scout, recruit and retain talented university researchers. The firm is first in line, so to speak, when it comes to leveraging research results and attracting talented researchers. This gives it an advantage over competitors who do not have such privileged access.

Considerations and trade-offs

Being a university's strategic partner means that the firm shares responsibility for the joint programme and the researchers involved. But the firm also bears joint responsibility for the university and the knowledge ecosystem in which it operates. This is in keeping with the principles of responsible business conduct, in which firms are partly responsible for the impact of their actions on their environment.[39]

This means that the firm must know what to do to play the role of strategic partner properly. First of all, it must take its role as a co-producer of scientific knowledge seriously, and be capable of understanding and absorbing such knowledge. To take effective advantage of a strategic partnership, the firm must itself devote sufficient time and energy to exchanges and interactions with academic researchers. Industry researchers must be able to talk to university researchers as equals. The firm therefore requires sufficient absorption capacity to pose relevant knowledge questions and to assess the value of scientific knowledge. Stated in practical terms, it needs a research department that can absorb scientific knowledge and use it for commercial purposes.

Second, entering into a strategic partnership requires the firm's senior management to be involved in the decision-making process. A strategic partnership entails a substantial and long-term investment in which the firm aims to build a good relationship with a carefully selected knowledge partner. The partnership is most useful if it is part of a long-term strategy setting out how the firm intends to operate in knowledge ecosystems. The firm must also have some idea of how the partnership will help it to develop the ecosystems for knowledge valorisation that it needs to innovate. A strategic partnership with a university is one of the factors that

39 The OECD Guidelines for Multinational Enterprises recommend that enterprises 'should develop ties with local universities, public research institutes, and participate in co-operative research projects with local industry or industry associations.' The underlying aim is to 'to promote…the diffusion by multinational enterprises of the fruits of research and development activities among the countries where they operate, contributing thereby to the innovative capacities of host countries'. This can include 'development of R&D co-operative ventures.' Source: http://www.oecd.org/daf/inv/mne/48004323.pdf

establishes a firm's global R&D footprint: in which university towns and regions will it have a presence, and with which R&D centres? Senior management must therefore devote the necessary attention to R&D when entering into a strategic partnership.

A third consideration is that the firm cannot manage a strategic partnership as it would a business-to-business relationship or a contract research arrangement. To cooperate successfully with a university, it must respect university researchers' academic freedom and help to protect them from improper influences due to conflicts of interest. Building a strategic relationship between a for-profit partner and a not-for-profit partner requires both sides to make adjustments. The firm cannot manage a joint lab as if it were an industry laboratory, where projects can be modified or discontinued at a stroke if market conditions so dictate. The partnership requires mutual understanding to accommodate differences in mission, culture and decision-making processes. The challenge is to balance the commercial and academic aspects in order to arrive at a research (and management) practice that serves both partners. For example, firms may require regular progress reports, but they must also give PhD students enough time and opportunity to work on scientific publications and to attend conferences.

A fourth consideration is that the firm should not have unrealistic expectations of what a university can offer in a strategic research partnership. Universities deliver scientific knowledge, not knowledge that can be applied immediately. Universities are not applied research institutes such as TNO. Scientific research is a lengthy process, whereas the market is extremely dynamic and can change very quickly. Universities have a public mission. They must be able to conduct research independently and share their results with the wider academic community. The firm, on the other hand, has a commercial mission and wants to innovate at high speed. The challenge is to work together in a way that allows both commercial and academic objectives to be attained.

Societal aspects

What does it mean for our economy and society when firms commit to a university as a strategic partner? That depends on the role that the relevant firm is willing and able to play in the Dutch economy and society, and where and by whom the knowledge will be commercialised.

The economic significance of the partnership is all the greater if the firm not only wants to tap into and extract knowledge from the Netherlands, but also aims to establish a permanent presence in the country. For example, the economic added value of the partnership will increase if it involves multinationals establishing or expanding their research and/or innovation centres in the Netherlands. Its added value will also increase if it makes university campuses or science parks more attractive to international companies, investors and highly educated employees.

The emergence of strategic partnerships cannot be seen in isolation from the globalisation of R&D by multinational firms. Nowadays, multinationals search the world over for co-locations and research partners. The opportunity to work closely with public knowledge institutions is an important factor in this context and drives the creation of regions that specialise in research and innovation. The significance for society of a multinational enterprise choosing to enter into a strategic partnership with a Dutch university therefore also lies in its contribution to creating regional knowledge and innovation hotspots.

The geopolitical context has changed dramatically in recent years, for example under the influence of trade protectionism and the arrival of China as a world power and innovation leader. Scientific knowledge is increasingly seen as a strategic tool for amassing national economic and military power. For example, China wants to gain a leading edge in artificial intelligence so as to consolidate its economic and military position on the world stage. This has implications for strategic partnerships between foreign firms and Dutch universities. They not only offer opportunities; if Dutch universities are mobilised to boost the innovativeness of large foreign enterprises, they also pose risks. That is, in part, why an assessment framework is needed to appraise the opportunities and risks of strategic partnerships for the Netherlands' status as a knowledge hub.

Strategic partnerships are especially useful for large R&D-intensive enterprises. After all, the firm must not only have the necessary financial clout but also sufficient knowledge absorption capacity. The question is what this means for smaller or start-up firms that do not have large R&D budgets. Does the advantage that large enterprises have in a strategic partnership come at the expense of smaller firms? Or do smaller firms benefit too? The underlying question is whether it is large established enterprises or small start-ups that are more likely to generate socially relevant innovation, or whether it is interaction between the two patterns of innovation that delivers the goods. For example, how much scope do strategic partnerships offer for creating spin-offs that can challenge the established order?

5.2 Universities: options and trade-offs

Strategic partnerships offer universities a new way of working with firms. What new opportunities do such partnerships create for them, and what do they need to consider in that context?

New opportunities

Universities have three core tasks: teaching students and training PhD candidates, conducting scientific research, and disseminating and transmitting knowledge in support of a vibrant knowledge-driven society. Strategic partnerships give

universities new opportunities to fulfil these tasks, subject to public-private partnership rules and guidelines designed to ensure academic freedom and research integrity.[40]

Universities can offer their PhD students a broader education in strategic partnerships. As they carry out their research, PhD students are exposed to the world of industrial research and R&D in a commercial context. They experience at first hand how firms conduct research and how they handle R&D. They also broaden their career prospects in this way and become more interesting job candidates for industry.[41]

Strategic partnership projects are also a good fit for students at universities of technology who are enrolled in the two-year post-graduate programme in engineering.[42] They promote cross-sector mobility for researchers and engineers, which in turn contributes to the university's third core task: knowledge transfer to society.

Strategic partnerships also give universities excellent opportunities to recruit talented researchers. The global competition for talent is fierce in many fields. A strategic partnership enhances the ability of university research groups to recruit young researchers, who are often attracted to academic-industrial research environments precisely they have ties with industry and focus on potential applications based on scientific evidence.

Conducting scientific research.
A strategic partnership gives university researchers the opportunity to set up and implement a consistent, long-term research programme that is funded largely by private means. It offers them a new way of obtaining private co-funding for scientific research at a time when the pressure on funding bodies has increased and applications for public research funding are not always successful.[43]

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40 The Netherlands Code of Conduct for Research Integrity is based on five principles of integrity in research: honesty; scrupulousness; transparency; independence; and responsibility (see http://www.vsnu.nl/files/documents/Netherlands%20Code%20of%20Conduct%20for%20Research%20Integrity%202018.pdf). In its report Wetenschap op Bestelling (2005), the Royal Netherlands Academy of Arts and Sciences advises researchers and clients to state their commitment to a 'Declaration of Scientific Independence'. In that statement, they agree that the client will not exercise an improper influence on the set-up and execution of the research or on the interpretation and publication of the research results. Source: https://www.knaw.nl/nl/actueel/publicaties/wetenschap-op-bestelling

41 Talent development and close bilateral cooperation are also focal points of NWO's Industrial Doctorates pilot, in which a PhD candidate carries out his or her research at both the knowledge institution and the participating firm. As part of the broader NWO policy of encouraging PPPs, the Industrial Doctorates call 'offers the opportunity for a different approach that is even more focused on talent development and that assumes further deepening through more intensive bilateral collaboration with a single company (even if a knowledge institution and company are embedded in a larger PPP or several PPPs). Furthermore, it is a collaboration in which the candidate PhD student takes centre stage as a talent'. Source: https://www.nwo.nl/en/news-and-events/news/2017/start-pilot-industrial-doctorates-to-facilitate-doing-a-phd-in-industry.html

42 Students enrolled in this programme gain a broader, deeper knowledge of technology and improve their design skills and their professional competences. Graduates may use the academic title PDEng: Professional Doctorate in Engineering.

43 In addition, strategic partnerships can be used to mobilise co-funding. For example, the private partner's cash contribution can provide the basis for a PPP allowance under the Dutch government's 'top sectors' policy.

In addition to new funding opportunities, strategic partnerships offer researchers the chance to develop a new research practice and culture in which they can work closely with industry researchers and developers. After all, the private partner not only co-funds the research but also helps to generate knowledge. Firms use strategic partnerships to address knowledge requirements that call for interdisciplinary research. As a result, strategic partnerships also demand (new) combinations of scientific disciplines and therefore facilitate interfaculty cooperation and new ways of organising and managing scientific research (strategically and otherwise) at universities.

Cooperating with firms on research need not be at the expense of scientific quality and productivity. In fact, in certain areas of expertise, working with an industry partner is an advantage precisely because it allows researchers to carry out pioneering research, for example because they have access to corporate data and systems.[44] Strategic partnerships furthermore give researchers and universities new opportunities to build their reputation in the scientific community. The fact that a reputable international (high-tech) firm wants to enter into a strategic partnership with a specific university research group is a sign of scientific quality – and that, in turn, helps the group and the university recruit and retain talented students and researchers.

Transferring knowledge to society

Strategic partnerships give universities and researchers new opportunities to fulfil their valorisation task. Having a firm closely involved as a knowledge partner leads to all kinds of 'productive interactions' at every stage of research, particularly in the form of direct or personal interactions (Spaapen & van Drooge, 2011). Interacting directly in this way, for example by sharing data, equipment and facilities and by setting up experiments together, increases the likelihood of knowledge absorption and valorisation.

Strategic partnerships allow universities to position themselves as building blocks in national and regional R&D ecosystems. This is particularly true if the partnership draws private-sector activity into the university's environs. The basic idea is that firms interested in strategic partnerships see the advantage of co-locating industry researchers and developers on or near the partner university's campus. The university board can capitalise on this by pursuing an active campus development policy or by promoting itself as an enterprising university or as a university that is helping to drive regional economic growth. Universities thus become stakeholders

44 Analysis of data gathered by the University of California suggests that the results of research funded by industry lead to licences more often and are cited more often than those of publicly funded research (Wright, Drivas, Lei, & Merrill, 2014). UK and US analysts have found that researchers who cooperate with industry are more productive after making a discovery (i.e. they publish more than researchers who do not cooperate with industry). Other analysts have suggested that such partnershps produce more patents and generate more publicity (Savage, 2017).

in attracting foreign investment in R&D. They also gain new opportunities to access funding from parties that are more interested in R&D ecosystems than in scientific research, for example municipal authorities, economy boards, metropolitan regions, regional development companies, provincial authorities, and so on.

Considerations and trade-offs

The close involvement of industry offers research groups and university boards new opportunities in all three core tasks. Like its private-sector counterpart, the public partner must also be aware of what it needs to do to play the role of strategic partner properly. The recent controversy about a partnership between Erasmus University's Rotterdam School of Management (RSM) and Shell illustrates the importance of making firm agreements about the involvement of industry in university education and research.[45]

First of all, the university must guarantee that industry will not have an undue influence on its teaching, its research or on the transfer of knowledge to society. Academic freedom must be protected. Public-private partnerships must not be at the expense of scientific integrity. The university must make appropriate agreements with the firm that co-funds the research about the influence that it can exert on the choice of subject matter, the methods used, the results of the research and the way in which they are shared with the scientific community.

Under the Dutch system, universities are themselves largely responsible for upholding the principles of research integrity. As universities forge closer ties with industry, this task is becoming all the more important, not only to avoid the semblance of a conflict of interest, but also to give young researchers (and their supervisors) a well-defined framework in the event that academic and commercial interests conflict.

Entering into a strategic partnership requires the faculty and university board to be involved in the decision-making process. After all, close cooperation with a large enterprise has consequences for the entire faculty and for the university as a public institution. Not everyone favours the involvement of large enterprises in universities. The university must therefore develop a strategic perspective on the type of university it wants to be and for which stakeholders, and how strategic partnerships fit into that picture. On that basis, the faculty and university boards can consider whether a strategic partnership is in fact desirable and whether the university will not come to rely too much on the enterprise. As part of this assessment, they should also consider whether there is sufficient scope to carry out scientific research for which they are unable to find a co-funding partner in the private sector.

45 See the debate in the Dutch House of Representatives on links between the fossil fuel industry and universities, 7 September 2017, in: Handelingen II, 2016/2017.

A third consideration is that a university cannot manage a joint lab as it would a traditional academic lab. Participating in strategic partnerships requires the university to make necessary changes in its management and decision-making processes. The requirements and expectations of the private partner must be taken into account. The university will have to become more pragmatic or enterprising. The challenge lies in combining academic and commercial interests in a way that is workable for both partners.

Societal aspects

The new opportunities open to universities have a ripple effect on society. What these broader implications are depends on how strategic partnerships affect university policy, organisation and culture. Which trends are they accelerating, and which are they curtailing?

In a bid to explore a number of different scenarios, we have borrowed from a previous Rathenau Instituut publication, *Future knowledge* (Faasse, Van der Meulen & Heerekop, 2014). The authors of this publication took two fundamental uncertainties as a basis for extrapolating four scenarios for universities. The first uncertainty is: who owns the university and who are its stakeholders? Who actually pays for teaching and research? What is the dominant value network in which the university operates? Who are the most important public and private stakeholders and what value do they attach to the university's achievements?

Strategic partnerships do well in scenarios in which domestic and international firms play an important role in teaching and research, and in the valorisation of research results. They also do well in scenarios in which enterprising universities actively seek out new (specifically private) sources of funding and make efforts to improve the knowledge economy. In these scenarios, universities are of value to society largely because they function as building blocks in regional hotspots of knowledge and innovation, and because they attract domestic and international firms and talented researchers.

The second uncertainty is the degree of competition between universities and the scale at which this competition takes place. Depending on how strategic partnerships are set up, they do well in two different scenarios, one in which universities compete internationally for the 'best' R&D investors and most talented researchers worldwide, and another in which universities seek strategic partnerships with firms that are important to the region.

5.3 Government: options and trade-offs

The emergence of strategic research partnerships creates new policy options for different tiers of government. Strategic partnerships are particularly relevant to national government's enterprise and R&D policy and to its science policy. In addition, strategic partnerships offer regional authorities new opportunities to boost the economy. Their relationship with various policy fields and tiers of government poses a coordination challenge, both 'horizontally' between policy fields and 'vertically' between tiers of government.

5.3.1 Enterprise and innovation policy

The Ministry of Economic Affairs and Climate Policy promotes innovation in industry by encouraging universities and firms to work together. The aim of its policy is to improve the Netherlands' economic structure. That is why it pursues policy measures aimed at creating an entrepreneurial climate that will stimulate firms to pursue sustainability and innovation in their business. One of the ways it envisages achieving this aim is by encouraging coordination between publicly funded research and R&D agendas in industry.

Enterprise policy

The general aim of the Ministry's enterprise policy is to support an outstanding business climate that encourages firms to pursue sustainability and innovation in their business. One of its four strategic goals is 'to develop and exploit high-quality (internationally) publicly funded research and technology, including public-private programmes for research, innovation and human capital'.

In its enterprise policy, the Ministry regards the generation, the quality and the valorisation of scientific and applied knowledge as one of the most important drivers of innovation and innovative entrepreneurship. That policy is meant to increase the 'yield accruing to society of investing in publicly funded research institutions' by making these institutions more responsive to society and by encouraging them to cooperate with industry, in the hope that this will induce industry to invest in public-private research partnerships and thus increase the financial resources available for research.
Source: Budget, Ministry of Economic Affairs, 2018 (Kst-34775-XIII-2)

New opportunities

Strategic public-private research partnerships offer the Ministry of Economic Affairs and Climate Policy the opportunity to work specifically on creating an attractive business climate that inspires firms to be sustainable and innovative. Close cooperation leads to knowledge valorisation. The Ministry sees strategic partnerships as a means to increase the 'yield accruing to society' of investing in publicly funded research institutions and to help boost the Dutch knowledge economy.

Strategic partnerships can also serve to improve the business climate for R&D-intensive firms. In that context, the Ministry could encourage universities to be willing and able to enter into strategic partnerships with firms. Strategic partnerships are a means of attracting research investments from multinational enterprises and forging links between these enterprises and the Dutch economy.

Considerations and trade-offs

One of the focal points of innovation policy is to ensure that strategic partnerships not only benefit the participating partners but also boost the vitality of the relevant ecosystems for knowledge generation and innovation. Questions for policymakers include: what do strategic partnerships mean for the position of smaller firms and start-ups that cannot afford such partnerships with universities? Do they end up in second place, or do they in fact benefit from the active involvement of a large enterprise in the relevant knowledge and innovation ecosystems? To what extent is the involvement of large established enterprises in the research agendas of leading research groups detrimental to investment in the innovation agendas of other private and public parties in society?

One important goal of the Ministry's innovation policy is to achieve a significant increase in R&D intensity, to 2.5% of GDP by 2020. In that respect, it is worth asking whether strategic partnerships lead to more or to less private investment in R&D. This study shows that strategic partnerships have emerged at a time when firms are changing their R&D and innovation strategies. As part of that change, they are reallocating their R&D budgets between R&D in their own labs, contract research by external parties, and co-funding through PPPs, including strategic partnerships. It is not yet clear whether their R&D budgets are increasing or decreasing as a result. What we do know, however, is that strategic partnerships lead to new 'hybrid' research practices and a different division of labour in knowledge ecosystems. The emergence of strategic partnerships therefore says more about the way firms invest in research and where they make their investments than about the scale of private R&D investment. As we noted above, strategic partnerships should primarily be understood as part of the globalisation of R&D and the location choices that firms are making for their research investments.

Another relevant question for policymakers is how strategic partnerships fit into a rapidly changing geopolitical context. Some are now arguing that EU rules should be applied when foreign enterprises acquire Dutch firms, and that a level playing field must be created.[46] Such rules and assessment frameworks may also be needed for strategic partnerships. For example, should American, Chinese and Indian enterprises be allowed to enter into strategic partnerships with Dutch universities in the same way as European firms? This question is especially pertinent when the partnership involves knowledge that can be used to generate strategic advantages and consolidate a country's economic and military clout.

When a firm wants to cooperate strategically with a Dutch university, it should not be left to the university or research group to decide whether its country or continent of origin matters. An assessment framework is needed that can help it decide whether or not to enter into a strategic partnership with a specific firm.

5.3.2 Science policy

The Ministry of Education, Culture and Science uses its research and science policy to intervene in knowledge ecosystems with a view to creating an internationally competitive research environment that challenges researchers to perform well. In addition to high-quality scientific research, important policy objectives are: fostering close ties between science and society (including industry) and encouraging researchers to develop their talent. Strategic partnerships offer the Ministry (and NWO) new opportunities to pursue these three main objectives, but they also raise questions.

Research and science policy

The overall objective of the Ministry's research and science policy is to create an internationally competitive research environment that challenges researchers to deliver the best possible scientific achievements and that meets society's needs.

In its policy, the Ministry promotes not only quality and excellence in scientific research but also unique areas of focus and specialisation at universities, as well as cooperation between industry, knowledge institutions and government (particularly by means of the 'top sector' strategy). The Ministry sees that

46 See, e.g., the NRC article 'Europese aanpak nodig tegen buitenlandse overnames', https://www.nrc.nl/nieuws/2018/01/18/hoogste-ambtenaar-ez-bescherm-tegen-buitenlandse-overnames-a1588785

public funds are well spent and that knowledge is properly disseminated to society. Source: Budget, Ministry of Education, Culture and Science 2018 (Kst-34775-VIII-2)

2025: Vision for Science, Choices for the Future

The policy document *2025: Vision for Science, Choices for the Future* identifies three main aims for Dutch science:

1. To be of worldwide significance.
2. To have even closer ties with society and the private sector; it has maximum impact.
3. To continue to be a breeding ground for top talent.

In a recent letter (16 June 2017) to the House of Representatives, the Science Minister stated that cooperation between industry and universities generally leads to positive outcomes. The Minister sees such partnerships as one of the strategies that will help achieve the three main aims for Dutch science identified in the policy document *2025: Vision for Science, Choices for the Future*. The basic principle is that universities can decide for themselves what they wish to research, what they wish to teach and also with whom they wish to cooperate. Universities are therefore free to cooperate with industry. They nevertheless have an obligation to comply with the principles of research integrity (honesty, scrupulousness, transparency, independence, and responsibility), as enshrined in the Netherlands Code of Conduct for Research Integrity.

New opportunities

i) Science of worldwide significance

Strategic partnerships offer policymakers an opportunity to promote high-quality science, specifically when it takes the form of use-inspired basic research. Close cooperation with knowledge-intensive (high-tech) firms allows scientists to capitalise on that firm's resources, knowledge, expertise and data, thereby boosting the quality of the research.[47] They can also involve knowledge-intensive firms in evaluating that quality.

The above is a useful counterweight to current practice, which places a great deal of emphasis (perhaps too much) on publications in top journals and impact scores. Large multinational enterprises that enter into a strategic research partnership spend the necessary time and energy scouting the best knowledge partners

47 The evaluation of FOM's Industrial Partnership Programmes, for example, has shown that research quality and industrial relevance can go hand in hand, provided that the participating firms are themselves also interested in pioneering basic research that has no practical application as yet.

(worldwide). When they choose a strategic partner, it is a sign of that research group's quality.

For some time now, NWO has focused on supporting new forms of public-private cooperation in research. It recognises the added value of strategic partnerships in promoting high-quality science and in helping to connect science and society. NWO has, for example, co-founded several strategic partnerships (ARCNL and ARC CBBC) and sits on their boards. FOM (now part of NWO) broke new ground in this regard with its Industrial Partnership Programmes. NWO intends to evaluate the strategic partnerships in which it is involved with a view to improving the concept.[48]

ii) Science has close ties with society and the private sector
Strategic partnerships offer policymakers a new way to encourage universities to engage with industry. Even more so than in other PPP arrangements, both parties make every effort to share knowledge and expertise. Exchanges between the two sides extend to all stages of the research process, from agenda-setting to dissemination of research results. It is precisely the close involvement of industry in conducting the research that is typical of strategic partnerships and offers added value compared to alliances that focus on cooperating at the 'front end' (joint agenda-setting) and/or 'back end' of research (sharing of results). Moreover, the alliance is long-term and programme-driven and not based only on individual projects.

iii) Science as a breeding ground for talent
Strategic partnerships give policymakers a new way to broaden the scope of PhD training. Thanks to close cooperation with industry, universities can give young researchers a much broader education than that offered in mainstream academic PhD programmes. Some strategic partnerships dovetail well with post-graduate engineering programmes. Strategic partnerships thus offer new ways to promote talent development and knowledge transfer (for example through cross-sector mobility). They also help to make an appointment at a Dutch university appealing to talented foreign researchers.

Considerations and trade-offs
Strategic partnerships also raise a number of questions for policymakers.

The first is how to ensure that the public and private partners maintain an appropriate distance from each other. While their intention is to cooperate closely, this must not lead to conflicts of interests, restrictions on academic freedom, or the impairment of research integrity. The Minister should be able to rely on universities to carry out proper 'border surveillance'.

48 In its new strategic plan for 2019-2022, NWO has announced that it will be evaluating 'relatively new forms of collaboration' such as ARCNL, in which NWO is collaborating with other parties over a period of many years so that the experiences acquired can be used to further improve the concepts (NWO, 2018).

Strategic partnerships are suitable for connecting the commercial R&D agendas of large enterprises to public research agendas. Policymakers should consider whether there is sufficient scope and interest to mobilise public science for other innovation agendas (relevant to society). With their vast financial resources and knowledge-intensive activities, large multinationals are extremely attractive partners. They can therefore easily recruit top researchers. It is in the public interest to ensure that outstanding scientists are also mobilised to work on other knowledge and R&D agendas, including agendas addressing the challenges facing society. Policymakers must strike the right balance between the various agendas (academic, commercial and societal) for which public research is mobilised.

Another point that policymakers must consider is how strategic partnerships between Dutch universities and large multinationals affect the Netherlands' ability to attract and retain talented researchers. On the one hand, such partnerships do help to bring international talent to the Netherlands. On the other, multinationals are first in line to scout and recruit talented researchers. For policy purposes, it is important to understand the net effect of strategic partnerships. Are knowledge and talent in fact exiting the Netherlands? There is also the geopolitical context: where are knowledge and talent going when they leave the Netherlands? Are they remaining in Europe, or are they benefiting (firms in) the US or China, for example?

The way that policymakers evaluate strategic partnerships depends on how they conceive of the university's future in the longer term. What role do they expect universities to play in society? Who owns the universities, and whose interests do they serve? How much discretion or incentive do universities have to differentiate and specialise? Some universities could very well position themselves as strategic partners for industry, for example, while others could focus on different stakeholders.

In the Netherlands' current science system, universities are basically free to enter into strategic partnerships, provided that they adhere to codes of research integrity. As a practice, strategic partnerships are still in their infancy at most universities. The science system as a whole would benefit from mutual learning in the interests of informed decision-making and responsible partnerships.

It is in the public interest to draw up a common assessment framework that offers a basis for determining which partnerships are or are not desirable and which terms and conditions are appropriate. The national government can play a coordinating role in this context, for example through NWO.

5.3.3 Regional government policy

Strategic partnerships give regional and local governments an opportunity to boost the regional or local economy. Such partnerships may help to attract new (knowledge-intensive) activities to the region and to consolidate the regional economic structure. In policy terms, a strategic partnership helps the region to attract knowledge-intensive investment and well-trained workers. It can, for example, put a local campus on the map as an interesting location for innovative companies.

To make informed choices with respect to strategic partnerships, regional policymakers must have a clear idea of the direction in which they want to see the regional economy developing, for example in the form of a strategy for regional specialisation.

Typical considerations in this context are whether policymakers choose to support strategic partnerships with existing (large) enterprises in the region, or whether they opt to attract new, international firms that do not yet have a presence there. Strategic partnerships enable regional and local authorities to involve local universities and industry more closely in economic development policy and in attracting knowledge-intensive investment.

What a regional government contributes to a strategic partnership varies from a one-off start-up grant to a significant multi-year financial package. In the case of large-scale public funding, the authorities will want to be more closely involved in the partnership, for example by participating in its governing body, so that it can monitor and evaluate the economic and societal impact of public funding.

5.3.4 Policy coordination

Strategic partnerships create new options for taking action and raise new concerns in different policy domains at different tiers of government. It is in everyone’s interest for municipal, regional and national authorities to coordinate their policies and interventions closely, not only ‘vertically’ between the different tiers of government but also ‘horizontally’ between the policy areas concerned. One possible route towards a coordinated approach is to establish a common assessment framework for deciding whether or not to support a strategic partnership. Such a framework should clarify the criteria and conditions that strategic partnerships between universities and industry must meet to qualify for (certain) public co-funding schemes.

6 Conclusions

Public-private research partnerships (PPP) between universities and industry have become commonplace in the Netherlands in recent decades. Since the 1980s, the Dutch government has also explicitly encouraged cooperation across successive generations of innovation policy, currently in the form of a public-private partnership allowance (the PPP allowance).[49] Public-private research consortia, virtual research institutes and separate collaborative projects illustrate the wide variety of PPP arrangements. In recent years, however, there has been a new trend in PPPs in which large firms and universities enter into *strategic* research partnerships. Their purpose is to build a solid relationship that has advantages for both parties. That relationship appears to be closer, more comprehensive, and more exclusive than in other PPP customary types so far. It is important for science and innovation policymakers to understand this trend, not only because it appears to offer all sorts of opportunities to support Dutch science and boost the Netherlands' knowledge economy in a global context, but also because the new options raise new questions.

The purpose of this study is to gain a better understanding of the phenomenon of strategic public-private research partnerships and what their emergence means for the dynamism and functioning of ecosystems in which knowledge is generated. This study answers four main research questions:

- How does a strategic partnership differ from other types of research PPPs?
- How can we understand the emergence of strategic partnerships?
- What new opportunities become available to firms and universities that enter into a strategic partnership?
- What new questions and trade-offs do such partnerships entail, both for the stakeholders themselves and for government science, innovation and regional policy?

Our research approach consisted of a conceptual study of the literature on strategic partnerships, an empirical study based on three case studies of strategic partnerships (Chemelot InSciTe, DELTA Lab and ARCNL), and two meetings with experts and stakeholders at universities, in industry and in policymaking.

Strategic partnerships as a new type of research PPP

Research cooperation in a strategic partnership is more selective, more exclusive, more intense and lengthier than has so far been customary in other forms of PPP. The partners wish to build a relationship that will generate the mutual trust

49 The Ministry of Economic Affairs' 'Top Sector' policy supported more than a thousand public-private partnership projects between 2013 and 2016. (See the factsheet Stimulering publiek-private samenwerking via de PPS-toeslag. Onderzoek en Innovatie by the Rathenau Instituut, 11 February 2018, https://www.rathenau.nl/nl/wetenschap-cijfers/het-geld/stimulering-publiek-private-samenwerking-de-pps-toeslag-onderzoek-en

necessary for close collaboration and for sharing knowledge, data, systems and facilities. Another typical feature is that the cooperation extends beyond the work of the research groups and R&D departments; senior management at both the university and the firm are also involved in decision-making.

We can position strategic partnerships on one end of a PPP continuum that runs from ‘networking’ to ‘coordination’ and from ‘collaboration’ to ‘strategic partnership’. At the ‘light’ end of the continuum (networking), cooperation in research mainly allows scientists to maintain mutually advantageous relationships with firms and their R&D departments (and vice versa). These are small-scale, often ad hoc research projects by students or PhD candidates where firms offer ideas, provide guidance, arrange internships and so on. In the second type of PPP (coordination), the primary goal is to better align academic research agendas with industry innovation agendas in broad public-private consortia. The third type of PPP (collaboration) sets the bar higher; industry no longer merely offers programme guidance but becomes actively involved in specific research projects within the programme. In the fourth PPP type (strategic partnership), a select group of partners aims to cooperate closely and for a lengthy period of time on research that is important to them all. The relationship is mutually advantageous, with bi-directional sharing of knowledge, data, systems and facilities.

Strategic partnerships differ from other types of PPP in that the partners are deliberately investing in building a relationship with each other. The relationship that they envisage is essentially very different from a client-contractor relationship in which transactions are central. The partners want to narrow or bridge the gap between their academic and industrial organisations in all sorts of ways. For example, they narrow the geographical gap by housing industry and academic researchers in a single lab (co-location), preferably on the university campus or science park. To narrow the cognitive gap (understanding each other’s work), the firm ensures that it has enough knowledge in-house (absorption capacity) and the partners see that academic and industry researchers share their knowledge with one another. Finally, to narrow the organisational gap, the partners get to know each other’s organisational cultures and together develop a research practice that combines academic and commercial elements.

Emergence of strategic partnerships

We can view the emergence of strategic partnerships as a response to the interplay between the changing strategies of industry, universities and government. Strategic partnerships are part of a new generation of open innovation strategies pursued by large enterprises in which cooperation with universities is meant to reinforce their research and innovation ecosystems in the longer term – including in their own facilities clustered around their strategic R&D centres.

Influenced in part by the globalisation of R&D, firms are taking a more strategic approach to the locus of their R&D as well as their partners and method of cooperation. Nowadays, their global R&D footprint consists of one or more key research centres that – thanks to the firm's partnerships – are closely connected to and firmly embedded in a local knowledge ecosystem made up of universities, research institutes, engineering firms, specialist suppliers and others. The research centres are supplemented by smaller research units elsewhere whose partnerships give them access to relevant knowledge ecosystems worldwide.

Universities have also altered their strategies in the past few decades. They are more open to the idea of cooperating strategically with large enterprises. They have come to rely more on industry to help fund their research. Universities have become more enterprising and are more intent on positioning themselves as part of a regional ecosystem for research and innovation. They use their campuses and science parks to engage with firms. Before the millennium, universities mainly used PPPs as a new way to set the research agenda and fund their research. Gradually, PPPs also offered universities a new way of organising research, for example within multidisciplinary research projects or in interfaculty (or even interuniversity) research groups.

Within the context of science policy, policymakers are increasingly aware that partnerships between universities and firms heighten the quality and societal relevance of scientific research. In terms of innovation policy, PPPs have been an important means of triggering innovativeness in industry since the 1980s. Such policy support has made PPPs in research standard practice. Strategic partnerships between universities and industry appear to be the next logical step. It is notable that regional governments are also becoming more closely involved in research and innovation PPPs with a view to stimulating the regional economy. They see strategic partnerships as a way to get large enterprises to commit to their region.

New opportunities and considerations for industry and universities

Strategic partnerships give firms the opportunity to be closely involved in innovative scientific research and to work with prominent researchers. When it comes to their more fundamental knowledge requirements, a strategic partnership is an attractive alternative to in-house research (too expensive and risky), contract research (too specific) and to a series of separate PPP projects with varying partners (too piecemeal). Firms also use their partnership to gain access to the knowledge ecosystems that they need to innovative effectively.

For universities, strategic partnerships offer new opportunities in each of their three core tasks by allowing them to broaden the scope of training for students and PhD candidates, set up appealing research programmes on subjects of economic interest, and boost regional knowledge and innovation ecosystems by attracting innovative firms to the campus or science park and gaining their commitment.

Firms and universities that enter into a strategic partnership seek proximity and extensive ‘border crossings’ because they generate knowledge for two worlds. At the same time, they must keep an appropriate distance from each other and avoid conflicts of interest. It is challenging on both sides to get to know each other’s boundaries and strike the right balance between proximity and distance. The new research practices that this demands are still under development.

A public-private lab cannot be managed in the same way as an industrial lab or a purely academic lab. For example, firms cannot simply alter or discontinue research projects if market circumstances change. They must allow for the fact that academic (PhD) research takes longer, that researchers need to publish their research results, and so on. In turn, researchers must take the firm’s commercial interests and business practices into account and be more pragmatic in the way they manage projects and report on the research. To manage the extensive ‘border crossings’, the partners need more than firm agreements and rules that guarantee academic freedom and research integrity; they also need to create a new research culture that combines academic and commercial elements in a manner acceptable to both sides.

For firms, strategic partnerships with universities offer important new opportunities to gain access to research and researchers. Such partnerships do make a number of demands on firms, however. The firm must invest in sufficient knowledge absorption capacity. Senior management must be involved. The firm must not treat the joint lab as it would an industrial lab. And it must not have unrealistic expectations of its academic partner. The relevance to society of a multinational enterprise that partners with a Dutch university depends on the role that the enterprise aims to play in the Netherlands. For example, will it apply that knowledge in the Netherlands or through its branches elsewhere? The firm’s origins and its market position also play a role.

For universities, strategic partnerships open up new opportunities in teaching, research and valorisation. Universities must ensure that the partnership does not impinge on its academic interests, however. To enter into informed strategic relationships with large multinationals, university boards must have a clear-cut notion of the type of university they want to be and who their stakeholders are. For example, strategic partnerships go well with scenarios in which the university regards the results of teaching and research as a private good (as well) and in which the university competes globally for money and talent. As part of these efforts, the university board must also decide to what extent the university will be selective about the firms that it considers suitable and, more to the point, unsuitable as a strategic partner.

Universities should consider the following points:

- The firm's strategy. Does it want to use the partnership to 'tap into' knowledge, or is it planning to maintain a long-term presence on the campus or in the Netherlands?
- The firm's origins. Should Chinese or US firms gain access to the university in the same way as Dutch or European firms? This is a relevant issue in strategic knowledge domains, such as artificial intelligence.
- The firm's position on markets and societal innovation routes. Will the partnership inadvertently help the firm maintain its dominance in the market, or will it contribute to preserving an undesirable status quo?

Options and issues for policymakers

The emergence of strategic partnerships is a relevant phenomenon in various policy domains, specifically in the national government's enterprise policy and science policy and in regional innovation policy.

In its **enterprise and innovation policy**, the Ministry of Economic Affairs and Climate Policy has identified an attractive business climate as a public objective. Strategic partnerships can contribute to creating such a climate because they offer firms solid opportunities to mobilise research and researchers in the pursuit of their innovation targets. They can furthermore play a role in attracting foreign investment in R&D and in making the business location climate in the Netherlands more welcoming to knowledge-intensive activity.

Policymakers active in these domains should consider the following points:

- The impact of strategic partnerships on the 'level playing field' for other parties (SMEs or public-sector organisations), i.e. on their ability to work with top researchers at universities, to provide input into research agendas, or to scout and recruit talented scientists. Strategic partners have direct access to knowledge and scientists that others do not have.
- Strategic partnerships in a changing geopolitical context in which knowledge generation and technological advances are tools in an economic and military battle for power. Similar to foreign take-overs of Dutch firms, the Netherlands needs an assessment framework and a set of requirements that non-EU enterprises must satisfy before they are permitted to enter into strategic partnerships with Dutch universities. To what extent should universities be free to choose their own strategic partners?

The three stated aims of the Netherlands' **science policy** are for Dutch science to be of worldwide significance, to have maximum impact, and to be a breeding ground for talent. Strategic partnerships offer new opportunities to pursue all three of these aims. Specifically, the research programmes undertaken in strategic partnerships combine quality academic research with prospects of valorisation. This

combination also adds a new dimension: academia as an appealing incubator for talent.

Policymakers active in this domain should consider the following points:

- Whether universities can represent the public interest properly in strategic partnerships and take informed decisions about entering into and managing them.
- The implications of strategic partnerships for diversity in – and coordination between – the various academic, economic and societal agendas that mobilise public research.
- The implications of strategic partnerships for the outflow of knowledge and researchers abroad and the influx of knowledge and talent into the Netherlands.
- The role of strategic partnerships in the long-term prospects of the university system. What is expected of (which) universities in their strategic cooperation with (which) firms?
- Whether universities do enough to learn from one another about managing strategic partnerships properly as a new research practice, and whether NWO should play a coordinating role in this context.

Regional and local governments focus on stimulating the regional or local economy. They view strategic partnerships as a route to getting large R&D-intensive firms to commit to their region or city, and to create distinctive regional knowledge and innovation hotspots.

Regional policymakers should consider the following points:

- The effect of a major market party on the dynamism of regional innovation ecosystems. Has the region set its sights on revamping ecosystems or on reinforcing existing ones? A strategic partnership between an existing party and a local university may block any partnership with a new party from outside the region.
- Involving universities in regional development policy and in acquiring knowledge-intensive investment.
- The form in which and the extent to which the regional government should support a strategic partnership. Is a one-off start-up grant enough, or is a multi-year financial commitment necessary?

Towards an assessment framework

All sorts of public and private interests converge in strategic partnerships. They not only bring together the interests of public and private researchers and the organisations they work for, but also those of public policymakers in different domains and tiers of government. Strategic partnerships are still in the throes of development. Now is a good time to devise an integrated assessment framework that will allow stakeholders to weigh up the various public and private interests,

opportunities and risks involved. That will help them take an informed decision as to whether they want to enter into or support a strategic partnership, and on which conditions. A sound assessment framework should in any event address the following issues:

- How does a strategic partnership impact the access to public knowledge and researchers of firms outside the partnership?
- How does a strategic partnership impact research agendas and the balance between the various academic, social and economic agendas that mobilise science?
- Geopolitical considerations. Knowledge generation and technological advances are pawns in the battle for economic and military power. Does a strategic partnership help to strengthen the regional / Dutch / European economy or does it boost the economy of global competitors? Is it contributing to the outflow of knowledge and (top-class) researchers to other countries, or is it in fact bringing about an influx of knowledge and talent?
- How does a strategic partnership fit in with the university's long-term perspective on the knowledge institution that it wants to be for stakeholders (and which ones)? How does it fit in with the government's long-term outlook on the Dutch research and science system?
- How does a strategic partnership tie in with regional development strategy? How does a strategic partnership impact the dynamism and vitality of regional ecosystems for R&D and innovation?

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Appendix 1: Individuals involved

Case study interviewees

Zeynep Akata	University of Amsterdam, DELTA Lab
Ger Baron	City of Amsterdam
Huib Daniels	Province of Limburg
Pieter Emans	Maastricht UMC+
Joost Frenken	ARCNL
Emiel Hensen	Eindhoven University of Technology
Michiel van den Hout	NWO-I
Annabel Jansen	Chemelot InSciTe
Bert Kip	Brightlands Chemelot Campus
Bart van Leijen	VU Amsterdam
Bart Noordam	ASML
Christoph Peylo	Bosch
Marcus Remmers	DSM
Miriam Roelofs	NWO-I
Albert Scherpbier	Maastricht University, Maastricht UMC+
Guus Schreiber	VU Amsterdam
Kalle van Seeters	Province of Noord-Holland
Arnold Smeulders	University of Amsterdam, DELTA Lab
Emiel Staring	Chemelot InSciTe
Jens Thies	DSM
Peter van Tienderen	University of Amsterdam
Oscar Versolato	ARCNL
Max Welling	University of Amsterdam, DELTA Lab
Stefan Witte	VU Amsterdam, ARCNL
Marcel Wubbolts	Corbion

Other interviewees

Mirjam Bult	University of Twente
Rutger Claassen	Utrecht University
Hans Dröge	Consultant
Kees Eijkel	University of Twente
Katrin Hahn	University of Twente
Peter Jan Knegtmans	University of Amsterdam
Harry Lintsen	Eindhoven University of Technology
Esther Smit	Amsterdam Data Science
Frans van der Zee	TNO

Liaison meeting, 30 November 2017

Jan van den Biesen	Consultant
Hans Dröge	Consultant
Kees Eijkel	University of Twente
Thomas Grosfeld	VNO-NCW
Bart van Leije	VU Amsterdam

Stakeholders meeting, 25 January 2018

Jan van den Biesen	Consultant
Bob van der Bijl	RVO
Patries Boekholt	Consultant
Daan Donkers	City of Amsterdam
Ton Flaman	Philips
Maarten Flinkenflögel	Utrecht University
Thomas Grosfeld	VNO-NCW
Annabel Jansen	Chemelot InSciTe
Didier Manjoero	City of Amsterdam
Maurice Mourad	ARC CBBC
Karen Passier	Ministry of Economic Affairs
Johan Vos	University of Amsterdam
Pieter de Witte	NWO
Wim van der Zande	ASML

Appendix 2: Additional information on the research approach

Case studies
We selected the case studies by seeking out partnerships in the Netherlands that are of strategic importance to the firm involved and in which a university is one of the lead partners. We performed desk research to identify (long-term) partnerships involving firms that number among the top 30 R&D enterprises in the Netherlands (Waardenburg, 12 May 2017).

We assessed the partnerships matching this description against criteria based on the OECD's definition of strategic partnerships (2016). The criteria were: use-inspired basic research, a joint research programme, all the partners made a substantial contribution, both the university and the firm played an active role, and the partnership had a term of at least five years.

Finally, we selected three cases that largely met the criteria described above but varied in terms of research domain and design: Chemelot InSciTe, DELTA Lab and ARCNL. We examined each case using a case study protocol, desk research and interviews.

During the interviews, we asked questions about:
- the history of the partnership
- how the interviewees got involved and what role they had or still played
- what made the cooperation strategic
- what made the cooperation a partnership
- what considerations had played a role in choosing to cooperate
- how the parties dealt with differences between their organisations (university and firm).

Other interviews
We also asked a number of people their views on the foregoing interview questions, based on their role and expertise (in a general sense).

Meetings
On 30 November 2017, we discussed our initial research findings with five individuals who had been invited to a liaison meeting.
On 25 January 2018, we discussed our interim report with a group of fourteen stakeholders and experts. Those invited commented on various matters, including the potential impact of strategic partnerships and possible policy implications.

Appendix 3: Agreements on intellectual property and scientific publications

The agreements that the partners in public-private research partnerships make about intellectual property rights (IP rights) and scientific publications are of crucial importance. A further factor is that the timing of the two activities differs with regard to confidentiality and disclosure. In the case of patents, confidentiality is required until the application has been filed, whereas in the case of publications, rapid disclosure is important to gain recognition in the academic world. To facilitate negotiations on such agreements, parties can turn to the report *Spelregels voor privaat-publieke samenwerking bij programmering en uitvoering van fundamenteel en toegepast onderzoek* [Rules for setting up and implementing programmes of basic and applied research in private-public partnerships] (Regiegroep Spelregels, 2013). The rules were developed in 2013 at the request of the Dutch Government by the Regiegroep Spelregels, consisting of representatives of the Royal Academy, the Association of Universities in the Netherlands, the Association of Dutch Universities of Applied Sciences, NWO, the Chemicals, Horticulture & Propagation Materials, and Logistics 'top sectors', TO2 (organisation of applied research institutes) and VNO-NCW employers' federation. Their purpose is to support successful research alliances in the Netherlands' top economic sectors and in the Top Consortia for Knowledge and Innovation (TKIs). The report makes recommendations concerning IP rights and publications as drawn up by the IP expert group, part of the Regiegroep.[50] NWO has incorporated the recommendations into its PPP research policy (NWO, 2014).

In this appendix, we summarise the recommendations relevant to strategic public-private research partnerships.[51] The report notes that flexibility is necessary to implement agreements in practical terms because there are major differences between sectors in the importance they attach to IP rights and how they use them. Pharmaceuticals firms must have exclusive patents, whereas in the electronics industry it is customary to draft general standards, with other parties being required to take out licences.

[50] The Intellectual Property expert group consisted of representatives of STW, NWO, TU/e, WUR/DLO, VU, VSNU, TKI Watertechnologie, TTI Groene Genetica, TNO, Holst, Ministry of Economic Affairs, Ministry of Science, Unilever, Philips, Tata, Tempress and TTO-Netwerk.

[51] The Regiegroep distinguishes three types of PPP: broad, specific and intensive. These types largely coincide with three of the four PPP types in the continuum described in Chapter 2, namely 'coordination', 'collaboration' and 'strategic partnership'.

Intellectual property

One typical feature of PPPs is that the IP rights are often transferred from the researcher to the firm. The inventor (researcher) usually owns the rights first, although the rights (subsequently) accrue to the research organisation (as the researcher's employer).

The PPP partners agree on how property rights and rights of use will then be transferred to the firm. A third party (e.g. a research funding body such as NWO) may also claim joint ownership. In determining the rights accruing to the firm, the parties will consider the percentage of the PPP's expenses covered through private funds. If the firm covers only 5% of the expenses, it will acquire fewer rights than if it covers 50%. NWO therefore breaks down private funding of PPP research into three categories: 0% to 10%, 11% to 30% and 31% to 50% (NWO, 2014).[52]

In strategic partnerships, private funding falls into the second category or higher. Ultimately, the IP rights usually end up belonging to the firm. The preferred agreement is that the firm is given a 'right of first refusal' on patents. If it is the government providing funding, then the EU framework for state aid offers two options if the firm wishes to acquire the IP rights. The first is that IP rights are assigned in a way that appropriately reflects the private partner's contributions to the partnership. The second is that the private partner pays a market-compliant fee for the IP rights. The size of the fee can be determined in three different ways: it can be based on expenses incurred, on market value (comparison with similar IP transactions) or on (projected) revenues. For practical reasons, the firm can agree to pay a fee based on expenses incurred. To avoid a situation in which the firm pays twice, it may deduct its contribution to the PPP research from the fee that it pays.

If the public partner covers a sizeable share of the PPP's expenses and the IP rights are broadly applicable, then the recommendation is to grant the firm a licence in a designated area of application. Licences can then also be granted in other areas of application.

Public and private parties also generate knowledge in PPP research projects that is not patentable, for example knowledge that is freely available and 'trade secrets'. The rules recommend allowing the parties to use this knowledge for their own purposes free of charge once the project has ended.

52 In the first category, firms can use the resuls of the research internally and non-commercially. In the second category, the firm is given an option on an exclusive right to make commercial use of the results (whether or not they have been patented). To make use of this option, the firm must pay a market-compliant fee, minus its own contribution to the research. In the third category, firms are granted a non-exclusive, royalty-free right to make commercial use of the results (in addition to the aforementioned option).

Scientific publications

In PPPs, scientists time the disclosure of their research results to allow for the firm's commercial interests. It is important to firms that certain knowledge remains confidential (temporarily) so that patents can be filed and trade secrets can be documented. It is therefore customary for the firm and the research organisation to screen scientific publications before they are submitted. This holds for all forms of disclosure, including conference papers and presentations. The report advises allowing no more than a month for screening. Trade secrets and confidential background information can then be edited out of the publication. In exceptional cases, the firm can ask for publication to be postponed for a maximum period of six months. After this period has expired, publication may always take place.

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