

Do Spin-Offs Make the Academics' Heads Spin?

The Impacts of Spin-Off Companies on Their Parent Research Organisation

Arend H. Zomer · Ben W. A. Jongbloed ·
Jürgen Enders

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Abstract As public research organisations are increasingly driven by their national and regional governments to engage in knowledge transfer, they have started to support the creation of companies. These research based spin-off companies (RBSOs) often keep contacts with the research institutes they originate from. In this paper we present the results of a study of four research institutes within two universities and two non-university public research organisations (PROs) in the Netherlands. We show that research organisations have distinct motivations to support the creation of spin-off companies. In terms of resources RBSOs contribute, mostly in a modest way, to research activities by providing information, equipment and monetary resources. In particular, RBSOs are helpful for researchers competing for research grants that demand participation of industry. Furthermore, RBSOs may be seen as a proactive response by Dutch public research organisations to demands of economic relevance from their institutional environment. RBSOs enhance the prestige of their parent organisations and create legitimacy for public funds invested in PROs. At the same time, most RBSOs do not have a significant impact on the direction of the research conducted at the PROs.

Keywords Public research organisations (PROs) ·
Research based spin-off companies (RBSOs) · Science-industry interaction ·
Industry funding · Commercialisation · Impacts on knowledge production

1 Introduction

Research based spin-off companies (RBSOs) originating from universities and other public research organisations (PROs) are an important channel of knowledge transfer

A. H. Zomer (✉) · B. W. A. Jongbloed · J. Enders
Center for Higher Education Policy Studies (CHEPS), University of Twente, Enschede, Netherlands
e-mail: a.h.zomer@utwente.nl

(DiGregorio and Shane 2003; Wright et al. 2004; Steffensen et al. 1999). The creation of spin-off companies by PROs has received a considerable amount of attention from policymakers in the past 15–20 years (Bozeman 2000; Rothwell and Dodgson 1992) and is often associated with policies that aim to foster the creation of high-tech industries, and increase regional development and jobs. In Europe, policymakers refer to the European paradox to spur universities and other PROs to increase knowledge transfer with industry and society in general (EC 1995, 2003). Like the United States, both the European Union and national governments in Europe have introduced policy instruments to promote and facilitate the transfer of knowledge between science and society. PROs in OECD countries are encouraged to engage in alliances with industry both to enhance the relevance of their research and to facilitate its use by industry (OECD 2004). Governments are also providing support to small and medium-sized enterprises, specifically in the high-tech sector, in order to increase the knowledge transfer between PROs and industry (Rothwell and Dodgson 1992; Larédo and Mustar 2004). These developments are indicative of the pressures PROs are facing from their environment to redefine their missions (Häyriinen-Alestalo 1999).

The phenomenon of RBSOs has also received much attention from academics (cf. Mustar et al. 2006; O'Shea et al. 2007; Djokovic and Souitaris 2008). So far, empirical studies of RBSOs have focused on the conditions for the initiation and development of RBSOs (Mustar 1997; Wright et al. 2004), the role of support structures (Lockett et al. 2003; Link and Scott 2005; DiGregorio and Shane 2003), and the importance of RBSOs in relation to other forms of technology transfer (Rogers et al. 2001). Studies interested in the impacts of knowledge transfer activities have focused on the effects of patenting (Geuna and Nesta 2006; Meyer 2006) and industry funding (Gulbrandsen and Smeby 2005; Crespo and Dridi 2007). The effects of increased spin-off generation and interactions with spin-off companies by research organisations have not been investigated thus far. The aim of this article is, first, to understand how the creation of RBSOs links up with demands for societal relevance in research. Second, we show how PROs benefit from and utilise the presence of RBSOs. And, third, we show what impacts RBSOs have on the research activities of their parent research organisation.

This contribution is organised as follows. Section 2 introduces new institutional theory (Meyer and Rowan 1977) and resource dependency theory (Pfeffer and Salancik 1978) as perspectives that we apply to understand the responses of PROs to increased pressure to engage in commercialisation and knowledge transfer activities. Section 3 will discuss methodological issues and specifically the case selection. In Sects. 4 to 6 we will show how PROs in the Netherlands have responded to the increased pressure to engage in knowledge transfer, how the presence of RBSOs is utilised by both researchers and PROs and to what extent exchange relationships between PROs and RBSOs may have affected the research activities of PROs. The final section summarises our findings.

2 Conceptualising the Behaviour of PROs

In this section we present two theoretical perspectives—resource dependence theory (Pfeffer and Salancik 1978) and new institutional theory (Meyer and Rowan 1977)—

to study the responses of PROs to changing behavioural expectations and financial incentives as regards the creation of RBSOs and their possible implications for the parent research organisations. We start from the assumption that PROs can be characterised as open systems that support themselves by exchanging resources with their environment (Meyer and Scott 1992), since research organisations depend to a large extent on the political system that provides them with the necessary funds to conduct research.

Resource dependence theory considers the survival of organisations an activity of managing environmental requirements in order to acquire critical resources (Pfeffer and Salancik 1978). Organisational action is directed towards the acquisition of resources in order to survive. For PROs to be effective in securing resources, they will need to produce acceptable outcomes for the environment to persuade external actors such as ministries, research councils and industry to provide them with resources. External organisations can influence the behaviour of the focal organisation because of their control of vital resources the focal organisation depends upon. The focal organisation on its behalf is to some extent able to select in its environment the organisations it chooses to obtain its resources from. According to Pfeffer and Salancik (1978), organisations can respond to environmental demands by either complying with these demands, attempt to avoid these demands or to manage the conditions which the organisation is confronted with.

New institutional theory, like resource dependence theory, assumes that in order to survive, organisations take their environment into account. Therefore, organisational responsiveness to demands from external organisations and anticipating future demands from external organisations is vital for their survival (Meyer and Rowan 1977). New institutionalism presumes that the environment of an organisation is dominated by rules, taken-for-granted assumptions, myths and routines about what constitutes appropriate or acceptable behaviour of organisations (Meyer and Rowan 1977; DiMaggio and Powell 1991). In every organisational field beliefs exist of best ways how to organise and how to respond to changing expectations in the organisational environment. Organisational responses can thus follow manifestations of such institutionalised rules and beliefs (Meyer and Rowan 1977). Organisations may be unaware of certain rules and norms, following them blindly or comply consciously and strategically in anticipation of specific self-serving benefits (Scott 1987). Under conditions of uncertainty, organisations may choose to imitate behaviour of other organisations in their environment they know and trust (Oliver 1991; Galaskiewicz and Wasserman 1989). This does not mean that organisations will simply adhere to demands and expectations from organisations in their environment. Organisations often have to cope with incommensurable demands originating internally as well as externally. This increases the likelihood that organisations will opt for a response other than a mere adherence to environmental rules and norms, thereby resisting institutionalisation (Oliver 1991). In doing so, organisations can de-couple their formal structure from their task core and respond symbolically to changes in their environment while leaving their core activities untouched (Powell 1988; Meyer and Rowan 1983). New institutional theory thus assumes that a changing institutional environment does not necessarily lead to

organisational change but that it is more likely that organisations maintain stability in their core activities since this is what they prefer (Tolbert and Zucker 1983).

Attempts have been made to integrate the two perspectives into a set of responses of organisations to their environment, most notably by Oliver (1991), and have been applied to the field of higher education (Huisman and Meek 1999). According to these studies, the logic of resource dependence theory is better applicable in situations where the organisation has a clear understanding of the tasks it should perform according to its environment, in which pressures are visible and in which the management of scarce resources is crucial. The logic of new institutionalism is better applicable in situations where invisible pressures are more dominant and where the primary goal is to attain social worthiness instead of the acquisition of resources. In this paper we will not seek to actively integrate the two perspectives. Instead, we seek to use both resource dependence and new institutional perspectives as interpretative frameworks for our empirical observations.

We will show in Sect. 4 that the institutional environment of PROs increasingly promotes knowledge transfer and commercialisation and how PROs have dealt with these environmental processes. We investigate to what extent PROs in the Netherlands have engaged in the support of spin-off activities in reaction to demands from their institutional environment and how they have engaged in the support of spin-off activities. Following new institutional theory, we can expect PROs to follow institutionalised norms and rules present on the policy level as long as this does not interfere with other external as well as internal requirements. A PRO will attempt to show stakeholders that it is acting in good faith, following norms and rules by supporting, promoting and engaging in knowledge transfer. Resource dependence theory expects organisations to actively pursue resources to the limit that this does not compromise their legitimacy and access to other significant amounts of resources. In Sect. 5 we show how researchers and PROs are utilising the presence of spin-off companies. We expect that PROs and individual researchers as strategic actors, who take their environment into account, will attempt to appease funding agencies by actively mobilising spin-off companies to show their engagement in knowledge transfer when this may lead to additional legitimacy and resources. At the same time, they might try to buffer their research activities from forces demanding knowledge transfer and commercialisation. Section 6 explores whether research activities within the selected PROs are actually affected by the presence and the exchange relationships with RBSOs. According to resource dependence theory, organisations will produce acceptable outcomes to obtain resources to the extent that it does not negatively affect their legitimacy or access to other resources. New institutional theory stresses that organisations prefer to maintain organisational stability which would mean that individual researchers might attempt to counter influences from RBSOs, not changing their research activities.

3 Case Selection and Methodology

Our empirical findings are based on case studies of four university research institutes and two non-university PROs in the Netherlands. We selected two large

organisational subunits within a comprehensive research university and two research institutes within a university with an entrepreneurial focus to investigate whether institutional missions would matter for their propensity to create spin-off companies. On the same basis two non-university PROs were selected: a national research institute with a basic research focus and a research institute with an applied and business oriented outlook. Our cases are positioned in the new technology oriented fields of micro- and nano sciences, life sciences, and information and computer sciences that receive particular attention from policymakers regarding knowledge transfer. In Table 1, the main characteristics of the investigated research institutes are presented.

Our approach focuses on two different organisational levels. One level is the managerial level, which is mainly concerned with the image and the legitimacy of the institute as it relates to its larger institutional environment. On this level, strategic planning occurs and collective actions such as the creation of support structures for spin-off companies take place. The shop floor level is our other level of interest. Here, we investigate how the presence of spin-off companies affects the research activities of researchers.

Within the institutes we selected research departments that had a higher than average amount of spin-off companies to minimise the amount of research departments investigated. We selected research departments that have spin-off companies because we are interested in the relationships these departments have with their spin-off companies, how they make use of them, and what impacts the relationships have on the research activities. We found that the selected departments did not differ significantly in their size and focus on basic and applied research in relation to other research departments in their institutes. The selection of spin-off companies was neither based on the extent of their relationships with the research departments nor their size. Other spin-off companies supported by the PROs were not studied since they did not originate from the selected research departments. In total, we investigated the exchange relationships of twenty-four spin-off companies with their parent research institutes. Annex 2 displays the investigated RBSOs, their size, year of establishment, the technology area they are active in, whether PRO staff owns shares, whether the PRO owns shares, and whether the RBSOs have a marketable product.

We applied an exploratory case study approach while being aware that attributing causality in social science research has proved difficult and that limitations exist in investigating impacts. We made sure to triangulate our data by interviewing multiple senior researchers within single research departments, technology transfer officers, directors of the research institutes and representatives from the spin-off companies. Additionally, we collected annual reports, strategic plans and research evaluations. A first round of interviews was conducted to identify all interactions that occurred between the spin-off companies and their parent research institutes. In a second round of interviews, researchers were questioned about the importance and the impact of the exchange relationships with RBSOs. A third round of interviews involved the management of the selected research institutes.

Table 1

Investigated research institutes	University Medical Centre (Utrecht UMC)	Utrecht Institute for Pharmaceutical Sciences (UIPS)	MESA + Institute for Nanotechnology	Centre for Telematics and Information Technology (CTIT)	Centre for Mathematics and Computer Science (CWI)	TNO ICT
Acronym	MedLab	Pharmlab	MicroLab	ICTLab	Fundamental ICT Institute	Applied ICT Institute
Part of:	University of Utrecht		University of Twente		-	TNO
Acronym of organisation	Comprehensive Research University		Technical University		-	Applied Research Organisation
Disciplinary field	Life sciences	Life sciences	Micro- nano sciences	Information & computer sciences	Information & computer sciences	Information & computer sciences
Type of organisation	Comprehensive research university		Technical university		Non-university research organisation	Non-university research organisation
Mission	Institute is focused on basic research that relates to practical problems.	Institute is focused on basic research that relates to practical problems.	Institute focuses on basic research as well as applied. Technology transfer is an important part of mission and professionalised in the institute.	Design, application of and integration of technology. Technology transfer is part of important part of mission and professionalised in the institute.	Basic research is the primary goal. Technology transfer is part of mission but not prominent.	Technology transfer is central to the institute's mission. No basic research but applied research.
Size of the institute	715 FTE (2006)	111 FTE (2007)	300 researchers (2006)	475 researchers (2006)	156 researchers (2006)	375 researchers (2005)
Total # of spin-offs reported	8 (1990–2006)	6 (1990–2006)	35 (1988–2006)	36 (1990–2006)	14 (1990–2006)	13 (2002–2006)
No. of spin-offs investigated	5		7	5	3	4

4 The Stimulation of Knowledge Transfer in the Netherlands and the Creation of Spin-Off Companies by Dutch PROs

Policymakers in the Dutch research system have tried to induce universities and PROs to engage in knowledge transfer with industry and to commercialise knowledge. Policy documents and directives for universities were released parallel to funding schemes that promote or require science-industry interaction and commercialisation. From the 1980s onwards, the Dutch research system has witnessed a steady growth of instruments that promote science-industry interaction and commercialisation of scientific knowledge. Most of these policy instruments do not prefer spin-off companies over existing industry. In Annex 1, an overview can be found of the main policy instruments that were introduced to support science-industry cooperation. Specifically for the creation of high-tech start ups the Technopartner support programme was introduced in 2004. For the life sciences, a similar programme called Biopartner was created. The Minister of Education, Culture and Science explicitly specified the societal role of universities in 2005. The role of universities should not only encompass education, training and the communication of research results, but also extend to the collaboration with private and public actors, the pursuance of intellectual property, the creation of spin-off companies, and the encouragement of entrepreneurship (MOCW 2005). Advisory councils, research councils and a recently created Innovation Platform (created in 2003) have stressed the importance of knowledge transfer and the creation of RBSOs. More recently, a consortium of employers' associations, universities, PROs, research funding organisations and government bodies signed an agreement to increase the knowledge transfer between science and society (Innovatieplatform 2007). Additionally, mandatory research evaluations of university research departments, taking place in six-year intervals, also assess the societal relevance of research in addition to quality and productivity, the traditional academic criteria. All in all, in the past three decades, the institutional environment of PROs was made increasingly conducive to spin-off generation and significant parts of research funding in the technical sciences are provided on the basis that knowledge transfer with industry is occurring within project funded research projects.

Obviously, the appearance of such policy documents and instruments in the Netherlands indicate a shift in the idea of what the tasks of PROs in the country should be; complementing research and teaching activities with an outreach role. In this sense, the rules and norms of the environment of PROs in the Netherlands changed. Nowadays, organisational legitimacy of PROs is not only obtained by showing its performance in academic activities. Commercialisation activities and knowledge transfer are highly desirable activities in the eyes of policymakers as well. Tangible incentives for the PROs, on the other hand, are less prominent. In 2000, the national government started a support programme for the creation of spin-off companies specifically for the life sciences which was converted into a broader support scheme in 2004. In addition to this support scheme, the Valorisation Grant programme was launched to support the creation of RBSOs as well.

Looking at the responses of Dutch universities and non-university PROs, we can note that they already peaked in their creation of incubators for RBSOs in the mid

1990s. Nowadays, almost all PROs in the Netherlands actively support the creation of RBSOs. A study of all Dutch research organisations, published in 2003, found that only one of the thirteen research universities in the Netherlands and only three other non-university PROs stated that the stimulation of RBSOs was not an important part of their activities (van Tilburg and Kreijen 2003). Additionally, all but one of the universities have at least one, but often more than one, incubator facility or other support structure that support the creation of RBSOs (van Tilburg and Kreijen 2003). Before 1996, three-quarters of the PROs did not have support structures for the creation of spin-off companies (van Tilburg and Kreijen 2003). Before 1995, only four universities had support structures in place to promote the creation of spin-off activities. The attention for supporting the creation of RBSOs can be found in official reports and other accountability statements of research institutes as well. Nowadays, all but a few PROs in the Netherlands pay explicit attention to knowledge transfer and spin-off creation in their communication of their activities. These developments are indicative of isomorphic behaviour of Dutch PROs. However, a more detailed description of six selected PROs will show that resource based views are able to explain the behaviour of some PROs. In general, PROs in the Netherlands appear to have followed institutional norms that stress the importance of entrepreneurial activities like the creation of spin-off companies. A disregard for these environmental norms and rules would have led to a decreased legitimacy with policymakers. At the same time, the creation of support structures does not directly affect the research and teaching activities of staff in these PROs, making it less problematic to follow norms and rules in the environment since there are no directly conflicting requirements the PROs are confronted with. Nationally orchestrated incentives did not play a role in the initial steps of PROs to create support structures for RBSOs since the large majority of PROs created support structures in the mid 1990s, whereas monetary incentives were introduced in 2000. Further, the monetary incentives for RBSO creation are insignificant in relation to the overall budget of PROs in the Netherlands. Although nationwide the creation of support structures for RBSOs by PROs appears to have occurred rather simultaneously, the individual pathways of RBSO stimulation by PROs differ.

The Technical University is one of the first universities in the Netherlands to dedicate resources to the creation of spin-off companies (Clark 1998). The university, established in 1961, positions itself as an entrepreneurial university and focuses on engineering and applied social sciences. In its conception the university "... was expected to link up with industry. Equally important, it was also conceived as a regional university ... to help the development of that particular region" (Clark 1998 p. 40). The Technical University can be regarded as a front runner in providing support structures for the creation of spin-off companies in the Netherlands. Already in the 1980s, the support of spin-off activities was seen as an active way to contribute to the mission of the university and to gain additional funds. As early as 1979, the university set up an industrial liaison office to facilitate interactions with industry and increase income from private companies (Maassen and van Buchem 1990). Since 1984, the university has been running its Temporary Entrepreneurial Positions programme that offers new entrepreneurs an interest-free loan as well as advice and training in the early phase of their company. At present, the IctLab and

MicroLab research institutes have incubator facilities and business accelerators to support their researchers in the creation and development of companies. The main motivation for the research institutes to support these activities is the creation of potential research partners to generate income for research. However, the Technical University as a whole was expected to link up with industry from its inception.

The MedLab and PharmLab institutes, part of the Comprehensive Research University, historically have a basic research focus and were considerably late in the creation of support structures for spin-off companies. A strategic plan of the PharmLab institute, published in early 2001, stated that: *“The climate within the university was long felt not to be stimulating or accommodating with regard to starting businesses from a research basis”* (UIPS 2001). In 1996, MedLab created a holding company. In 1997, the MedLab holding company merged with the central holding company of the Comprehensive Research University which aims to assist researchers in patenting, trading of patents and the creation of spin-off companies. An incubator facility for new life science companies was introduced in 2004 which is relatively late in comparison to other universities in the Netherlands. According to interviewees, the university followed other universities in the Netherlands in their support for commercialisation activities. *“At that time the university did not steer on commercialisation. That came later when everybody started doing it”*. The later than average creation of support structures is likely to have resulted from the fact that both PharmLab and MedLab reside within a comprehensive and research intensive university that emphasises its teaching and research activities. The university is predominantly interested in positioning itself as a university that is excellent in academic research, while keeping an eye open for knowledge transfer to society. The university has also tried to counter the attention of policymakers on commercialisation and knowledge transfer together with other research intensive universities in Europe (LERU 2008). This indicates that the university has not merely tried to avoid influences but it has also attempted to counter influences from its environment.

The Applied ICT Institute, a sub-unit of The Applied Research Organisation, has the explicit mission to offer scientific knowledge to society, industry, and small businesses in particular. The Applied Research Organisation operates a holding company that holds shares in spin-off companies. The organisation was evaluated in 2004 and received a negative assessment regarding its knowledge transfer activities. The evaluation, initiated by the government, called for an increase in knowledge transfer and commercialisation activities. The Applied Research Organisation was specifically advised to raise the amount of spin-off companies and patents. As a result, the Applied Research Organisation was keen to increase the amount of spin-off companies and display the spin-off companies it helped to create. From 2006 onwards, the institute's annual report lists the amount of created spin-off companies. Within the Applied ICT Institute, employees are actively supported if they have plans to start their own company. The organisation created its own version of the national valorisation grant (Annex 1) aimed to support commercialisation of knowledge by existing SMEs (small and medium sized enterprises) and RBSOs. There is an annual budget that supports employees to explore technical possibilities which might be developed into ideas for a spin-off company or knowledge that is

appropriated by existing industry. This indicates that the institute is actively rewarding its employees to engage in commercialisation of research results.

The Fundamental ICT Institute has had a twofold mission from its onset in 1945, i.e., to perform frontier research and to transfer new knowledge to society. However, as a fundamentally oriented research institute principally financed by the Dutch research council NWO, it focused mainly on basic research. Organisational attention to knowledge transfer and commercialisation emerged in the early 1990s. A more difficult financial situation and “*the reaction to societal developments triggered a specification of our mission*”. The societal developments were also felt by the main sponsor of the research institute. “*There was a kind of demand for relevance from the outside, which also pressed on NWO*”. The Fundamental ICT Institute in recent years has started to pay more attention to the generation and support of spin-off companies. The institute set up an incubator in 2000. And the institute recently decided to restructure its research activities into societally relevant themes in order to show that its research has direct societal relevance.

In sum, we observe that from the year 1996 onwards the large majority of research organisations in the Netherlands started to introduce support structures for spin-off companies. The overwhelming majority of research organisations started offering various types of support (legal, financial, know-how, infrastructure) to researchers who wished to interact with industry or start their own company (van Tilburg and Kreijen 2003). The fact that the creation of support structures does not directly affect research and teaching activities of the PROs diminishes the risk of internal conflicts and tensions, thereby making it less complicated for PROs to introduce these support structures. The support structures are thus a clear example of PROs creating formal structures to show their environment that they are acting in good faith and adhere to norms in the environment. At the same time, they are able not to antagonise internal stakeholders mainly occupied with research and teaching activities.

The reasons for the PROs to engage in the support of spin-off companies differ across our cases. The Technical University who expected to benefit from its support of spin-off activities is the case with the highest amount of spin-off companies reported, and is a front runner in the creation of support activities, preceding national policy initiatives. In the case of the Technical University, it is also evident that the university was expected by its sponsors to engage in collaboration with industry from its onset. The Applied ICT Institute with its applied focus reacted to environmental demands to create more spin-off companies. The Fundamental ICT Institute and the Comprehensive Research University have a focus on basic research, and appear to have adapted to institutional processes in the Dutch research system that request PROs to show that they are engaging in knowledge transfer. While some PROs have been front runners, because creating spin-off companies is a part of their mission, others followed mostly because of concrete demands from constituents in their environment or adhered to collective norms. Thus, the engagement of PROs in the creation of spin-off companies can in some cases be best described by interests in resources and coping with visible pressures and interdependencies, while in other cases institutional logic is more dominant. In the cases of the Applied ICT Institute and the Technical University, key stakeholders in the environment of the institutes demand engagement in knowledge

transfer. In the case of the Technical University, acquisition of additional resources is another motivation to support the creation of spin-off companies. For the Fundamental ICT Institute, both resource dependence and new institutional perspectives are useful to explain the behaviour of the PRO. The support of RBSO creation by Pharmlab and Medlab is better explained by institutional pressures and less by a direct interest in resource diversification. The Pharmlab and Medlab cases are actually examples of institutes which did not simply adapt to institutional pressures but have attempted to counter these influences.

5 How PROs Utilise the Presence of Spin-Off Companies

In this section we show how researchers and PROs utilise the presence of RBSOs. We use the evidence presented to discuss our expectation that when policymakers reward commercialisation and knowledge transfer activities, PROs will strategically present their spin-off companies to benefit from opportunities in their environment.

5.1 Reputational Effects of Spin-Off Companies

The last section showed that almost all universities and other non-university PROs have engaged in the support of RBSOs, and that all but one of the research universities stated that the stimulation of RBSOs was an important part of their activities. Eleven out of thirteen research universities in the Netherlands reported that enhancing the image of the university was a motive to stimulate the creation of spin-off companies (van Tilburg and Kreijen 2003). Enhancing relations with industry or inspiration for research were mentioned less frequently. Respectively, 64 and 50% of the universities reported this as motivations. We think these figures might be indicative for the difference in importance that PROs and the national government attach to engagement in the creation of RBSOs.

From the analysis of our six cases the following picture emerges. Researchers from PharmLab & MedLab did not report that spin-off companies contributed to the image of their institute, possibly because they feel they are working in a traditional research university where commercialisation activities do not add to the stature of individual researchers as well as the institute as a whole.

On the contrary, respondents from the MicroLab institute, part of the Technical University, stated that the spin-off companies did contribute positively to the reputation of the institute. The support of the creation of over thirty spin-off companies in the past twenty years is an accomplishment used by MicroLab in its communications to the outside world. Respondents within the institute consider its spin-off record to illustrate that the institute carries out interesting scientific research that is economically relevant as well.

Researchers in the IctLab institute also mention that their spin-off companies are not only helpful in the acquisition of research projects but are also beneficial for the image of the institute and the university in general. The university and the IctLab mention publicly that they have supported and created spin-off companies. Success stories of spin-off companies are published in the media.

The Fundamental ICT Institute utilises its spin-off companies as a reputational asset to legitimise its existence as well. The institute mentions its spin-off companies on its website and perceives the presence of its spin-off companies as manifestations of the relevance of its research activities. *“It is a good thing that we are able to say, well look here, our ideas can prove themselves in the market and there are executives that are willing to pay for it”*.

For the Applied ICT Institute, spin-off companies are useful as well to illustrate to its stakeholders that the institute is able to contribute to the economy. Contributing to the economy is an explicit goal of the Applied Research Organisation the Applied ICT Institute is part of. *“Especially for the outside world it’s a nice story. It is a story that appeals to people. It helps to position us. People look differently at [the Applied Research Organisation] if you say; we have got companies too”*. The spin-off companies therefore help legitimise the existence of the institute. This is particularly important given the criticisms that were expressed towards the institute in a recent evaluation which called for more spin-off companies, collaboration with small and medium size enterprises, and patenting.

5.2 Legitimising Public Support

We showed in Sect. 4 that competitive research funding in the life sciences, micro- and nano sciences, and information and computer sciences is increasingly tied to collaboration with industry. We found in our cases that research institutes and spin-off companies often collaborate in such consortia, and engage in this type of collaboration more than contract research since most spin-off companies do not have the resources to invest in long term research. Spin-off companies thus legitimise public support for research activities and enhance the research capacity of research institutes. Exemplary for this is the following statement from one of the respondents: *“I think spin-offs are essential for the institute. It is an additional right to exist. ... I think it would have been much harder to convince the ministry of Economic Affairs to grant certain programmes”*. Another respondent stated: *“For these kinds of projects you need industry support, otherwise you will not get the money. STW grants have certain rules; at least 30% needs to be paid by the company”*. Thus, the presence of spin-off companies legitimises the support received from the national government. Actually, spin-off companies are aware of this. One of the spin-off company interviewees stated: *“They needed to have SMEs in the consortium to have a chance. We knew that and we profited from that”*. Additionally, spin-off companies are mentioned by researchers in their grant applications. A respondent stated: *“We report it in project proposals. I have been working on an FP7 proposal and we mentioned explicitly that we have a spin-off”*. Another respondent: *“Funding sources from the EU want us to have these companies as partners, such as small companies and start-ups. These are attractive partners”*. Researchers actively solicit spin-off companies to participate in their project proposals and mention spin-off companies in them to increase the chances of getting their proposal funded.

Although RBSOs interacted substantially in third party funded research projects, the question remains to what extent they enabled the obtainment of the research funds

for the PRO or whether the PRO would have acquired these research projects nevertheless. Respondents from the PROs indicated that only on a few occasions the RBSOs actually filled a gap which could not be filled by existing industry. Mostly the RBSOs were a welcome partner but other potential industrial partners would have been found to collaborate with in research projects that require industry participation. However, RBSOs are often a preferable partner for PROs since they are geographically as well as cognitively close to the research departments they originate from. Furthermore, employees of the RBSOs and researchers are acquainted with each other, often having worked together in the same research department.

Overall, RBSOs are used strategically by research institutes to gain legitimacy and thereby to secure resources from their environment. By highlighting their spin-off record and by using spin-off companies as partners in research projects, research institutes can reduce uncertainty in their funding environment. Most research funding schemes ask explicitly for the involvement of industry or even more specifically for the involvement of SMEs. While research funding schemes usually do not prioritise collaboration with spin-off companies, RBSOs are a preferable research partner for scientific researchers. The geographical, social and cognitive proximity of the RBSO to its former research department is on average higher than other SMEs or larger industrial actors. Results, however, were not uniform across the investigated cases. Spin-off companies are used to show the relevance of the knowledge production researchers engage in. This does not necessarily mean that PROs engage more in knowledge transfer or gear their research towards commercialisation activities.

6 Exchange Relationships and the Impact on PROs

In this section we explore whether the presence of RBSOs and the exchange relationships between PROs and RBSOs affect the resource base and the research activities of the PROs. We first give a description and impression of the relationships between RBSOs and PROs. Subsequently, we describe how the relationships have contributed, directly and indirectly, to the research capacity of the PROs. Thirdly, the impacts of the relationships are presented and discussed.

6.1 Exchange Relationships

RBSOs, like other profit and non-profit organisations, can engage in exchange relationships with PROs in order to acquire knowledge from the PRO. Hagedoorn et al. (2000) show that firms in general participate in research partnerships among other things to decrease transaction costs, enhance competences, enhance the appropriability of research results and lower R&D costs. Although no research has been conducted on the specific motivations of RBSOs to engage in exchange relationships with its parent research organisation, we assume that RBSOs on average interact on a comparable level, and probably on a higher level given their geographical, cognitive and social proximity.

Annex 3 provides an overview of the exchange relationships between the RBSOs and the six PROs. We asked respondents, from both spin-off companies and research institutes, to what extent they had engaged in co-publications, co-patenting, contract research, acquisition of third party funded research projects, whether IPR was sold to the spin-off companies, and to what extent information and physical resources were exchanged. Exchange relationships differed significantly across the cases. However, in most cases co-publications did not occur frequently, neither did co-patenting and contract research. On the other hand, the acquisition of third party funded research projects and informal exchange of information and physical resources occurred more frequently. We bring to light the relationships of two spin-off companies and their parent research department in order to show what these relationships look like. One of the spin-off companies of the MedLab institute was co-initiated by one of the professors of a department within the MedLab institute. Researchers in the department performed contract research for the company worth several million Euros annually. Additionally, the spin-off company and the department acquired third party funded projects in which the department performed research for the spin-off company. The company and the research department did not engage in the joint publication of journal articles. There were no double appointments other than that the professor of the department was a member of the board of the spin-off company. Another spin-off company, originating from the IctLab, was founded by four graduate students from the research institute. The research department, from which the spin-off company originated, collaborated mainly through student internships since the company did not possess the funds to commission contract research. Additionally, the department and the spin-off company engaged in two-third party funded projects. No co-publications occurred, nor were there double staff appointments.

6.2 Direct Contributions to Research Capacity

According to resource dependence theory, organisations need to take into account the demands from organisations they obtain resources from. Therefore, we could expect that additional funds directly deriving from spin-off companies might influence research activities. We first investigate the significance of RBSOs regarding the access they may provide to additional funds for the parent research institutes. In the case of the PharmLab & MedLab institutes, three out of the five spin-off companies contributed directly to research activities in the institute. These contributions ranged from none at all to the funding of ten PhD projects and to the direct investment of several million Euros in the institute for contract research. One of the professors stated: “*We benefited from the fact that we had those connections. It got us funds, and you could do whatever you want, buy equipment, or just appoint someone. It was easy money*”. In the MicroLab case, we observed direct financial contributions from spin-off companies for commissioned research activities, but in most cases the resources were not sufficient to fund PhD or postdoc positions. The director of MicroLab stated: “*There are not many spin-offs that start a research project at the university. But there are of course exceptions*”. In IctLab, we found

that direct support of research by spin-off companies has been modest; one spin-off company financed a PhD project and small contract research projects were conducted. One of the department leaders of IctLab stated: “*Spin-offs are not such important partners money wise. These are small companies in the vicinity and that is very good and there is a lot of positive things you can say about it, but they don't have a lot of money*”. Both the Fundamental ICT Institute and Applied ICT Institute did not receive significant amounts of direct funding from their spin-off companies either. Most spin-off companies felt that a research contract with the institute would be too expensive and the research outcomes would take too long to be delivered. The spin-off companies that supply funding for PhD projects in the institutes are mostly life science companies who have a long term research focus.

In addition to financial resources, spin-off companies may provide information to researchers about real-life issues that relate to basic scientific research questions. Thereby the collaborations with spin-off companies serve as a reality check and inform researchers about the relevance of their research questions and the feasibility of potential solutions. “*We know what the developments are in the sector. The research institutes sometimes don't look at that at all*”.

6.3 Indirect Contributions to the Research Capacity

All selected PROs participated with their spin-off companies in research projects funded by the national Dutch government or the EU. This type of interaction was particularly relevant in the MicroLab, ICTLab (cf. Annex 3). In the Netherlands, competitive funding within the life sciences, micro- and nano sciences, and information and computer sciences is predominantly accessible from the STW research council, the SenterNovem agency and the BSIK programme (see Annex 1). These funding organisations and funding schemes demand researchers to show societal relevance by collaborating with an industry partner. Respondents from all cases noted that the presence of spin-off companies is very convenient when research grants require the involvement of an industry partner from outside the university. “*It would have been a lot more difficult to persuade the Ministry of Economic Affairs that they should fund this programme. The fact that we have those spin-off companies tipped the balance because it convinced them it is also useful for the economy. Spin-offs are very tangible*”.

In the remainder of this section we will explore the impact of RBSOs on the output, the scientific reputation and the research agendas of researchers within the parent research institutes.

6.4 Scientific Output

In the six cases we studied, the quality and volume of the scientific output appears not to be affected by the exchange relationships with spin-off companies. Only in the cases where spin-off companies contributed a large amount of funds directly, changes were observed. In the case of the PharmLab & MedLab, two spin-off companies contributed greatly to the institute's research activities by commissioning

research worth several million Euros. This resulted in a number of high quality publications. One of the department leaders stated: “*The research came in such high journals, we published in Nature. So it has induced an acceleration which brought the research on such a level that we still benefit from it*”. At the IctLab, we found that two spin-off companies were interested in publishing articles with researchers in the institute. This was because the spin-off companies were led by researchers from the institute and still have scientific ambitions. Apart from these cases, we observed no other significant impacts on research output.

6.5 Non-scientific Output

None of the respondents reported that patenting of research findings had increased due to interactions with spin-off companies. In one case, a research group from the PharmLab institute exchanged patents with a spin-off company several times in exchange for the commissioning of research projects. In the MicroLab, IctLab, PharmLab, and MedLab cases researchers feel that spin-off companies are channels for the dissemination of research findings. However, in the cases of Applied ICT Institute and the Fundamental ICT Institute, where exchange relationships with the spin-off companies generally were of a lower frequency and intensity, respondents did not mention this explicitly.

6.6 Scientific Reputation

Respondents in all six research institutes state that the creation of spin-off activities does not benefit their scientific reputation. Scientific reputation is acquired through publishing peer reviewed journal and conference papers, not through the creation of spin-off companies. In the national (i.e. QANU) research evaluations, two research departments, one from IctLab and another from MicroLab which both have produced a significant amount of spin-off companies, received positive reviews for the creation of respectively two and three spin-off companies. This judgement, however, should not be regarded as an appreciation of the departments’ scientific achievements. Rather, it shows that criteria such as societal relevance and commercialisation have found their way into research assessments.

6.7 Research Agenda

Interview data showed that engaging in the creation of spin-off activities and collaboration with RBSOs was not detrimental to the academic freedom of researchers. According to our respondents, scientific research agendas were not negatively influenced by RBSOs. In most cases the spin-off companies simply do not possess the resources to exert a considerable influence on the research topics pursued by the institute’s researchers. Even a research department within the MedLab, which was heavily funded by two of its spin-off companies, did not perceive this support as forcing its researchers to change their research course. The support simply gave more prominence to certain research lines in the department.

Researchers did not experience that they were forced to engage in research which was not interesting for them. A professor from the Fundamental ICT Institute stated: *“It’s much more important for our research what The Hague and Brussels spend their money on. I tend to think that people with bags of money have much more influence, and spin-offs do not have that”*. Although most spin-off companies do not appear to visibly affect research agendas, they do exert some ‘soft’ force through their involvement in government funded projects. In addition, the participation of spin-off companies makes researchers aware of practical problems that are in line with their research agenda. This awareness may indirectly have an impact on the choice of research topics. Since researchers have to take into account the demands of key stakeholders in their environment who stress science-industry collaboration, researchers will also need to take into account the wishes of RBSOs in the long term when they want to collaborate with them and receive third party funded research projects..

We expected that the increased involvement of universities and non-university PROs in the creation of spin-off companies does not lead to significant changes in the core activities of research organisations. We can conclude from the evidence found in our case studies that changes in the research activities of the research organisations depend on the amount of extra resources and legitimacy these spin-off companies will yield. We encountered various types of exchange relationships with spin-off companies, some occurring frequently, others less often. Government funded projects in which spin-off companies and researchers collaborate are dominant types of interactions. However, we encountered little or no impacts on research agenda and research outputs. Respondents attribute this to the fact that the spin-off companies hardly bring any financial resources into the projects, which makes it hard to exert influence on research outputs. Furthermore, when spin-off companies make up only a small part of the larger institutional environment of research departments, and at the same time do not possess significant resources to spend on commissioned research, then core characteristics, (i.e., output, reputation and research agenda) of research departments are unlikely to be affected. The actual change in the core of the behaviour of the research organisations depends on the amount of extra resources and legitimacy these changes will yield. And since research organisations and especially researchers are path-dependent actors and loosely coupled to their environment, it is not likely they will change their core activities promptly. However, in the long term, researchers need to take the needs and wishes of companies into account. Not doing so will result in an absence of industrial partners willing to participate in research proposals that require industry participation. Therefore, scientific researchers, conducting research within scientific disciplines that have funding structures that prescribe science-industry interaction, will inevitably be induced to take demands from their industrial partners into account.

7 Conclusions

In this paper we set out to investigate the phenomenon of research based spin-off companies (RSBOs) with a special focus on the public research organisations

(PROs) they originate from. We investigated the case of the Netherlands, first, to enhance our understanding how PROs overall respond to increasing expectations for more societal relevance in research. Second, we showed how research departments within PROs utilise and benefit from the creation and presence of RBSOs, and, third, we discussed what impacts RBSOs might have on the research activities of their parent organisation. We based our study on two theoretical perspectives—resource dependence theory and new institutional theory.

We found that the engagement in entrepreneurial activities occurs differently across organisational levels. At the central level of the PROs, support structures for the creation of spin-off companies and commercialisation of knowledge have emerged almost uniformly in the Netherlands. Interestingly, such support structures have mainly been initiated before financial public incentives for such activities were put in place. Many organisations responded to changing expectations in ways that new institutional theory would expect, i.e., by creating formal structures that do not interfere directly with research and teaching while showing stakeholders in their environment that they act in good faith. Motivation and timing differed among PROs however. First movers were PROs who could integrate such support structures for research commercialisation into their mission hoping for related financial benefits. Pro-active anticipation and management of resource dependencies have played a role in these cases. PROs with a basic research orientation responded later to institutional pressures to adhere to changing behavioural expectation, some of them also trying to counter such demands.

As regards the research departments within the PROs, we showed that they have distinct motivations to support the creation of spin-off companies. In terms of resources, RBSOs contribute, mostly in a modest way, to research activities by providing information, equipment and monetary resources. More importantly, RBSOs are helpful for researchers competing for research grants that demand participation of industry. RBSOs enhance the prestige of their parent organisations and create legitimacy for public funds invested in PROs. While such funding schemes usually do not prioritise collaboration with spin-off companies, RBSOs can be a preferable research partner for scientific researchers given their geographical, social and cognitive proximity. External organisations and their changing behavioural expectations influence the behaviour of the research organisations while the research departments are to some extent able to pro-actively select the organisations chosen for resource mobilisation.

At the same time, most RBSOs do not have a significant impact on the direction of the research conducted at the PROs. While there is a large variety in type and intensity of exchange relationships between spin-off companies and their parent research institutes, little evidence of a change in research output or research agendas was found. RBSOs form only a small part of the larger institutional environment of researchers and any influence coming from RBSOs is expected to be relatively small. Although scientists collaborate with companies, our findings indicate that the core activities of researchers are not affected. Researchers utilise the presence of spin-off companies to demonstrate to the outside world that relevant and applicable knowledge is being produced. They strategically present their spin-off companies to

legitimise the acquisition of funds, stressing public–private interaction while they de-couple their core activities.

Overlooking the results from our empirical analyses we conclude that the parent institutes of spin-off companies certainly remain close to their offspring and maintain contacts in various ways. Parent institutes will call upon their offspring when needs and/or opportunities (mostly of a financial nature) arise. The spin-off companies themselves often have too few resources and too short time horizons to significantly affect the core activities of their parents. In sum, spin-off companies from public research organisations are not very likely to make the academics' heads spin.

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Annex 1 Key policy instruments and programmes that promote commercialisation and science–industry collaboration in the Netherlands, 1980–2008

Instrument	Description	Budget	Year of operation
Innovation-Oriented Research Programme (IOP)	Competitive grants for innovative research projects in public–private cooperation	66 million 2006–2009	1980–present
Open Technology Programme (OTP)]	Competitive grants to stimulate projects in universities with a potential for application and commercialisation	Average of 43 million Euros annually (2000–2008)	1981–present
Economic Reinforcement Fund (ICES/KIS 1)	Subsidies for cooperative research alliances involving public research institutions and private companies	113 million Euros	1994–1998
Economic Reinforcement Fund (ICES/KIS 2) (precursor to Bsik)	Subsidies for cooperative research alliances involving public research institutions and private companies	211 million Euros	1998–2002
ICES/KIS 3–Bsik (Knowledge and Research Capacity)	Subsidies to set up public–private research consortia	802 million Euros	2003–2009
Smartmix	Subsidies for cooperative research alliances concentrated on creating innovations and developing focus and mass in excellent scientific research.	100 million Euros annually	2007–present
Innovation vouchers	Subsidies for SMEs to allow them to purchase knowledge from universities and other public research institutions.	25 million annually	2004–present

Annex 1 continued

Instrument	Description	Budget	Year of operation
Technopartner	Subsidies and venture capital for private start-ups	Total of 21.2 million Euros 2006–2009	2004–present
Biopartner	Subsidies, seed funding and venture capital for start-up companies in the life sciences	See above	2000–2004
Valorisation Grant–SBIR	Subsidies for feasibility studies and seed funding	Approximately 1.5 million Euros annually	2004–present
Casimir	Incidental grants to foster staff mobility between universities and private companies	2,8 million Euros in 2007	2005–2007

Annex 2 Characteristics of the spin-off companies

Spin off	Founded in:	Size (in FTE)	Technology area	Staff owns shares	PRO owns shares	Product available
MedLab 1	2000	140	Development of vaccines based on antibodies	Yes	No	Yes
MedLab 2	2000	20	Development anti inflammatory drugs	No	Yes	No
PharmLab 1	2004	5	Drug development against inflammatory disorders	Yes	Yes	No
PharmLab 2	1995	5	Development of antibody-based therapeutics	Yes	No	No
PharmLab 3	1995	150	Development of methods for drug delivery	No	No	Yes
Fundamental ICT 1	1998	12	Authoring and player systems for web based multimedia	Yes	Yes	No
Fundamental ICT 3	1994	6	Foundation supporting open source software development	No	No	Yes
Fundamental ICT 2	2000	20	Assessment and improvement of legacy software	Yes	Yes	Yes
ICTLab 3	1996	10	Speech analysis	No	No	Yes
ICTLab 4	1999	8	Development of middleware for visualisations in simulators	No	No	Yes
ICTLab 1	2004	15	Wireless sensory networks	No	Yes	Yes
ICTLab 2	2005	12	Chip-technology; energy efficient digital signal processing	No	Yes	Yes
ICTLab 5	2002	3	Speech technology for health- and home-care applications	No	No	Yes
MicroLab 1	1995	25	Development and production of mems and integrated optics	No	No	Yes
MicroLab 2	1998	10	Development and production of micro-machined particle velocity sensors	No	No	Yes

Annex 2 continued

Spin off	Founded in:	Size (in FTE)	Technology area	Staff owns shares	PRO owns shares	Product available
MicroLab 3	1992	4	Microfiltration membranes, microsieve membranes	No	No	Yes
MicroLab 4	2004	3	Advanced scanning probes	Unknown	Yes	No
MicroLab 5	1999	25	Microfluidic lab-on-a-chip technology	Unknown	Yes	Yes
MicroLab 6	2001	19	Integrated optical microsystems	Yes	Yes	Yes
MicroLab 7	2006	3	Diagnostic medical systems	Unknown	Yes	No
Applied ICT 1	2005	10	Multimedia video applications for 3G mobile phones	No	No	Yes
Applied ICT 2	2001	30	Image interpretation applications	No	Yes	Yes
Applied ICT 3	2002	20	Developing and marketing of telecom software	No	No	Yes
Applied ICT 4	2006	4	Development of equipment for internet and phone-based telecom	No	Yes	Yes

Annex 3 Type and intensity of the relationship between the research organisations and RBSOs*

Spin-off	Co-publications	Co-patenting	Contract research	Acquisition of third party funds	Income derived from IPR sales	Exchange of information & physical resources
MedLab 1	+++	0	+++	++	+++	+++
MedLab 2	0	0	+++	+++	+++	+
PharmLab 1	0	0	0	+	+	+
PharmLab 2	0	0	0	0	0	0
PharmLab 3	++	++	++	+++	++	++
Fundamental ICT 1	+	0	0	+	0	+
Fundamental ICT 3	0	0	+	0	0	+
Fundamental ICT 2	++	0	0	+	+	++
ICTLab 3	0	0	0	+	0	+
ICTLab 4	0	0	+	+	0	+
ICTLab 1	++	0	0	++	+	+++
ICTLab 2	++	0	0	+	+	++
ICTLab 5	0	0	0	+	0	+
MicroLab 1	0	0	+	++	0	+
MicroLab 2	+	+	0	++	0	++
MicroLab 3	++	0	<missing>	++	0	+
MicroLab 4	0	0	0	+	0	+
MicroLab 5	+	0	+	++	+	++
MicroLab 6	+	0	+	++	+	++

Annex 3 continued

Spin-off	Co-publications	Co-patenting	Contract research	Acquisition of third party funds	Income derived from IPR sales	Exchange of information & physical resources
MicroLab 7	0	+	0	0	0	+
Applied ICT 1	0	0	+	0	++	+
Applied ICT 2	0	0	0	0	+	0
Applied ICT 3	0	0	0	+	0	++
Applied ICT 4	0	0	0	0	0	0

*0 = no relationship; + = minor relationship; ++ = significant relationship; +++ = major relationship

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