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The Coupling of Spin-Offs and Research Institutions in the Triangle of Policy, Science and Industry

– An International Comparison –

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Abstract

Academic spin-offs have received increasing attention in discussions about science and innovation policy and in research. Most of the attention has been focused on determining the conditions for fostering spin-offs, but this paper shifts the focus back to the potential repercussions for academic institutions. These may result from the involvement of researchers in spin-off processes and from incentives aimed at supporting spin-off activities. In a first step, the paper develops a conceptual framework with which to analyse repercussions that result from the interaction between policy measures for supporting spin-offs and structural features of national science systems. Policy measures and structural aspects of the science systems influence the ways spin-offs and their parent institutions interact. As patterns of linkages differ, so too may their impacts on academic institutions. Secondly, based on secondary analysis of comparative studies, we develop a number of hypotheses as to which repercussions on academic institutions may be expected in a number of European countries. The paper concludes by proposing implications for policy as well as for further research.

Zusammenfassung

Akademische Ausgründungen (Spin-offs) haben in den letzten Jahren zunehmende Aufmerksamkeit in der Forschungs- und Innovationspolitik, in den wissenschaftlichen Institutionen wie Universitäten und Forschungsinstituten und in der Forschung selbst gewonnen. Dabei werden überwiegend die geeigneten Förderbedingungen für Ausgründungen diskutiert. In diesem Papier wenden wir hingegen den Blick zurück auf die wissenschaftlichen Institutionen und fragen, welche Rückwirkungen Ausgründungsprozesse sowie die Maßnahmen zur Förderung von Ausgründungsprozessen auf die wissenschaftlichen Institutionen und die wissenschaftliche Arbeit haben können. Das Papier gliedert sich in zwei Teile. Erstens präsentieren wir einen konzeptionellen Rahmen, der Rückwirkungen auf die wissenschaftlichen Institutionen in Abhängigkeit von den spezifischen Fördermaßnahmen wie von den spezifischen Strukturen des Wissenschaftssystems innerhalb eines Landes beschreibt. Ferner nehmen wir an, dass Fördermaßnahmen und die Struktur des Wissenschaftssystems auch die Beziehungen und Interaktionen zwischen Ausgründung und Mutterinstitution beeinflussen können. Die je unterschiedlichen Beziehungen können wiederum zu unterschiedlichen Effekten für die wissenschaftlichen Institutionen führen. Zweitens entwickeln wir, basierend auf einer Sekundäranalyse von vergleichenden Studien, Hypothesen dazu, welche Rückwirkungen in mehreren europäischen Ländern in Anbetracht der jeweiligen Bedingungen zu erwarten sind. Das Papier schließt mit einem Ausblick auf Implikationen für Politik und weitere Forschung.

Content

1 Introduction

Established demarcations between the public science system and the political and economic system have become increasingly questioned in the past few years. More and more, the usefulness of scientific practice has to be demonstrated in order to legitimise public funds flowing into universities and public research institutes. Research and innovation policies in different countries aim at supporting industry-science-relations with the further aim to enhance the contribution of science to innovation, and ultimately economic welfare. At the same time, a number of scholars in science and innovation studies maintain that knowledge production and innovation increasingly take place in hybrid arrangements, where the industrial and academic as well as governmental spheres overlap (Etzkowitz & Leydesdorff 2000; Nowotny et al. 2001).

One element of industry-science-relations which has received substantial attention lately is academic spin-offs, that is, firms founded by staff or graduates from universities or research institutes, which commercialize research results. Accordingly, a large number of national policies and support programmes for spin-off formation have been launched, in Europe and elsewhere. There are several comparative studies which describe, analyse, and partly benchmark different national policies and their interaction with the national innovation systems (Larédo & Mustar 2001; Polt et al. 2001; EU-Commission 2002; Koschatzky 2002; OECD 2002). A central interest of these studies is to assess the performance of these policies with regard to technology and knowledge transfer from science to industry.

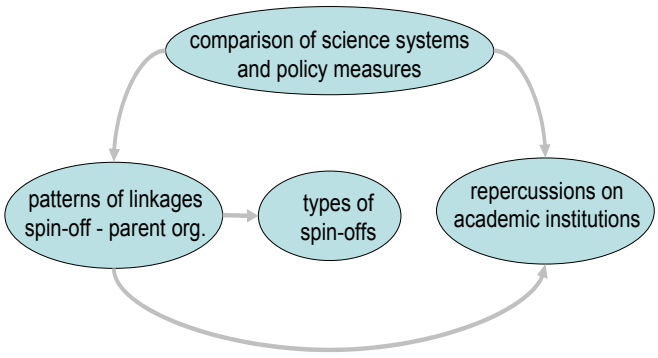
In the present study, we analyse these phenomena from a different perspective. We assume that the creation and operation of spin-offs as well as the supporting policies may retroact – positively or negatively - on the core of the science system. So, these seemingly “marginal” activities would not only transform or perhaps shift the boundary zone between science and industry. In the long run, it may also transform the research activity within academic institutes. More precisely, we will develop a number of hypotheses as to which repercussions on the science system related to spin-off supporting measures may be expected in a number of European countries. By science system, we refer to research institutions, i.e. universities and public research institutes, their specific organisation and institutional frameworks, as well as the typical practices and processes within these research institutions. Policy measures targeted at supporting spin-off creation may impact the science systems in different ways. Firstly, they may impact the science systems by modifying institutional structures and framework conditions (‘top-down repercussions’). This may affect research priorities and practices in the respective research institutions. Secondly, these policy measures may also encourage more or less intense linkages between spin-offs and research institutions. By linkages, we refer to various formal and informal relationships and interactions between spin-offs and parent institution, e.g. research co-operations, shared staff, regular

exchanges, contract research, etc. (see also 2.2). The structure of linkages may then affect the repercussions, which can be expected to result from the involvement of academic staff in the creation and operation of spin-offs ('bottom-up repercussions').

Which effects are to be expected depends on the specific supporting measures chosen in each country and on the specific structures of the national science systems, as well as the interaction between both. Accordingly, we will estimate how repercussions may vary depending on differences between national styles of spin-off promotion and the specific characteristics of the national science systems. We analyse, in how far these measures are likely to impact the science system, either by modifying institutional structures and framework conditions or by encouraging specific types of linkages between spin-offs and research institutions. As we will not be able to collect original empirical evidence, our primary aim is to elaborate and specify hypotheses based on secondary analysis. As a background we draw on a study of (Goldfarb & Henrekson 2003), who present the American and the Swedish science system and policy styles as two opposed quasi ideal types. The American model is presented as an example where policy and science system interact in a way that is highly conducive to spin-off creation. The Swedish model rather disencourages such activities. Against this background, we compare policies and science systems of other selected European countries (UK, France, Germany and Finland) and ask which repercussions on the science system we may expect in each country, and whether we may identify a homogeneous European model of spin-off creation, or in what respect we have to distinguish different sub-models and national styles.

It has been shown that a wide variety of spin-off types exist. Spin-offs vary considerably with regard to their growth patterns as well as the relationships to their parent institution (Stankiewicz 1994; Rappert & Webster 1998; Mustar 2003; Knie et al. 2003; Potthast & Lengwiler 2005). This prompts the question, whether in different countries the specific conditions favour certain types of spin-offs over others. Therefore, we will try to estimate the diversity of the structural forms of spin-offs in Europe as a result of this interaction. As a conclusion, we may then ask about the implications for policy to deal with the complexity of the spin-off phenomenon at the interface between science, policy and industry. With regard to the "Crossover"-project this study is a part of, the analysis will help to position the specific situation of German spin-offs in the context of other European countries and thus contribute to the contextualisation and generalisation of the projects' core results.

Figure 1: *Structure of argument*



The report is structured as follows: Section 2 sets out the conceptual framework for the comparative study. It starts with a presentation of the ideal type distinction of spin-off promotion proposed by Goldfarb and Henrekson. This is followed by a presentation of recent findings on the scope of variation among spin-offs and the linkages between spin-offs and research institutions. We then describe major supporting measures and assess their likely repercussions on the national science systems. Section 3 sketches a number of key characteristics of the science system and spin-off promotion policy for the UK, Germany, France and Finland. In section 4, a comparison of these profiles leads us to propose a number of guiding hypotheses for the specific repercussions on science systems and diverging patterns of spin-offs in these countries. We conclude by proposing implications from a policy-oriented research perspective as well as for further research.

2 The interplay between science policy, parent institutions and spin-offs

2.1 Spin-off policies and the structure of the national science systems

There exists a long tradition of research comparing different national systems of innovation aiming at the identification of strengths and weaknesses of different approaches. Focussing on the subsets of the US and Swedish innovation systems that affect the commercialisation of university technology and particularly commercialisation through academic spin-offs, Goldfarb and Henrekson (2003) maintain that the (continental) European science systems may be considered as a homogenously structured cluster that differs more or less clearly from the US-American system.

In a comparative analysis of the Swedish and the American system, they put forward the hypothesis that the American university system and the measures chosen for promoting commercialisation of academic research are more efficient than the Swedish model and, as an implication, continental European models more generally. This is put down to the differences in the university systems and the national policies. They argue that the American university system provides a different incentive structure to researchers to engage in commercialisation activities. Drawing on findings from Jensen and Thursby (2001), this is considered as highly important, since commercialisation of research often requires researchers to remain involved in the process, largely because of the tacit nature of the knowledge required for successful commercialisation.[1] Differences in the incentive structure for researchers result from the interplay between policy type and incentives given to universities and their organisational structure.

The American policy type is presented as a bottom-up approach. By conceding universities property rights to inventions resulting from university research financed by federal grants, American policy, more precisely the Baye-Dole Act, created an incentive for universities to facilitate the commercialisation of academic R&D without, however, prescribing by which specific measures this should be realised. Largely, this is done by technology licensing offices run by universities. The organisational structure of universities being rather decentralised with a strong competition for research personnel and research funds, universities tend to give academic staff a stronger incentive for commercialisation to keep or attract research personnel. Research personnel is granted more freedom to engage in commercialisation activities while at the same time keeping

[1] Similar findings are reported by Webster and Packer (1997) with respect to the efforts needed to assist young firms in taking up the patents of researchers.

the position as a faculty member than in the Swedish system. Furthermore, in case of successful commercialisation, not only the inventor, but also the school or faculty is rewarded, thereby giving an incentive for the larger environment of an inventor to support commercialisation activities.

In contrast to this, the Swedish system is characterised as centralised and rather bureaucratic. There is only little competition for academic personnel. Evaluation criteria give researchers no incentive to dedicate time and efforts to commercialisation, since this would distract them from pursuing their academic work. Property rights remain with the inventor, which, at first glance, has the paradoxical effect that he or she in general has only moderate interest in taking the risk of commercialisation in comparison to a large institution such as a university.[2] Accordingly, universities have no direct incentive to foster commercialisation activities of research personnel. Swedish policy has put considerable effort into supporting the commercialisation of research and, more particularly, in fostering spin-offs. However, it follows a top-down model prescribing the specific form, e.g. regional technology transfer institutions, but hasn't changed the incentive structure for universities, faculties and academics.

Taking the analysis of Goldfarb and Henrekson one step further, we may hypothesise that the impact of commercialisation strategies on the science system is likely to be more profound in the American than in the Swedish system. While in the Swedish system, activities related to commercialisation are treated as marginal activities, in the American system, the boundary between academic work and commercialisation seems to be less clearly defined. Hence, research practices and priorities at the level of the individual researcher as well as at the level of the faculty may be more easily affected than in the Swedish case. This is touched upon by the authors when pointing to the possible compromise of academic norms, which is implied by the American model. Furthermore, the analysis illustrates that the effects of commercialisation strategies on the science system result from the interplay of both, the structure of the science system and the specific policy approach. Accordingly, the authors conclude that a straightforward imitation of American policy, e.g. granting intellectual property rights to universities, may not yield the same results in the Swedish context.

For the following, it is important to note that Goldfarb and Henrekson's analysis seems to be implicitly based on a specific model of the interaction between spin-offs and their parent institution. By highlighting the importance of researchers remaining continuously involved in the commercialisation process, and, at the same time, the importance of the transfer of tacit knowledge, they refer to a model that is based on rather strong linkages between parent institution and spin-off. Moreover, their analysis suggests that the US

[2] For a similar argumentation see OECD (2002: 52).

policy and science model is not only more conducive to spin-off creation in general than the Swedish model, but, more specifically, it seems to be more conducive to spin-offs based on strong linkages. In the next section, we will take a closer look at different models and empirical findings on how spin-off and parent institution interrelate.

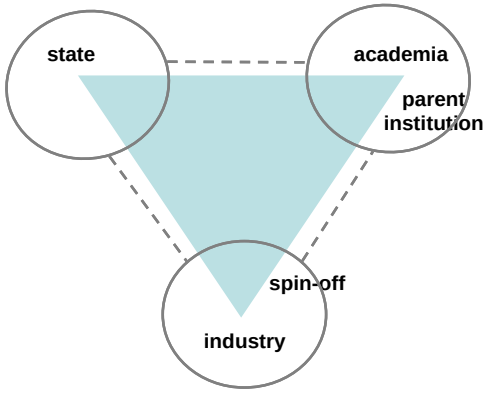
The authors' hypothesis that the Swedish model is likely to be representative for a larger cluster of similarly structured science systems in continental Europe, and that therefore their findings should be transferable, is not too convincing. Comparative studies focussing on Europe illustrate the important heterogeneity of science systems in Europe and the relative importance of spin-offs. Thus, we use their findings as a background and a starting point for comparing national structures of science systems and policy approaches. This analysis will not only allow us to test the hypothesis of convergent European science systems and policy approaches, but it will serve as a basis to appraise repercussions of policies and support measures on the science systems in the different countries.

2.2 The interaction between research institutions and spin-offs

As stated above, we expect that policy measures for promoting spin-offs may also impact the science systems indirectly by encouraging or discouraging specific types of linkages between spin-offs and research institutions which may, as such, affect research institutions. Therefore, we will now take a more systematic look at different models of how research institutions and spin-offs interact. Basically, this interaction will be more or less intense and formalised. At the one end of intensity we locate spin-offs which, at least after the creation phase, do not engage in any formal or informal relations with their parent institution. At the other end, we find spin-offs and parent institutions which interact intensely and continuously, either on a formal or informal basis. An intermediary form would be relations which are concentrated at a certain point in time, e.g. transfer of intellectual property rights or short-term contract research. Formal relations are those which are underpinned by a contract or the licensing of property rights. A formal linkage between spin-off and parent organisation may also be the sharing of personnel, e.g. a researcher who holds a position or equity in a spin-off while keeping his academic position, or the conduct of diploma or doctoral theses in a spin-off (see also figure 4 below).

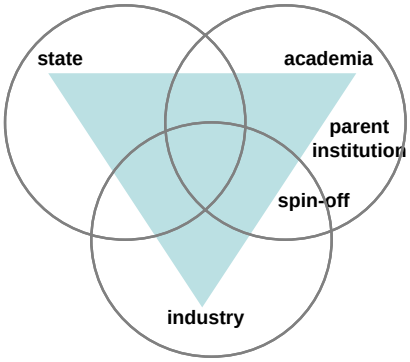
We may differentiate between two ideal types or models of how spin-offs and their parent organisation interact. According to the first model, spin-offs decouple largely from the parent institution after the creation phase. This model of interaction could be interpreted as referring implicitly to a triple helix II model. In the triple helix II model, the institutional

Figure 2: *spin-off model according to triple helix II*



spheres of academia, industry and state are separate with strong borders dividing them and highly circumscribed relations among the spheres (Etzkowitz & Leydesdorff 2000: 111).[3] Accordingly, spin-offs are supposed to "migrate" from the academic sphere to the industry sphere (see figure 2). Relations to the academic sphere and the parent institution as part of it should not be too intense and highly circumscribed.

Figure 3: *spin-off model according to triple helix III*



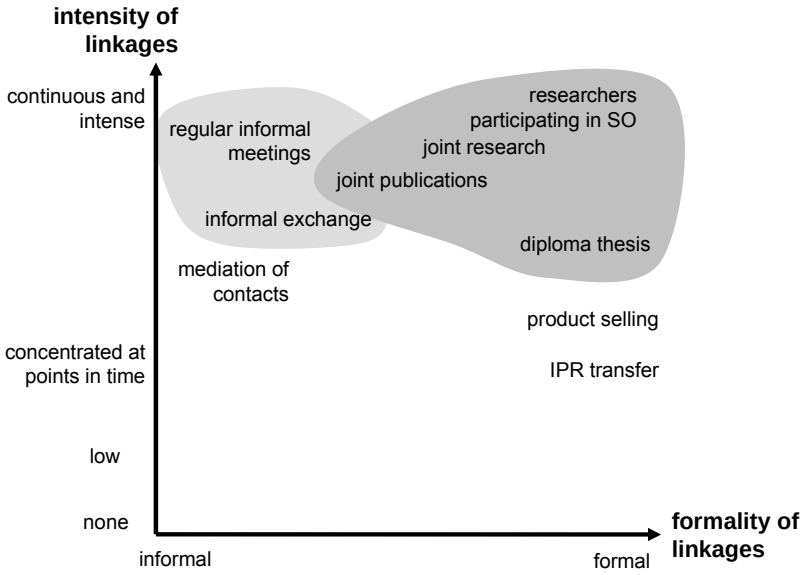
In the second model spin-offs function as a triple helix III organisation. In contrast to the triple helix II model, triple helix III generates a knowledge infrastructure with overlapping institutional spheres, where each may take over the roles of the others, and with hybrid organisations emerging at the interfaces. Spin-offs may then be interpreted as such hybrid organisations located where the academic and industrial sphere overlap (figure 3). They function as interface structures bridging industry and academia (Etzkowitz et al. 2000), rather than organisations migrating from academia to industry. Relationships between spin-off and the parent organisation are rather intense and not always clearly defined.

The first model is, as a normative model, often advocated by (German) transfer institutions (Potthast & Lengwiler 2005). However, empirical findings show that many spin-offs do not follow this model, and that it may not even be a highly successful one. In a comprehensive longitudinal survey of French spin-offs, it was shown that firms, which established strong links with academia were most successful, measured by survival rates as well as growth rates (Mustar 1997). Generally, linkages with academia decline after the creation phase, but they still remain highly important for a large number of spin-offs. According to Mustar (2003b), for four out of five enterprises, linkages with the parent organisation are important in the creation phase, while after six years this holds for half of the firms. Similar findings are reported in a German survey (Egeln et al. 2002).

As for the type of interaction between spin-off and parent organisation – or spin-off and academia more generally – a number of studies show that this interaction can partly be characterised as belonging to a hybrid sphere, where academic and commercial activities are not clearly separated. This is quite obvious in cases where spin-offs are engaged in joint research projects with research institutions, particularly publicly funded research, and joint publishing (Mustar 1997; Egeln et al. 2002; Potthast & Lengwiler 2005). Also, the participation of diploma and doctoral students in spin-offs is part of these hybrid

[3] Triple helix I refers to a configuration, where the nation state encompasses academia and industry and directs the relations between them.

Figure 4: *types of interactions by intensity and formality*



activities. The sharing of personnel, when the same person holds a position in the spin-off and academia at the same time is less clear. Yet it seems likely that also here boundaries between activities in both institutions may partly be blurred (see figure 4, the grey areas symbolise linkages which are supposed to signify hybrid - dark grey - or potentially hybrid - light grey - constellations).

As has been shown, these hybrid constellations are not only quite common[4], but also considered as conducive to the spin-off and to the research sphere.[5] Mustar (1997) found that spin-off firms did benefit strongly from the participation in publicly funded research projects. These benefits occurred partly indirectly through the establishment of network ties, which were essential for the development of the firm, and not so much through the development of commercial products within the project. Potthast & Lengwiler (2005) report that research institutes and research personnel take advantage of spin-offs by working in both institutions at the same time or successively, thereby acquiring the necessary industry experience for a professorship at a polytechnic, by co-operating in research projects, or by allocating research personnel that can no longer be employed in the parent institution. On the other hand, the blurring of boundaries between science and business may also lead to problematic effects. Scientists with a financial interest in their research are likely to face conflicts of interests which may result in biased research results or a disincentive to share research results (Krimsky 1999; 2006). Furthermore, publicly funded research, i.e. personnel, space and equipment, may be diverted to support private profits.

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4 Mustar (2003b) found that more than a third of the French firms which were part of his study published scientific articles. A German survey reported that about half of the spin-offs held contacts to research institutions and about a quarter engaged in joint R&D (Egeln et al. 2002: 38f.). About half of the spin-offs held informal contacts to academia, about a third employed students for internships and diploma theses, a little less sold products and services to research institutions, engaged in joint research projects and further education of their staff and about a fifth commissioned contracts to academia.

5 Most of the research on linkages and interactions between spin-off and parent organisation considers the conduciveness of these linkages for the spin-off, only some reflect on the consequences for the parent organisation.

Most likely, it depends on a variety of specific conditions, how a certain type of interaction affects research institutions. Knie et al. (2003) set up a typology of spin-off creation processes showing that in some cases, parent institutions benefit from a hybrid constellation whereas in other cases, such a constellation is rather harmful. They also showed that an intense interaction may be of a more hybrid type as well as clearly defined and both may be productive.

Finally, and independent of the type of interaction, research institutions may also draw more indirect benefits from spin-off creation. Spin-off creation has been reported to be conducive to the image of a university or research institute. It is considered as a sign of a dynamic institution, thereby attracting young researchers and helping to attract public funding. It is also considered as a sign of a dynamic region (EU-Commission 2002; Mustar 2003).

The assumptions on how spin-off and parent organisation interact are coupled with assumptions on what is the specific function spin-offs are supposed to fulfil for the economy and, more precisely, the innovation system. Whilst according to an earlier understanding which is by now largely rejected, spin-offs were supposed to significantly contribute to job creation: nowadays they are considered to fulfil a significant function in the innovation system. They are supposed to serve as mediators, translators or catalysts between academia and industry, going back and forth between science and markets (Mustar 2003). Similarly, Stankiewicz (1994) proposed to value spin-offs mainly because of their specific function in knowledge production filling certain gaps which neither academia nor industry are likely to fill, e.g. the development of technologies that are yet too generic for a company and, on the other hand, require a scale and financing which is beyond what can generally be achieved in an academic setting.

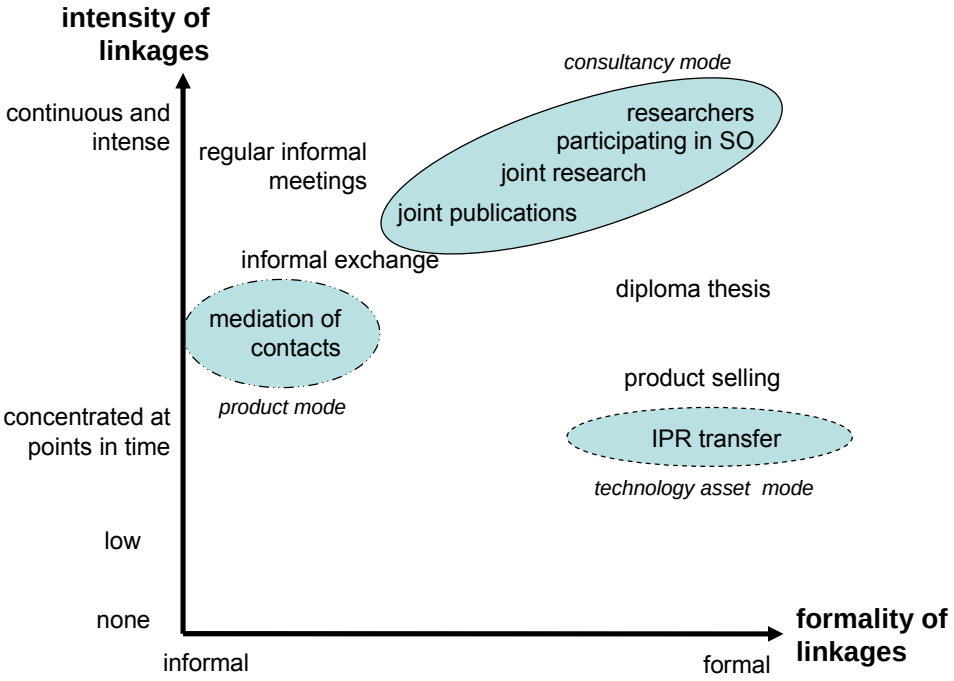
So, rather strong linkages between spin-offs and parent institutions or other research institutions and hybrid functions seem to be an important characteristic of spin-offs in general. Yet, a closer look shows that these characteristics may vary for different types of spin-offs. Quite a number of authors have put forward various typologies to capture the heterogeneity of spin-offs, partly with the intention to propose adequate and differentiated supporting structures for spin-off creation. These studies take the available resources, the business model or the linkages to the parent institution[6] as the central differentiating dimensions (for an overview see Mustar et al. 2006). Furthermore, types of spin-offs and

[6] The referenced studies focusing on the relation of spin-offs with their parent organisation mostly analyse how decisions made by the parent institution influence the starting configuration and the business model. For example, they analyse what type of supportive structures are given to spin-offs. However, this does not give information about the interaction between parent institution and spin-off in their regular activities.

their interaction with academia have shown to vary according to the technological sector they are part of (Rappert & Webster 1998; Gewin 2005).

Most relevant to us, Stankiewicz (1994)[7] proposes three types of spin-offs based on their mode of activity, that is, consultancy and R&D contracting, products or technology assets. Spin-offs may also fulfil several of these modes or change them over time. These modes differ among other features in the type of linkages to academia. The consultancy mode is characterised by strong linkages with academia; they may also be run by academics retaining their university position. For spin-offs mainly following the product mode, strong links are considered as not advisable, because growth orientation and business-like attitude seem to be more important here, and the academic environment is not conducive for this. Still, in most cases, some links are retained with academia. The third type of spin-offs develops technologies which are then commercialised through other firms. They largely rely on intellectual property rights. Here again close links to academia are considered as rather conducive, not the least because of the possibility to recruit adequate personnel (see figure 5 for an estimation which of the linkages described above are most relevant for the different types of spin-offs).

Figure 5: *Types of linkages and their relevance for specific types of spin-offs*



As for the degree of formalisation of the linkages between spin-offs and parent organisations, informal linkages seem to be as important, or even more so, than formal

[7] A similar model is proposed by Druilhe & Garnsey (2004).

linkages.[8] In a qualitative study of about 40 British spin-offs, informal linkages, e.g. regular personal contacts or exchange of equipment, testing and feedback, were reported as equally or more important than formal linkages. Partly informal linkages accompany or support formal ones. Informal linkages provide various knowledge flows, which incorporate a variety of codified and tacit knowledge and skills concerning theory, experimentation procedures, material and interpretation, and research organisation (Rappert 1997; Rappert & Webster 1998). Similarly, a quantitative study of German spin-offs reported informal linkages for half of the spin-offs, more than for any other type of linkages (Egeln et al. 2002, see footnote 4). These findings point in a similar direction as the assumption underlying the reasoning of Goldfarb & Henrekson, according to which a continuous involvement of university staff is required for successful commercialisation of research results.

On the other hand, formal linkages, particularly intellectual property rights, seem to be less important for spin-offs than generally assumed. According to the above-mentioned quantitative survey, patents played only a marginal role for the creation of spin-offs. Egeln et al. (2002) found that 5% or less than 1% of spin-offs were created on the basis of a patent.[9] Again, the situation varies for different types of spin-offs. Intellectual property rights seem to be of minor importance for spin-offs in the IT sector and only somewhat important for those developing scientific instruments and new materials (Rappert et al. 1999). More precisely, it may be that the increased attention to intellectual property, as valid as it may be, may have perverted effects inhibiting in some cases co-operation among academia and industry and ultimately technology transfer rather than facilitating it (Webster & Packer 1997, Rappert et al. 1999, Gewin 2005).

2.3 How policy measures may impact research institutions

There is a variety of policies and support measures which aim at the promotion of academic spin-offs. These measures are located at three different levels. The first type of measures addresses the *micro level* of potential entrepreneurs in academia and is targeted specifically at raising awareness and providing the necessary entrepreneurial competences for them. The second type addresses the *meso level* by setting up intermediary institutions that support founders of spin-offs and the respective research institutions. These are technology centres, incubators, consulting networks, information networks and databases, as well as the provision of financial resources, e.g. seed capital. The third type addresses the *macro level* of institutional structures of research institutions

[8] This contrasts somewhat with the high attention which is given to formal linkages, particularly those concerning intellectual property rights, in recent debates on the commercialisation of research results.

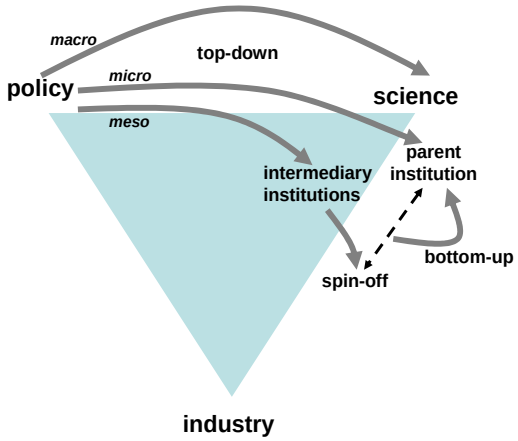
[9] Furthermore, the percentage of patent-based spin-offs is much higher for spin-offs from research institutes than for those coming from universities.

and framework conditions. These measures concern legislation and regulation, e.g. civil servants law, institutional settings in universities and research institutes, e.g. evaluation criteria and procedures, individual remuneration, financing sources, institutional missions and organisational cultures and recruitment policies. Meso and macro level measures are often not specifically targeted at spin-off promotion, but industry-science-relations more generally.[10]

These measures may be more or less effective for the promotion of spin-off activity. In general, as has been claimed before, effectiveness may not be assessed independently from the prevalent structures of the national science system. What is more important to us, is that these support measures do not only impact spin-off activity and industry-science relations, but may also have consequences for the core business of research institutions. Again, these effects will depend on the structure of the national science systems. Effects on the science system which may affect research institutions both positively and negatively could be the following:

- changes in the content, structure and practices of research and teaching
- rearrangement of research agendas
- effects on internal or external career opportunities
- organisational changes (within research institutions or in the relations between institutions)
- additional funding resources
- additional requirements, if commercialisation efforts are requested for research activities, e.g. for the acquisition of project funding

Figure 6: *repercussions of policy measures on research institutions*



Next to impacts on the structure of the science system, measures may also influence the relationship between parent institution and spin-off. That is, they may influence the intensity of linkages, formal as well as informal linkages. This is all the more important, since we assume that interactions between spin-off and parent organisation, particularly those of a hybrid type, may result in further repercussions on the parent organisation and, potentially, the wider academic

[10] For a similar classification see Polt et al. (2001: 30).

environment. We call the first type of repercussions top-down and the second type, resulting from the interaction between spin-off and parent organisation, bottom-up repercussions (see figure 6). Bottom-up repercussions may affect research institutions positively as well as negatively.

They may take the form of

- changes in the content and practices of research and research agendas, e.g. a stronger application orientation or a reluctance to exchange research results
- new career opportunities for academic staff
- enlarging the capacities and sharpening the profile of research institutions
- privatising research and drawing off personnel, thus extracting competences and capacities
- conflicts of interest at the level of the individual researcher or an institute arising from the involvement in both research and business
- additional funding resources.

In the following, we present a short overview of the impacts on the science system which can be expected from the different measures.

Measures at the macro level

Participation of academic staff in enterprises and leave regulation: In recent years, restrictions have been reduced in a number of countries which relate to the possibility for university staff to participate in private industry activities or to leave their position temporarily. These regulations may show effects on the relationship between parent institution and spin-off, because they facilitate the parallel involvement of researchers in spin-offs and academic research. As a consequence, we may expect that this type of arrangement supports intense interactions of a hybrid nature between spin-off and parent organisation. This may then affect research and teaching agendas and practices in the parent institution, mainly the respective department. Potentially, this may also have more general spill-over effects for the research institution.

Intellectual property rights: Regulations concerning intellectual property generated by publicly funded research differ between countries. Some accord property rights to the researcher/professor, some to the institution. Royalties from intellectual property rights are partly distributed among researcher and institution. In a couple of countries, the regulation has recently been changed mostly by transferring property rights from the individual researcher to the institution. When intellectual property rights are granted to research institutions, we may generally expect an increase in the attention given to the economic potential of research for two reasons. Increased attention may result from expected financial rewards. How strong this increase is though, is unclear. Only some

universities are reported to generate substantial income by royalties, while the majority is not even able to remunerate the costs of supporting structures (Webster & Packer 1997; Gewin 2005). In addition, attention may increase, because research institutions become responsible for the management of intellectual property rights, whatever the generated income may be.

Academic evaluation criteria: We expect that changes in academic evaluation criteria and procedures, either at the level of individual researchers, projects, or institutions may have strong effects on the science system. They change the incentive structure for academic work in general and, in the longer term, this may affect the selection of research personnel. In addition, evaluation criteria which reward commercialisation activities may have an effect on the linkages between spin-offs and parent institutions, because they do not discourage, or even provide an incentive, for researchers to engage in the creation and operation of spin-offs.

Measures at the meso level

Transfer institutions: Transfer institutions as such may not necessarily affect the science system, since they function as an add-on to the existing institutional structure. This assumption is supported by a study of German transfer offices at universities (Krücken 2003). The transfer offices, which were mainly pushed by political actors but received only small interest from academia and industry, served symbolic functions, while the "transfer business" largely continued as usual, that is, mainly based on direct and informal relations between individual researchers and industry actors. Considering that transfer offices meet difficulties in changing transfer practices, it seems even less likely that they have a strong impact on the regular academic practices. Of course, the impact will also depend on the specific institutionalisation of the offices. For instance, we would expect stronger effects if transfer offices were part of research institutions as if these were regional initiatives.

Supporting measures for the creation process[11]: The provision of counselling services, the mediation of business contacts, business plan competitions, incubators and financial support, e.g. in the form of seed capital, is a typical part of spin-off programmes. These measures may also be considered as add-ons, which will probably not directly affect the science system. Transfer offices, as well as business plan competitions and support measures for the founding phase may affect the interaction between spin-offs and their parent institution, if they support a specific model of spin-off and orientate the particular

[11] These measures are partly, but not always, implemented by or in co-operation with transfer offices. Therefore, they are presented as a separate point.

advice and support they are giving accordingly. By this, depending on the preferred model, they may either en- or discourage strong linkages with parent institutions.

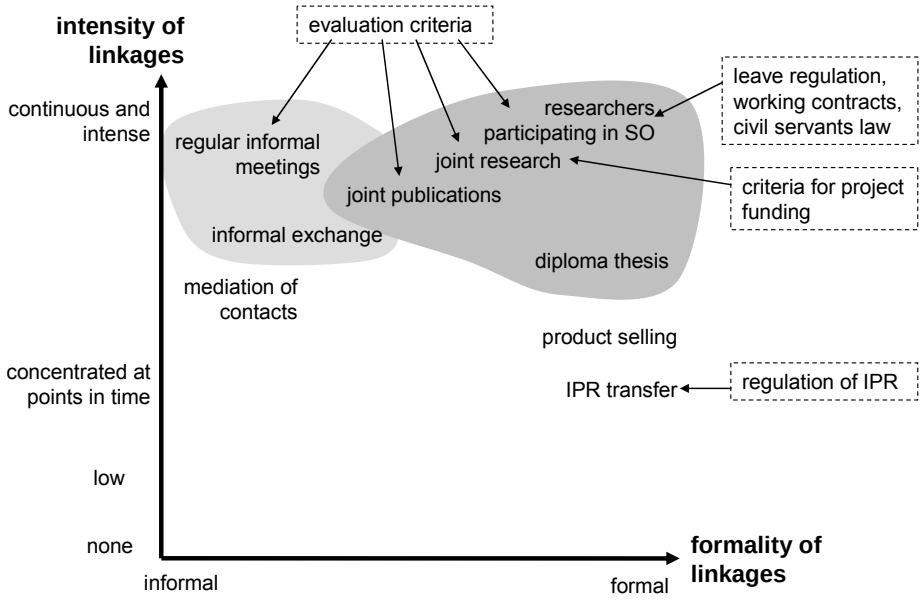
Measures at the micro level

Programmes for creating awareness and providing qualification in entrepreneurship: These programmes are largely, though not solely, targeted at master and doctoral students. They do not imply direct changes in the structure of the science system. However, they may slowly enhance the attention for the economic potential for research results and thereby contribute to changes in the cultural attitude towards commercialisation.

Summarising these assumptions, we may hypothesise that macro measures changing the institutional settings may have the strongest effect for research institutions. Micro measures targeted at the entrepreneurial culture in research institutions may have indirect effects, while measures at the meso level, that is, specific institutions and programmes for supporting the business creation process, should have the least effect.

Concerning the linkages between spin-offs and their parent organisations, we hypothesise that leave regulations and commercial engagement may influence the formal linkages between parent institutions and spin-offs. Also regulation of intellectual property rights will be important here. Evaluation criteria and criteria for project funding may have an effect on formal as well as informal linkages (see figure 7). Measures at the intermediary and micro level may have an effect on the relationship depending on the specific spin-off model.

Figure 7: *Impact of framework conditions on specific types of linkages*



3 The interaction between science and technology policy and science systems: an international comparison

In this section we compare the structure of science systems and the type of policies and support measures towards spin-off creation in a number of European countries. Firstly, we estimate the repercussions which policy measures may exert on the science systems. Secondly, we estimate whether the set of measures in each country encourages specific types of linkages between spin-off and parent organisation.

The analysis of country profiles is structured according to the dimensions referred to by Goldfarb and Henrekson. First, the organisational structure of research institutions (centralised versus decentralised systems) is presented, followed by the incentive structure for academic staff to engage in commercialisation of research results (e.g. evaluation criteria, structure of funding, leave regulations). Then, we identify incentives for research institutions to support the commercialisation of research results, mainly the regulation of intellectual property rights. In addition to the dimensions of Goldfarb and Henrekson, we add cultural attitudes as a further element which may influence the behaviour of researchers and research institutions.[12] Finally, we try to ascertain the policy type (top-down versus bottom-up). The analysis is based on secondary analysis. The main source for each country is stated at the beginning of the section, other sources are cited. An overview of the characteristics of the countries is given in Table A.1 in the Appendix.

As our research interest lies on the possible repercussions of measures for spin-off promotion on the science system, we will not look in detail at the specific performance in spin-off creation of the different countries. Moreover, data on spin-off creation at a national level are notoriously difficult to generate and the comparability of the data is problematic (Callan 2001; OECD 2002). As far as data is available, the rate of spin-off creation does not differ strongly between the countries in our sample (see Appendix). Still, the pattern of linkages between spin-off and parent organisation may differ between the countries. Apparently no representative data are available on this issue (OECD 2001: 40).

[12] This variable has to be considered with caution though, since we expect cultural attitudes to vary also between institutions and not only at a national level.

3.1 United Kingdom[13]

The British university system shows a number of similarities to the American model. It is *decentralised* in the sense that universities are independent institutions and employees are not civil servants; there are no common working contract schemes. The situation is different for research institutes, where researchers are partly civil servants. Research activities in universities are concentrated in a small number of institutions. Funding is provided mainly on a *competitive* basis. Basic funding is distributed following the results of a regular disciplinary *evaluation procedure*, the Research Assessment Exercise. In addition, funding can be obtained for specific research projects. The set of criteria underlying the competitive funding is focussed on academic performance and commercialisation efforts are not rewarded. Therefore, similar to the situation in Sweden, this type of competition creates an incentive to concentrate on academic work and, in contrast to the American model, cannot be expected to facilitate the engagement of researchers in spin-offs and other commercialisation efforts requiring a substantial engagement of the researcher (OECD 2002: 140).[14] This has been criticised and a "third leg" of funding, in addition to research and teaching, has been established.[15] This funding has been used largely for the setting up of intermediary organisations, improvement of intellectual property right infrastructure and enterprise training for staff (DTI 2002). It remains an open question, if this is able to counterbalance the effects from the evaluation system working against commercialisation activities.[16]

The regulation of *intellectual property rights* has changed over the last 20 years and also differed between institutions. Different (centralised) institutional bodies were entitled to intellectual property rights and their exploitation. As an exception, Cambridge University followed a liberal and seemingly successful approach. Researchers have been granted the intellectual property rights and no specific policy or restrictions as to the engagement of researchers in commercial activities were given, but also only little institutionalised support. Recently, there has been a development in the direction toward a more structured approach in convergence with developments in other universities (Druilhe & Garnsey 2004). Now, the management of intellectual property rights in universities is very

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[13] If not stated otherwise, this section is based on Polt et al. (2001).

[14] In a similar vein, an empirical study came to the conclusion that the transfer of IPR to universities (see below) does not automatically result in substantial incentives for researchers to engage strongly in patenting, since patenting distracts researchers from their primary objective, that is publishing. This is all the more important against the background of the British evaluation procedures (Webster & Packer 1997).

[15] The Higher Education Innovation Fund, formerly the HEROBAC programme, see (DTI 2000; 2002) and http://www.hefce.ac.uk/reachout/heif/heif1.asp.

[16] This caveat concerning the effects of HEIF for the activity of researchers seems all the more important, since in the past much of the funding has gone to non-research intensive higher education institutions (DTI 2002). However, this may change, since in the future HEIF funding will be distributed to a large extent based on a formula that reflects strongly academic staff members (OST 2005).

similar to the situation in the US. The sharing of royalties varies between institutions. In national research institutes researchers are mostly civil servants and have no comparable incentives. This is supposed to change for some institutions.

The general *cultural attitude* is said to be in favour of commercialisation because of a long tradition of industry-science-relations and because technology transfer is considered as a major mission in many institutions. On the other hand, differences in the educational background are presented as a possible obstacle to industry-science-relations because, in contrast to the US, business managers are generally not scientifically trained (OECD 2002).

The *type of policies* chosen to support commercialisation efforts also shows similarities to the US bottom-up model, that is, there is a tendency to state the objective, but not to prescribe the means to achieve them (OECD 2002: 78).[17] There is a rather large number of *measures* supporting spin-off at the intermediary level and on the micro level of promotion programmes, e.g. aimed at education in entrepreneurship and awareness raising. These measures are (seemingly) university-centred and less network-oriented as for example measures chosen in Germany (OECD 2002: 58). A question of debate is whether the strong emphasis on intermediary structures may even create a barrier to a common knowledge culture at the industry-science-nexus (OECD 2002: 153).

To summarise, the UK model of interaction between science system and policy type shows in many aspects strong similarities with the US model as described by Goldfarb & Henrekson (2003). However, the incentive structure for researchers is comparable to the Swedish model. The similarity to the US model in a number of framework conditions may be a reason that measures for supporting spin-offs and commercialization of research results have lately focused not so much on these, but rather on the intermediary and micro level. Accordingly, we may hypothesize that only to a limited extent did these affect the science system. The framework conditions in the UK seem only partly to be conducive to strong linkages between spin-offs and their parent institutions. Strong relationships may to some extent be discouraged because of the design of evaluation criteria. As for the regulations relevant for the formal participation of researchers, we do not have appropriate data. These will probably vary between institutions, since there is no national binding regulation for working contract schemes.

[17] This is illustrated also by changes made to the HEIF. Formerly there had been two separate programmes providing seed capital on the one hand (University Challenge) and support for teaching entrepreneurial skills (Science Enterprise Challenge). These programmes were integrated, so as to grant universities more freedom in choosing the measures they deem appropriate for supporting commercialisation efforts (DTI 2002).

3.2 Germany[18]

Generally, the German science system can be characterised as a *centralised system* with only *little competition* between institutions. Research institutions are mostly subordinate to public ministries. A specific characteristic is the high differentiation between different types of institutions with each having a specific mission according to education, research and technology transfer, e.g. (technical) universities, polytechnics or various types of research institutes (Fraunhofer-, Max-Planck-, Helmholtz- and Leibniz-Society). Universities and research institutes are mainly financed by basic funding (about 2/3, respectively 3/4 of funding). It should be noted though that there is high variation between different types of research institutes. There is little or no wage flexibility and therefore no direct wage-based competition between universities for personnel. However, there are currently a couple of structural changes under way. These changes aim at fostering academic excellence as well as knowledge transfer seen to enhance the capacity of the German innovation system. One may ask though, if the two aims may not partly contradict each other. Competitive project and programme-based funding is strengthened with respect to basic funding (BMBF 2002). Furthermore, policy aims at introducing more competition and qualitative differentiation between research institutions. This is supported by measures such as clustering first-class research and the competition for additional funding for universities with a specific potential for becoming elite universities. While knowledge transfer is mentioned as one criterion characterising excellent universities, the main weight lies upon classical academic criteria.[19] Therefore, one may expect that this type of competition will motivate researchers to concentrate on academic work and not put much effort in commercialisation activities. This is also reflected by the concepts presented by universities participating in the competition. Out of 10 concepts which had been chosen in a first round, only one put the concept of an entrepreneurial university centre stage and one university presents knowledge transfer as one element among others.[20]

In the German system there are no regular evaluations with a direct effect on funding as in the British system. *Evaluation* is carried out mainly at the level of institutes or scientific organisations ("Systemevaluation"). We would therefore expect effects to be comparatively small and to occur slowly. Performance criteria vary strongly between the different types of institutions; thus also effects may vary. At least for some, e.g. Fraunhofer institutes, criteria nowadays also consider the number of spin-offs (Meyer-Krahmer & Kulicke 2002). With respect to evaluation criteria at the project level, for some sources of

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[18] If not stated otherwise, this section is based on Polt et al. (2001).

[19] Bund-Länder-Vereinbarung gemäß Artikel 91 b des Grundgesetzes (Forschungsförderung) über die Exzellenzinitiative des Bundes und der Länder zur Förderung von Wissenschaft und Forschung an deutschen Hochschulen, Stand 7.6.2005.

[20] Stuttgarter Zeitung, 27.1.2006, "Wir sind ein armes Land".

funding, commercialisation of results is required. The German Ministry for Education and Research (BMBF) has introduced the rule that for results obtained from BMBF funded research, intellectual property rights must be applied for and results must be commercialised (OECD 2002: 55).

Researchers at universities and research institutes are partly civil servants. Here, *employment law* may hamper commercialisation because it restricts participation in companies and earning profits, as well as mobility out of academia (pension schemes). Universities and some research institutes are not allowed to earn profits and engage in entrepreneurial activities, including investment in start-ups. However, university professors may dedicate some of their time to an enterprise owned by themselves as a secondary activity.

The regulation concerning *intellectual property rights* has changed recently. Until 2001, in universities researchers were granted intellectual property rights. Accordingly, universities have been reported to show little interest in supporting patenting and its exploitation (Koschatzky 2002: 250). Since 2002, universities have been granted intellectual property rights and royalties are shared equally between university, commercialisation unit and inventor. Research institutes had already been granted intellectual property rights.

Cultural attitudes are supposed to exert an ambivalent effect on the commercialisation of research results. On the one hand, there is a long tradition of intense industry-science relations in Germany, mainly in specific sectors such as electronics, machinery, and chemistry, and in specific institutions such as technical universities and polytechnic colleges. On the other hand, the majority of universities are oriented towards a Humboldtian model of science emphasising the autonomy of curiosity driven research. In an empirical study on German transfer offices at universities it became apparent that this Humboldtian model as well as a certain reluctance to embrace a third mission of universities was one of the reasons why the universities in the sample did not actively support the transfer offices (Krücken 2003).

The German *policy type* may be characterised as intermediary, though rather pending towards a bottom-up approach. There is a strong focus on framework conditions (macro measures) resulting in a number of structural changes (see above). In addition, there is also a focus on micro and meso measures. An important instrument here has been the EXIST programme: via a competition various regional networks for supporting spin-off creation and comprising public and private actors have been supported. While some elements were required, there was no prescription of the specific form. Accordingly, each network adapted the set goals differently (BMBF 2002; Meyer-Krahmer & Kulicke 2002). All networks are engaged in awareness raising, training in entrepreneurship, business plan competitions and provision of seed capital. Furthermore, there is a large number of transfer organisations, which are again heterogeneously organised; some are institu-

tionalised at universities, others at the level of the Länder or at the level of a specific type of research institute, e.g. the Max-Planck-Society. The latter type is rather specific; most other countries follow regional or institution-specific approaches (Rammer et al. 2004). Generally, in Germany intermediary institutions are often of a network type (OECD 2002: 58). Considering all types of measures, Meyer-Krahmer and Kulicke (2002) state that since the mid 1990s the creation of spin-offs has strongly gained in importance. Indicators are the establishment of various professorships for entrepreneurship, the foundation of networks, the large number of initiatives and the creation of internal organisations for supporting spin-offs at research institutions as well as the fact that the performance of the Fraunhofer Society is now also measured by the number of spin-offs.

To summarise, the German science system has so far shown a number of similarities to the Swedish system, e.g. little competition between universities, rather bureaucratic structures with a number of hampering elements for commercial involvement (employment laws, intellectual property rights until 2001). At a more concrete level of specific institutional settings and incentive structures there is, however, a lot of variety due to the different types of research institutions. Lately, there are structural changes going on which point in the direction of decentralisation and, at some points, an incentive structure comparable to the American model (intellectual property rights). The policy approach may be considered as an intermediary or almost bottom-up type.

The strong focus on macro and micro measures may be interpreted as having a strong potential for affecting the science system. However, the incentive structure resulting from structural changes is ambivalent, thus the concrete effects are difficult to appraise. Furthermore, it remains a question for empirical research, in how far micro measures had an impact on the entrepreneurial culture of universities.

Framework conditions in Germany seem to be neither highly conducive nor discouraging for strong linkages between spin-offs and their parent institutions because of the comparably low impact of evaluation systems (so far), and the possibility for – at least professors – to engage in formal links with spin-offs.

3.3 France[21]

The French science system is *centralised*. Research institutions are public and allocation of staffing and resources, and also partly priority setting, are decided at the national level. All researchers, except doctoral students, are *civil servants* and contract employment is not possible, except for doctoral students. The mobility of researchers to industry is very

[21] If not stated otherwise, this section is based on OECD (2002).

low. *Evaluation* of researchers is conducted by national disciplinary committees. Industry ties have largely been ignored or may even have hampered academic promotion. Following the *plan d'innovation* 2003, activities of researchers and organisations in favour of innovation shall now be evaluated too. A number of changes in legislation have been introduced in 1999, following the *loi d'innovation*, which aimed at facilitating the creation of spin-offs (see below). Intellectual property rights are generally granted to institutions. However, this may vary between institutions, e.g. intellectual property rights may be granted to industrial partners with royalties in exchange. *Cultural attitudes* are supposed to be rather unfavourable to academic entrepreneurship, because of the former long-term tradition of large public support programmes focussing on industrial champions and a tradition of involving engineers in government or large industry corporations (Project Group Science Policy Studies (2006)).

The French *policy type* can be characterised as a top-down approach. The means to achieve objectives are generally stated, for example the shape and function of transfer offices at universities. Framework conditions have been changed in a way to lower substantial hurdles to spin-off creation. The new regulations include leave regulations for researchers and the possibility to hold shares or to act as an executive of a firm. Furthermore, it enabled research organisations to provide seed capital and to set up incubators and provide funding to do so. It has been stated though that management of the industry linkages by a body of the research institution does not generally work because of a number of administrative hurdles. Therefore, the management is partly provided by subsidiary firms or independent organisations. The setting up of subsidiaries for seed funding is a new practice for research institutions and some have started to do this. Generally, the effect of the measures provided by the *loi d'innovation* has been stated to be not yet clear (OECD 2002) or even difficult to carry out in practice. The *loi d'innovation* was followed by the *plan d'innovation* in 2003, which carried a number of measures further, e.g. it comprised the modification of transfer institutions, the possibility to participate in enterprises for staff at further research organisations and an increase of seed capital. Furthermore, incentives for patenting and awareness campaigns in universities were provided.

To summarise, the French science system and the French policy show a number of similarities to the Swedish system. A range of measures at the macro level have been taken. These concern the facilitation of formal engagements of researchers in spin-offs and the evaluation of commercialisation efforts. If the former should show effects, further repercussions of the bottom-up type seem possible. Furthermore, a number of measures addressed the meso level (transfer offices, support of the creation phase) and some also the micro level. As for strong linkages between spin-offs and their parent institution, the French system has been rather discouraging in the past. This is due to the discouraging

effect of the evaluation procedures and, until recently, the legislation concerning the formal involvement of researchers in spin-offs. However, the changes under way may modify this picture in the future.

3.4 Finland[22]

The Finnish science system has *central as well as decentral characteristics*. All universities are state-run and general objectives and funding levels are set by the ministry in discussion with the universities. Yet the legal framework leaves room for individual universities to decide on detailed organisation, administration and appointment of professors. A further decentralisation process is said to be under way. Universities are complemented by public research institutes, which account for about 2/5 of public R&D. Researchers are *civil servants* with rather severe restrictions on possibilities for secondary occupation and leave regulations. For the latter consent by the employer is required. According to the *Act on the Right to Carry on Business* it is not acceptable that the line between official service and private business becomes vague. However, these limitations are said to have only little effect in practice. Similarly, restrictions are set for investments of universities in private companies. The *provision of funding* has become increasingly competitive in recent years; the level of competitively distributed funding now lies between Germany and the UK, similar to those of Sweden. *Evaluation procedures* are mainly carried out on the aggregate level of organisations with consequences also taken mainly at the organisational level. In the case of universities, these have focussed largely on teaching performance (Ormala 2001). It is unclear though, if these procedures have a favourable or negative effect on researchers' commercial activities.

Until recently, *intellectual property rights* in universities have generally been owned by the inventor, but specific arrangements may have applied depending on the funding source of the research and the specific arrangements taken; therefore, there is no common scheme. The legal framework was changed in 2005, shifting the ownership of intellectual property rights to universities (Project Group Science Policy Studies (2006)). Universities have just started to provide supportive measures for researchers to make use of intellectual property rights. The income from royalties is rather low. In institutions other than public sector research institutes intellectual property rights have already belonged to the employer.

Cultural attitudes in universities seem not to work in favour of commercialisation of research, since universities are rooted in a strong tradition of "pure" science. In the policy realm though, the awareness that science should contribute to the economy is high.

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[22] If not stated otherwise, this section is based on Polt et al. (2001).

The Finnish *policy type* relevant for spin-off creation may be considered as a predominantly top-down approach. It consists to a large extent in various programmes initiated, funded and organised by the public technology agency TEKES. As far as we can see, the only measure on the macro level of framework conditions has been the recent change of intellectual property rights regulation. The bulk of measures seem to be located at the meso level. With a focus on spin-offs this is the TULI programme co-ordinated by TEKES, consisting of science parks and incubators searching for research results with business potential. In addition, TEKES provides advisory services and capital loan schemes. Financing conditions for spin-offs are reported to be generally favourable, both by public as well as private sources (EU-Commission 2002). Finally, the SPINNO programme provides expert advice. In addition, there are further transfer companies jointly owned by universities and other regional organisations, innovation centres at universities and technology incubators, which do not only focus on spin-offs, but on industry-science relations in general. We do not have appropriate data for the state of measures at the micro level.

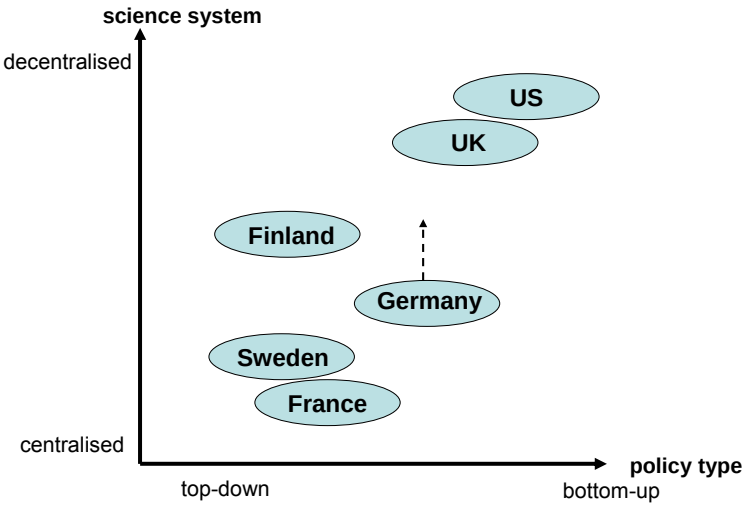
In summary, the Finnish model does not fit one of the ideal types of science and policy models presented by Goldfarb & Henrekson. As for the profile of measures, we found a strong emphasis on measures at the meso level, which we suspect to have the least repercussions on the regular academic activities. Similar to the UK, there are almost no measures at the macro level except for the recent changes of intellectual property rights regulation, but for these it is too early to expect effects. Therefore, we would hypothesise that in the Finnish case, repercussions of the top-down type have not been very strong so far. Repercussions may nevertheless result bottom-up from linkages between spin-offs and universities. We did not find evidence that intense linkages between spin-offs and parent organisation of the informal type are specifically discouraged by framework conditions. From our data, the effect of evaluation procedures remained unclear. However, framework conditions are discouraging for the formal involvement of researchers still active in academia and, particularly, for the blurring of boundaries between academic and commercial activities.

4 Discussion and conclusions

4.1 Lessons learned from national case studies

The comparative analysis showed that there is *no common Continental-European model of science systems and policy styles* as assumed by Goldfarb & Henrekson. Rather, we found substantial differences in both science systems and policy approaches. This corresponds with the findings of other studies that concluded that "there is no European model of spin-out programmes" (EU Commission 2002: 49). There is a large variety of policies and science systems. At one end of the spectrum we find France, which is quite close to the Swedish model, characterised by a centralised science system and a top-down policy approach which tends to state the means to achieve objectives. At the other end we find the UK, which shows a number of similarities to the US model, characterised by a decentralised science system and a bottom-up policy type which sets frameworks to create incentives to reach objectives, but leaves more freedom as to the means by which objectives may be attained. Germany and Finland seem to take an intermediary position (see figure 8). Moreover, Germany, and to some extent France, are likely to experience the strongest transformations of their position because of current changes in the structure of the science system.

Figure 8: *countries by type of science system and policy*



The diagram depicted in figure 8 could be interpreted as representing a nearly linear relationship between policy type and science system. However, apart from the fact that Germany and Finland deviate from this linear relationship, one should keep in mind that these two dimensions provide a very crude characterisation. As the – already sketchy – presentation of the country profiles has shown, each science system has to be characterised by several dimensions (or structural elements) to estimate its conduciveness for spin-off formation and potential repercussions on the science system. For instance, the UK model is not as similar to the US model as the diagrammatic characterisation suggests, because of the differences in evaluation procedures. Accordingly, the Goldfarb and Henrekson model seems to be too

simple to apply for a larger number of countries. Nevertheless, the mechanisms highlighted by the model are a useful starting point to analyse the effects of the interaction between policy and science systems for national conditions of the commercialisation of research results.

According to Goldfarb and Henrekson, the specific characteristics of the science system and the policy type should explain differences in the number of spin-offs created in a country. They could not draw on empirical data to substantiate this hypothesis. From our own very limited database, however, it seems that we have to reject this hypothesis: while for France we could not find any data, for Germany, Finland and the UK the rate of spin-off creation seems not to differ strongly (see Appendix). On the other hand, the data are not reliable enough to clearly discard the hypothesis.

It should be highlighted that *framework conditions may also vary within countries*. This may be due to a highly differentiated set of research institutions as in the case of Germany, for example, or due to a rather open and flexible framework which leaves room for individual institutions to build up diverging structures, as in the case of the UK. In contrast to this, France and Finland exhibit a comparatively small internal variety.

The analysis also made clear that a *dynamic perspective* is necessary since in Germany and France, the science systems seem to be subject to substantial changes. Science policy focussed on commercialisation of research results seems to be a major driving force. However, a convergence of these science systems towards the US or UK model is not to be expected, since each system has too many specific characteristics (see above).

As already stated by others (Mustar 2003: 637), the set of measures for supporting spin-offs shows strong similarities in all selected countries. However, as our analysis indicates, there seem to be *differences in the relative role of specific support measures* in the overall spin- off promotion. Furthermore, the specific shaping of the measures (e.g. the type of transfer institutions established) may differ substantially, but this could not be discussed in detail here. In Germany and France, substantial measures have been taken at the macro level concerning possibilities for researchers to be involved in spin-offs, the regulation of property rights, and also evaluation criteria. However, evaluation criteria, which are supposed to be highly important for commercialisation efforts in general, have received comparably little attention by policy measures so far. A hypothesis would be that this is exactly the case, because changes to evaluation criteria would affect the science systems most directly and strongly. More precisely, it may be due to a reluctance of both researchers as well as policy actors to give way to more hybrid forms of research (see below). Measures at the meso and micro level have been applied in all countries, with the UK and Finland seemingly focussing particularly at the meso-level and the UK also giving a strong emphasis on the micro level. Accordingly, we expect the following *top-down repercussions* on science systems resulting from policy measures (see 2.3). We expect a

strong potential for repercussions because of direct structural changes to the science system for Germany and France. These repercussions may show largely in the coming years, since measures have been implemented only recently. In the UK, repercussions may be expected mainly from supporting measures at the micro level, while Finland should show comparatively little top-down repercussions.

The repercussions of policy measures for supporting spin-offs on the science systems will probably not only depend on the measures as such, but also on the *interplay between policy measures and the science system*. For example, while there is obviously a convergence in the regulation of intellectual property rights, this regulation may have different effects in different countries, which should be monitored in the future. Whether incentives given by intellectual property rights will be fully exploited will also depend on incentives given by evaluation procedures and on the cultural attitudes concerning the commercialisation of research. Accordingly, unfavourable evaluation criteria may constitute a barrier in the UK, unfavourable cultural attitudes a barrier in Germany, and, in Finland and in France, even both may be a problem. In a similar vein, measures at the micro level targeted at creating awareness and building entrepreneurial competences could have a stronger impact on the general cultural attitude, if this attitude is already favourable as compared to other countries.

Framework conditions which create incentives for specific *types of linkages* between spin-off and parent institutions vary substantially between the countries (see figure 7 and table 1).

Table 1: *framework conditions influencing linkages between spin-off and parent organisation by country*

	US	*S*	*UK*	*D*	*F*	*SF*
leave regulation etc.	+	-	+/-	+/-	- → +	-
evaluation	(+)	-	-	+/-	- → +?	-/+
IPR	+	-	+	- → +	+	- → +

Therefore, it may be expected that each country displays a specific distribution of spin-offs showing a specific form of linkages to their parent institution. For example, a hypothesis would be that in the US a rather high percentage of spin-offs is characterised by rather intense – formal as well as informal - linkages between spin-off and parent institutions, since framework conditions seem to be favourable to both. As a counter-model, France and Sweden would show a smaller proportion of spin-offs of this type, though in France, the situation may be changing. In the UK then, intense interactions are

generally not favoured by evaluation criteria, while the situation for a formal involvement of researchers is not clear. In Finland, we find the opposite situation. Finally, the German framework seems not to discourage intense linkages.

Following our assessment of potential repercussions of measures (see 2.3), we may furthermore speculate that an intense interaction between spin-offs and parent institutions will result in comparably strong *bottom-up repercussions* on parent institutions. This seems all the more likely if the linkage includes the direct involvement of researchers in spin-offs. Thus, the strongest bottom-up repercussions can be expected for the US, followed by Germany, and then by the UK and Finland, while France and Sweden may show substantially less.

Going one step further, we deduce the hypothesis that national patterns of spin-offs may differ according to the relative importance of *spin-offs fulfilling specific modes of activities* (see 2.2). According to Stankiewicz (1994), spin-offs, which mainly engage in consultancy and R&D contracting, are characterised by rather strong linkages with academia and they are partly run by academics retaining their university position. Therefore, we would expect a similar distribution of country profiles as for the bottom-up repercussions. Spin-offs, which develop technologies to be commercialised through further firms (technology asset mode), rely strongly on intellectual property rights and, to some extent, on linkages with academia. Here again, the framework in the US seems to be most conducive, followed by the UK and France, because of its regulation of intellectual property rights. In the future, the situation in France, Germany and Finland may be rather favourable for this type of spin-off because of the combination of intellectual property rights and a predominance of intense linkages. For spin-offs relying largely on the selling of products, linkages with academia are not as important. Here, we expect that a favourable environment concerning measures at the meso and micro level (supporting measures for the creation phase, transfer offices, awareness and competence campaigns) may be most important. Therefore the UK, which has put large emphasis on these measures for quite some time, may provide the most favourable environment.

Our hypotheses on potential repercussions and national patterns of spin-off types are extremely tentative though. First of all, the framework condition these assumptions are based on are but one of a surely much larger number of factors influencing national patterns of spin-off types. Secondly, we do not know of any comparative empirical data which could serve to substantiate these assumptions. Thus, an empirical analysis of national-specific types and styles of spin-offs and their interaction with academia remains an important field for further research. Moreover, in our analysis we could mainly point to various ways and forms by which policy measures, as well as the interaction with spin-offs, may lead to repercussions at research institutions. There is, however, still only very

little empirical research, which analyses what the specific repercussions on research institutions would be. Again, important work remains to be done here.

4.2 Implications for policy

Nevertheless, this perspective on different types of spin-offs displaying various patterns of linkages to their parent organisation and academia is important also from a policy point of view. Depending on which model of spin-offs are presumed, supporting measures may turn out differently. Stankiewicz (1994), for example, concluded that policy measures presuppose a “Schumpeterian” spin-off model which shows strong similarities to spin-offs following the product-mode. Similarly, Mustar (2003) has pointed out that policy measures for fostering spin-off creation tend to presume that spin-offs ideally follow a specific development model. The spin-off is created by a researcher on the basis of a technology license or patent, often in partnership with a business person. Then, the spin-off follows a steady growth. Taking into account the variety of spin-off forms, Mustar concludes that many of the typical supporting measures targeted at providing risk capital, regulating intellectual property or financial management, are not appropriate for a large number of spin-offs. A similar critique has been made by further authors who analysed the variety of spin-off models (Rappert & Webster 1998; Mustar 2003; Druilhe & Garnsey 2004; Gewin 2005; Moray & Clarysse 2005; Mustar et al. 2006). Moreover, recent evaluations of spin-off support policies in the US suggest that these are narrowly inspired by a specific disciplinary field of knowledge transfer, namely from the bio-tech sector. Increasingly, criticism is coming from other sectors that emphasise their specific form of spin-off life cycle (and accordingly of patent regulations, etc.) which is overlooked by the prevailing conception of support policies, and even hinders exchange between science and industry (Gewin 2005).

It would be highly interesting now, to conduct a comparative in-depth study of the models which underly policy measures for supporting the commercialisation of research and spin-off creation in different countries, potential changes to these models over time, and to see, how they impact the chosen policy measures. More precisely, we may ask which function spin-offs are supposed to fulfil in innovation and the science system. One may think of at least four types: are spin-offs supposed to a) create significant economic effects, e.g. employment, b) fulfil a linear transfer function (this does not necessarily imply growth), c) allow for continuous co-operation between science and industry (in contrast to linear transfer), while spin-off and parent institution follow a particular rationale and fulfil distinct functions, or d) are spin-offs and parent institution supposed to produce knowledge in a more integrative or hybrid way, that is, borders between the two are continuously crossed?

Such an analysis however is beyond the scope of this study. Considering just a number of exemplary policy documents, it seems that the models about the role of spin-offs may be located somewhere between the two ideal types presented in section 2.2: the triple helix II model, where spin-offs are supposed to rapidly decouple from their parent institution and the triple helix III model, where spin-offs function as hybrid organisations exerting strong interactions with the parent organisation which are not always clearly circumscribed. More precisely, it seems to be assumed by policy (actors) that spin-offs may entertain continuous interactions with their parent organisations. This is indicated e.g. by the presentation of outstanding examples of spin-offs in a British policy document which show exactly this attribute (DTI 2000: 28), or by the fact that French policy refers to "young innovating enterprises emanating from or linked to public research" (MER 2005). However, a blurring of boundaries between research institution and spin-off and academic and commercial activities is clearly disapproved. This is indicated by the argumentation in the British document just mentioned as to why a separate third stream of funding is necessary to support commercialisation efforts, while the regular British research evaluation procedure (RAE) should not "be used to divert research funds to support universities' applied work with business, instead of its present focus on excellent fundamental research" (DTI 2000: 20). As for the French policy, the *loi d'innovation de 1999* grants the possibility to research staff to engage in the creation of a company while retaining their status as a civil servant. This is under the condition that they step back from their academic position and decide, after a maximum of 6 years, either to remain with the company or turn back to academia.[23]

As has been discussed in section 2, the effects of a blurring of boundaries between academic and commercial work are quite ambiguous. Considering the potential benefits of hybrid constellations, it is at least a point for discussion, if regulatory frameworks should not allow for transgressions of boundaries. The main challenge remains, however, to identify under which specific conditions a hybrid constellation is beneficial, and what would be an appropriate framework to foster these conditions.

4.3 Implications for further research

The present study aimed at providing a number of hypotheses as to how spin-off creation, operation, and support may influence the science system. We have specified these hypotheses by drawing on evidence of recent experiences from selected European countries. A thorough assessment of the importance of spin-offs for the development of

[23] What is possible though for research staff on a continuous basis, is to provide consulting or contribute to the capital of a firm.

the national science and/or the national innovation systems would need a much more detailed analysis. An empirical and partly explorative study is also needed to develop a clearer picture of the specific repercussions at different levels of the science system, e.g. at the organisational level, concerning research and teaching practices, or concerning role and career models. In the final section, we will therefore summarise our main conclusions in the form of research questions and comparative dimensions that could serve as a starting point for an empirical comparative research project at the European level, such as the currently starting PROKNOW project.[24]

We have shown that the national science systems in Europe and their associate science policy approaches may not be easily subsumed under one specific style. Rather, the national systems differ in a wide number of respects. As has been shown, national differences may result from the specific structure of the science system, the specific profile of supporting measures, and the interaction of both. Furthermore, they may result from different patterns of linkages between spin-off and research institutions.

The assessment of impacts of spin-off creation and operation, and of specific spin-off policies, will therefore depend on the *specific structure, culture and history of the national science system.* Thus, a research concept for analysing the role and impact of spin-offs for the respective science systems has to take into account a number of dimensions along which the national science systems may differ and which may influence the repercussions. From our analysis we propose the following:

- structure of the science system: decentralized vs. centralized
- evaluation criteria and procedures
- cultural attitudes of researchers towards economic activities: lower level activities vs. part of a normal portfolio of biographical success
- institutional boundaries between the science and the economic systems, e.g. in the form of leave regulations, working contract schemes and civil servant laws
- intellectual property rights.

When aiming at a comparative analytical framework, it is important to be aware of the internal heterogeneity that may exist within each country. Conditions may change depending on whether a university or a research institute is considered, depending on which kind of discipline or sector is at stake, and perhaps also in which region a specific promotional activity is taking place. Ultimately, individual and historically contingent factors may play a role that may not be grasped in a rough comparative framework.

[24] For more detail see http://www.wz-berlin.de/ag/wp/default.en.htm.

Furthermore, the science systems are moving targets. Therefore, comparisons have to take dynamic aspects into account. This implies for example that an analysis and comparison of case studies – either case studies of specific spin-offs or national case studies - has to take the time dimension quite carefully into account, since framework conditions may differ substantially between one point in time and another. And given the substantial internal heterogeneity within at least some countries, the overall direction of development may be extremely difficult to assess.

A second cluster of research questions and comparative dimensions relates to the *national policy measures* for supporting spin-off creation as well as industry-science-relations. Policies for supporting spin-offs show strong similarities over a wide range of countries. However, the relative weight attributed to the individual policies seems to differ, as well as the specific shaping of the measures. We might therefore expect to find specific national styles in the details, where at a general level there seems to be convergence. And, as has been elaborated above, the specific profile of policy measures may result in a particular profile of repercussions.

More specifically, with respect to *measures at the macro level*, it remains to be empirically analysed to what extent different framework conditions, e.g. evaluation criteria or leave regulation, influence research and teaching practices and, also, if and how they influence the interaction between spin-offs and parent organisations. This may be analysed by tracing back the impacts of changes to framework conditions within a country or by analysing varying framework conditions in different countries. As for supporting *measures at the meso level*, we may ask whether intermediary organisations as transfer offices etc. function independently from the regular processes in the research institutions or if both interact more intensely. In the latter case and in contrast to what we have assumed in this report, substantial repercussions may also result from measures at this level. Finally, it remains to be empirically analysed to what extent (the specific) supporting *measures at the micro level* as awareness campaigns within research institutions indeed affect the cultural attitudes of students and staff.

Thirdly, the interaction between policies and structural elements of the science system is likely to give rise to *differentiated distributions of spin-offs* with respect to the patterns of linkages between spin-off and parent institution and with respect to the modes of activities fulfilled by the spin-offs. For instance, countries with a cultural attitude and entry/exit rules for academics which create low barriers are expected to have a high percentage of spin-offs depending on intense linkages between spin-off and parent institution.

An intense interaction between spin-offs and parent institution is supposed to result in comparably strong bottom-up repercussions on parent institutions. This seems all the more likely if the linkage includes the direct involvement of researchers in spin-offs.

Therefore, a study which aims at exploring bottom-up repercussions may usefully concentrate on this type of spin-off. However, one should be aware and take into account that there are other types of spin-offs, e.g. by estimating the relevance of the specific type of spin-off under scrutiny.

These three fields of investigation may serve to support a comparative analysis of spin-off activity, and would ultimately lead to a more adequate and encompassing assessment of the role and importance of spin-off activity within the science system(s). While obviously a lot of research remains to be done, our study should at least have shown that it is necessary and timely to shift the analytical focus back from spin-off promotion to potential repercussions on research institutions, that a (national) comparative approach to analysing the spin-off phenomenon is necessary in addition to the comparative analyses of the broader national innovation system conducted so far, and that a differentiated view on the spin-off phenomenon is called for, particularly from a policy perspective. Finally, this type of study promises to produce substantial results for the assessment of the spin-off phenomenon as an element in and indicator for a larger transformation process of knowledge production happening within the science-industry-policy triangle.

5 Appendix

The following table provides an overview of various structural characteristics of the national science systems and policy styles in the countries treated in the report. The data for the US and Sweden is based on Goldfarb & Henrekson (2003), complemented by Polt et al. (2001); other countries are based on Polt et al., if not stated otherwise. For the share of research conducted by publicly funded organisations (HEI + PSRE), relevance of universities, share of R&D of GDP and share of business funded research in publicly funded organisations, see diagrams in OECD (2002: 32).

Table A. 1: *Science systems and policy measures by countries*

	US[1]	Sweden	UK[2]
organisational structure of universities	decentralised, competition for personnel and funding	centralised, little competition	decentralised, no common working contract schemes however: centralising effect of research councils and RAE[3]
R&D spending - HEI (%)	14[4]	22	19
- PSRE (%)	8	4	15
- industry (%)	75	75	66
basic funding (%)	HEI:<20 / Psre: 75	51	HEI: 36, Psre: 25
project/competitive (%)	HEI:>80 / Psre:25[5]	49	HEI: 64, Psre: 75
IPR, Incentives for universities	universities are granted IPR, sharing of royalties required by law TT is part of evaluation of HEI[6]	researchers are granted IPR; universities do not profit from commercialisation activities of personnel	current arrangement comparable to US; has changed in the past; sharing of royalties encouraged in institute guidelines[7] various sets of rules (OECD 2002)
incentive for academic staff	rather large "freedom" to engage in commercialisation (e.g. possibility to take leaves, consulting privileges) evaluation criteria? professors at HEI are mostly salaried for 9 months at PSRE the situation is less favorable; employees are civil servants	evaluation criteria are purely academic, rather restrictive leave regulation[8] 3rd mission of universities: commercialisation; PSRE: ISR as objective, evaluation criteria, awareness measures employees at PSRE are no civil servants	highly competitive funding structure clearly focussed on academic criteria thereby not giving incentive to ISR[9]; third leg of funding shall add incentives for commercialisation activities[10] employment arrangement mainly neutral with exception of government research institutes
cultural attitude	long tradition of ISR, partly through military research projects	wide-spread debate on systems of innovation; general framework supposed to be favourable to ISR[11]	rather in favour of commercialisation business managers are typically not scientifically trained (in contrast to the situation in the US)[12]
policy type	bottom-up: setting of framework[13]	top-down: implementation of specific measures	tendency to bottom-up approaches setting goals, but not prescribing the means to achieve them[14]
measures supporting HEI, PSRE spin-offs	various public *and private* measures supporting ISR and spin-offs	all publicly funded: technopole infrastructure, part of univ or science parks, publicly funded Technology Bridge Foundations university holding companies supposed to become minority owners educational programmes for entrepreneurship	various educational programmes for entrepreneurship, HEIF (formerly also University Challenge, Science Enterprise Challenge)
spin-off creation[15]	no systematic data, spin-offs from HEI are reported to be high (>3); at PSRE somewhat lower	no systematic data; comparative (non representative) study rather suggests similar situation as Finland	spin-offs from HEI are supposed to be rather high, from PSRE medium.

	Germany	France[16]	Finland
organisational structure of universities	little competition, centralised changes in the direction of more competition, e.g. competition for elite universities "	all universities are public, staffing and resources are decided at the national level; mainly centralised priority setting and allocation of resources; no contract employment possible except for doctoral students, but civil servants	all universities state-run, general objectives and funding levels set by the ministry and the universities, legal frame-work leaves room for individual universities to decide on detailed organisation, administration, appointment of professors (decentralisation process under way)
industry	69	~ 62	68
PSRE	14		12
HEI	17		20
basic fund.	HEI: 67, Psre:77		HEI: 46 PSRE: 55
project/competition	HEI: 33, Psre: 23		HEI: 54, PSRE: 45
IPR, Incentives for universities	until 2001: researchers were granted IPR; since 2002 universities are granted IPR (royalties are equally shared between university, commercialisation unit and inventor). PSRE are granted IPR performance FhG is also measured by number of spin-offs	generally IPR are granted to institutions, however, this may vary between institutions, e.g. IPR may be granted to industrial partners with royalties in exchange sharing of royalties (in public labs)	IPR in universities is generally owned by the inventor, specific arrangements depending on the financer of the research in other institutions IPR belong to the employer
incentive for academic staff	restriction for participation in companies and earning profits mainly "Systemevaluation" of the scienctific organisations; partly evaluation of universities; no binding evaluations as e.g. in the British system BMBF funded research: researchers are required to apply for IPR and commercialise results[17]	researchers are civil servants; incentive structures are centralised loi d'innovation changed leave regulations; possibilities to hold shares or act as executive of a firm researchers are evaluated by disciplinary committees, industry ties ignore or hamper academic promotion; slow changes under way	researchers are mostly civil servants, who are limited in their right to hold secondary occupations.
cultural attitude	Long tradition of ISR versus Humboldtian science model	not favourable to academic entrepreneurship: tradition of large public support programmes and tradition of involving engineers in government or large industry corporations[18]	policy: high awareness that science should contribute to the economy; in universities strong tradition of "pure" science
policy type	in between: EXIST: no specific prescription, but certain elements were given, each network adapted the set goals differently[19]; further (non-prescriptive) impact of the competition, e.g. on non-winning participants	top-down, means to achive objectives are generally stated	top-down, centrally co-ordinated, e.g. TULI/SPINNO programme: publicly initiated and funded[20],
measures supporting HEI, PSRE spin-offs	EXIST: regional networks, EEF, seed capital comparatively low[21] *cross-institutional* initiative for exploitation of patents (most other countries follow regional or institution-specific approaches)[22]	loi d'innovation 1999: changes of framework for fostering spin-offs, also measures as providing funding for seed capital and incubators; plan d'innovation 2003: awareness campaign and incentives for patenting, possibility to participate in enterprises for further research organisations, increase of seed capital[23] 2 national supporting measures for founders (consulting, financing); French measures are focussed on early founding phases[24]	TULI programme: science parks and incubators; furthermore TEKES provides advisory services and capital loan schemes; SPINNO programme providing advice by a network of experts; furthermore, not focusing specifically on spin-offs: S&T parks, technology transfer companies, partly owned by university foundations, innovation centres, technology incubators
spin-off creation	HEI: 3-4, PSRE 2-3	no data	HEI: 2-3, PSRE ~1

Notes to Table A. 1

[1] See also Etzkowitz et al. 2000.

[2] See also Etzkowitz et al. 2000.

[3] OECD 2002: 73

[4] 3% private non-profit

[5] Estimations

[6] OECD 2002: 58

[7] OECD 2002: 53

[8] Polt et al. 2001: 215: research outside university is no qualification for career as university researcher; leaves are possible for up to 6 months, if this does not create inconvenience to the employer; contact researcher: university researchers may work full or part time for a company for a certain period

[9] Roberts 2003 cited in Rammer et al. (2004: 138).

[10] Etzkowitz et al. 2000: UK Higher Education Funding Council requests that patents are considered as evidence of quality research in RAE; however also evidence that regime change to entrepreneurial university is not always realised

[11] Polt et al. 2001: 214; no specification of this statement

[12] OECD 2002

[13] For an overview of various legislative acts in favour of ISR see Polt et al. (2001: 278f.).

[14] OECD 2002: 78

[15] Numbers refer to number of technology-based start-ups in HEI / PSRE per 1'000 R&D personnel (OECD 2002).

[16] Mainly based on OECD 2002.

[17] OECD 2002: 55

[18] Project Group Science Policy Studies (2006)

[19] Meyer-Krahmer & Kulicke 2002: 271

[20] (Novakovic & Sturn 2000)

[21] Rammer et al. 2004: 120

[22] Rammer et al. 2004: 134

[23] Rammer et al. 2004: 212f.

[24] Koschatzky 2002

6 Bibliography

BMBF (2002). Erfahrungen aus EXIST – Querschau über die einzelnen Projekte. Bonn, Bundesministerium für Bildung und Forschung.

BMBF (2002). im Detail. Bonn, Bundesministerium für Bildung und Forschung.

Callan, Bénédicte (2001). Generating Spin-offs: Evidence from Across the OECD. Paris, OECD.

Druilhe, Céline & Elizabeth Garnsey (2004). "Do Academic Spin-Outs Differ and Does it Matter?" The Journal of Technology Transfer 29(3-4): 269-285.

DTI (2000). Excellence and Opportunity – a science and innovation policy for the 21st century, Department of Trade and Industry.

DTI (2002). Investing in Innovation – A strategy for science, engineering and technology, Department for Trade and Industry, HM Treasury, Department for Education and Skills.

Egeln, Jürgen, Sandra Gottschalk, Christian Rammer & Alfred Spielkamp (2002). Spin-off Gründungen aus der öffentlichen Forschung in Deutschland. Mannheim, ZEW – Zentrum für Europäische Wirtschaftsforschung.

Etzkowitz, Henry & Loet Leydesdorff (2000). "The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations." Research Policy 29(2): 109-123.

Etzkowitz, Henry, Andrew Webster, Christiane Gebhardt & Branca Regina Cantisano Terra (2000). "The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm." Research Policy 29: 313-330.

EU-Commission (2002). University spin-outs in Europe – Overview and good practice. Brussels.

Gewin, Virginia (2005). "The technology trap." nature 437(13): 948-949.

Goldfarb, Brent & Magnus Henrekson (2003). "Bottom-up versus top-down policies towards the commercialization of university intellectual property." Research Policy 32(4): 639-658.

Knie, Andreas, Dagmar Simon & Bernhard Truffer (2003). Reise durchs Grenzland: Ausgründungen als Cross-Over der Wissensproduktion. Forschen – lernen – beraten. Der Wandel von Wissensproduktion und -transfer in den Sozialwissenschaften. Franz, H.-W., J. Howaldt & R. Kopp, edition sigma Berlin: 339-356.

Koschatzky, Knut (2002). Entrepreneurship- und Gründungsförderung an Hochschulen – ein internationaler Vergleich. Gründungsforschungsforum 2001: Dokumentation des 5. G-Forums Lüneburg, 4./5. Oktober 2001. Klandt, Heinz & Hermann Weihe. Lohmar, Josef Eul Verlag: 247-269.

Krimsky, Sheldon (1999). "The Profit of Scientific Discovery and its Normative Implications." Chicago Kent Law Review 75(1): 15-39.

Krimsky, Sheldon (2006). The Ethical and Legal Foundations of Scientific 'Conflict of Interest'. Law and Ethics in Biomedical Research: Regulation, Conflict of Interest, and Liability. Lemmens, Trudo & Duff R. Waring. Toronto Buffalo London, University of Toronto Press.

Krücken, Georg (2003). "Mission impossible? Institutional barriers to the diffusion of the 'third mission' at German universities." International Journal of Technology Management 25(1/2): 18-33.

Larédo, Philippe & Philippe Mustar (2001). Research and Innovation Policies in the New Global Economy. Cheltenham, Edward Elgar.

MER (2005). Les incubateurs d'entreprises innovantes liés à la recherche publique. Définition et politique. www.recherche.gouv.fr/technologie/mesur/incub/, 11.1.06, Ministère délégué à l'Enseignement supérieur et à la Recherche.

Meyer-Krahmer, Frieder & Marianne Kulicke (2002). "Gründungen an der Schnittstelle zwischen Wissenschaft und Wirtschaft – die Rolle der Hochschulen." Perspektiven der Wirtschaftspolitik 3(3): 257-277.

Moray, Nathalie & Bart Clarysse (2005). "Institutional change and resource endowments to science-based entrepreneurial firms." Research Policy 34(7): 1010-1027.

Mustar, Philippe (1997). "How French academics create hi-tech companies: the conditions for success or failure." Science and Public Policy 24(1): 37-43.

Mustar, Philippe (2003). Création d'entreprises à partir de la recherche. Encyclopédie de l'innovation. Mustar, Philippe & Hervé Penan. Paris, Economica.

Mustar, Philippe (2003). Politiques de soutien à la création d'entreprises de haute technologie. Encyclopédie de l'innovation. Mustar, Philippe & Hervé Penan. Paris, Economica.

Mustar, Philippe, Marie Renault, Massimo G. Colombo, Evila Piva, Margarida Fontes, Andy Lockett, Mike Wright, Bart Clarysse & Nathalie Moraye (2006). "Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy." Research Policy 35: 289-308.

Novakovic, Mirjam & Dorothea Sturn (2000). Start-up on Campus - European Models for the Stimulation of Academic Spin-offs. 4. Forum Gründungsforschung, Vienna.

Nowotny, Helga, Peter Scott & Michael Gibbons (2001). Re-Thinking Science - Knowledge and the Public in an Age of Uncertainty. Cambridge, Polity Press.

OECD (2002). Benchmarking Industry-Science-Relations. Paris.

Ormala, Erkki (2001). Science, Technology and Innovation Policy in Finland. Research and Innovation policies in the New Global Economy. Laredo, Philippe & Philippe Mustar. Cheltenham, Edgar Elgar.

OST (2005). Higher Education Innovation Fund round 3: Invitation and guidance for institutional plans and competitive bids, November 2005/46. Office for Science and Technology / Higher Education funding Council for England.

Polt, Wolfgang, Helmut Gassler, Andreas Schibany, Christian Rammer, Nadine Valentinelli & Doris Schartinger (2001). Benchmarking Industry-Science Relations – The Role of Framework Conditions. Vienna/Mannheim.

Potthast, Jörg & Martin Lengwiler (2005). "Arrangements der Wissensproduktion – Akademische Ausgründungen zwischen Forschung und Markt." Sozialwissenschaften und Berufspraxis 28(2): 214-230.

Project Group Science Policy Studies (2006). Production of Knowledge Revisited: The Impact of Academic Spin-Offs on Public Research Performance in Europe. Berlin, Abbreviated description of the research project funded by the European Commission, Discussion Paper P 2006-101, Wissenschaftszentrum Berlin für Sozialforschung, Berlin

Rammer, Christian, Wolfgang Polt, Jürgen Egeln, Georg Licht & Andreas Schibany (2004). Internationale Trends der Forschung- und Innovationspolitik – Fällt Deutschland zurück? Baden-Baden, Nomos.

Rappert, Brian (1997). "University spin-offs in the commercialisation of research – A balancing act." Industry & Higher Education: 270-277.

Rappert, Brian & Andrew Webster (1998). "Links between universities and their spin-offs." Industry & Higher Education 12: 332-338.

Rappert, Brian, Andrew Webster & David Charles (1999). "Making sense of diversity and reluctance: academic-industrial relations and intellectual property." Research Policy 28(8): 873-890.

Stankiewicz, Rikard (1994). "Spin-off companies from universities." Science and Public Policy 21(2): 99-107.

Webster, Andrew & Kathryn Packer (1997). When Worlds Collide: Patents in Public-Sector Research. Universities and the Global Knowledge Economy – A Triple Helix of University-Industry-Government Relationships. Etzkowitz, Henry & Loet Leydesdorff. London/Washington, Pinter.

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