FIRMS' RATIONALES FOR INTERACTION WITH RESEARCH UNIVERSITIES and the principles for public co-funding*

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Abstract

R&D managers at 50 firms randomly selected from all firms who have formal relations with two research universities in Stockholm are being interviewed about their rationales for collaboration. Drawing on this material, a distinctive typology of rationales and the therewith associated effects from cooperative relations is presented. As expected, rationales related to innovation, in terms of invented or improved products or processes, are found to be the main drivers for interaction. As regards the nature of the innovation process leading to innovation, most respondents indicate that "indirect" relationships between collaboration outcomes and successful innovation dominate over "direct" appropriation of results. Contrasting open ended search rationales with pursuit of defined objectives, we find that both types are strongly represented among the studied collaborative linkages. We also find that interaction rationales often go beyond the pursuit of innovation per se; firms also work with university researchers to access academic networks, to develop its human capital and to realise direct business opportunities. The consequences of these findings for policy measures steered towards the strengthening of collaborative university-industry linkages are discussed.

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1 Introduction

Formal R&D related interaction between firms and universities, where both sides signal commitment to the collaborative effort, is probably the type of linkage through which the main *direct* influence of science on the economy is realised (Kaufmann & Tödtling, 2001; Adams et al., 2003). A large number of studies have established a link between collaboration with a university and a firm's ability to innovate (Pavitt, 2003; Laursen & Salter, 2006). However, extrapolating the rationale for R&D subsidies as a solution to a problem which Martin & Scott (2000) refer to as an "innovation" market failure, it has often been claimed that limited appropriation possibilities cause firms to invest less in collaborative R&D with universities than what would be desirable from the point of view of social returns. Motivated by a need to overcome such failures, governments in many countries have set up schemes to encourage and financially support R&D in collaboration between university and industry. Still, the conceptualisation of motives for and effects from collaborative R&D remains poor, and empirical evidence scattered. In this exploratory study, we delineate firms' rationales to interact with universities as an empirically founded typology of rationales. Drawing on this typology, we then discuss how public support for university-industry interaction can be made compliant with firm rationales.

A number of studies have surveyed the information gathering patterns of firms, reporting on which firm characteristics (size, sector, R&D-intensity, innovation search profiles etc) that are typically associated with university cooperation (see e.g. Mohnen & Hoareau, 2002). Other studies have contributed to the understanding of what purposes university knowledge serves in different firms (Klevorick et al., 1995; Cohen et al., 2002). The motives and effects of formalized interaction between firms and universities have been subject to some enquiry. A considerable portion of this literature is based on survey data. While such studies have increased our understanding about how cooperation with universities and the effects of cooperation are distributed among firms of different sizes, from different sectors and with different business logics, only such interaction rationales defined in the survey can be studied. Furthermore, survey results will always suffer from a low level of in-depth information on the context and situation of each unit of analysis, which restricts the understanding of interaction rationales. Findings from survey studies are complemented by case studies on university-industry cooperation, which provide contextual in-depth understanding (Harrysson et al., 2007). However, such studies suffer from inherent problems to establish whether the findings are representative outside the case at hand.

We argue that, as a consequence of a methodological gap between "top-down" survey approaches to the study of interaction rationales and "bottom-up" case study approaches, the question of what rationales that drive firms to participate in R&D collaboration with universities has not been systematically studied in its full scope. Accordingly, it can be suggested that there is a persisting tendency to ignore the full variety of university-industry linkages in the innovation studies literature. We further note that the literature on drivers for R&D collaboration between firms and university researchers reports predominantly from the U.S. manufacturing and life science sectors. The *first* aim of this study is therefore to systematically explore the breadth of rationales driving firms to collaborate with Swedish

universities and to contribute to more precise conceptualisation of how research-related interaction between university and industry affect the innovation processes in firms. Empirically, this study draws on semi-structured interviews with R&D managers at 50 firms which collaborate with at least one of two research universities in Stockholm, Sweden: the Karolinska Institute (KI) and the Royal Institute of Technology (KTH). The studied firms are a randomized subset of all large and medium size firms which maintained a formal relationship with either one of these universities at some point in the period 2003-2005.

Collaborative research between university and industry is often enabled through special public schemes for co-funding. Public intervention is typically motivated with reference to market failures or, in "systemic" approaches, to systemic failures of the innovation system (Foray & Steinmueller, 2003). The conditions for occurrence of these failures and possible designs for co-funding schemes through which these failures can be overcome are studied in a stream of papers (cf. Feldman & Kelley, 2006; Giebe et al., 2006). However, demands on the design of co-funding schemes have hardly ever been studied from the perspective of industry rationales for interaction. As public co-funding works through strengthening of incentives for collaborative R&D, an explorative investigation of what types of co-funding schemes that comply with which types of industry rationales for interaction should enable new insights into the options for public support. The *second* aim of this study is therefore to provide a framework for the design of public co-funding schemes for collaboration, drawing on the refined conceptualisation of firm rationales for interaction following from the first aim. In particular, we wish to examine whether there are important interaction rationales that cannot be successfully pursued with public support, unless this support comes with a set of conditions that involves deviations from standard academic norms.

The rest of this article is organised as follows. Section 2 briefly reviews a relevant set of previous empirical studies dealing with rationales for university-industry cooperation. The selection process of respondents and the series of interviews are described in section 3. In section 4, we suggest a typology for cooperation rationales. Based on this typology, we discuss how public support for intercation (co-funding) must be organized to allow different cooperation rationales in section 5. In section 6, we summarize and offer conclusions.

2 Rationales for university-industry interaction

External research linkages are growing in importance. With increased pressure from (1) increasing international competition, (2) technological evolution and therewith associated increasing complexity of technology and (3) continued shortening of development lead times and product cycles, firms in nearly all traditionally R&D-intensive sectors find that it is not viable to invest in extensive in-house-only research (Gerybadze & Reger, 1999; Tidd et al., 2001). It is clear that the need for the firm to tie its research efforts to research networks is increasing as this development is evolving; more collaboration and stronger management of external relations is needed to reduce the costs and risks of investments in innovation (Hagedoorn et al. 2000; Chesbrough, 2003).

A number of case-based studies have suggested possible mechanisms through which firms benefit from collaboration with universities, including opportunities to leverage research

spendings, recruit young talents, opportunities to collaborate around complementary knowledge bases and accessing advanced equipment (Harryson et al., 2007). In an influential paper, Lee (2000) presents evaluations of reasons to seek partnership with universities from a large survey. The most important reasons for partnering are found to be (1) access to new research, (2) development of new products and (3) maintaining a relationship with the university. However, Lee does not discuss why firms need access to new research, which types of research that are sought or in what way the relationship to a university is valuable for a firm. A number of studies based on the community innovation survey (CIS) can be interpreted as confirmation that cooperation with universities actually help firms to develop new products, at least as regards large manufacturing firms (Lööf & Broström, 2006). Furtermore, exploratory studies from the 1990s (Mansfield, 1998; Beise & Stahl, 1998) have indicated that industrial innovations that could not have been developed without a delay of a year or more in the absence of academic research accounted for approximately five percent of total sales in major firms. The finding of Narin et al. (1997) that the number of academic citations in US industrial patents had increased threefold through the mid 1990s has also been interpreted as evidence that academic research indeed is relevant to modern product development.

Lee's second reason to interact with universities – to promote development of new products – thus seem to be strongly supported by empirical evidence. But the question remains: through what mechanisms does interaction result in innovative products? The nowadays discredited 'linear' model of innovation (Pavitt, 2003) is said to suggest that firms pick up research results produced in academe, which are cultivated into innovation and manufactured products. Obviously, this simplified model of thought needs refinement. Contributions by Cohen et al. (2002), Fontana et al. (2006) and Klevorick et al. (1995) make a distinction between how academic research is used by a firm; for new ideas or for innovation completion? It seems that the latter type of event is at least as common as the first one. In the terminology of evolutionary economics, where technological development is said to expand the state space of the economy (Loasby, 1999), the question can be posed as follows: under which circumstances are the benefits for the singular firm of research collaboration with universities dominated by state space expansion and under what circumstances does collaboration enable a firm to reach a point in state space already identified by the firm? Similarly, in the words of Holmén et al. (2007), the question is when collaboration serves the purpose of creating new or exploring already identified innovative opportunities.

In large parts of the hitherto reviewed literature, there is a prevailing focus on collaboration outcomes in terms of innovation, i.e. novel or dramatically improved products and processes. However, the tendency to limit the analysis to innovation outcomes may lead to serious biases. A growing body of evidence indicates that the major benefits for industry from university research probably emerge from indirect and hard-to-measure processes (Jacobsson, 2002). For examples, Santoro & Chakrabarti (2002) find that while smaller firms, particularly in high-tech sectors, use universities mainly to solve problems in "essential areas central to the business", large industrial firms mainly use cooperation with universities as a

means to build competencies in areas different from the core competence of the firm. Adams (2006) claims that R&D collaboration with universities generates technological opportunities through learning. Other authors have provided a framework that suggests how such effects can be understood. Extending the seminal work on the resource-based view of the firm of Barney (1991), Teece et al. (1997) develop a framework for the study of how organizations develop advantage in rapidly changing industries. Teece et al. suggest that competitive advantage depends on – but does not automatically follow from – a firm's dynamic capabilities, which may be developed through external linkages (Eisenhardt & Martin, 2000). A partly similar view of knowledge related capabilities is developed in two influential studies by Cohen & Levinthal (1989, 1990) who introduce the term absorptive capacity. The authors emphasize that continuous absorbing of knowledge is vital to maintain absorptive capacity within an organization. Building on this concept, Lim (2006) claims that a firm's absorptive capacity depends upon both internal R&D and its' connectedness to external sources of technical knowledge, including university relationships.

We conclude by noting that studies of university-industry partnerships have rendered insights into different rationales for collaboration and that survey-based studies have allowed interesting comparisons between the relative importance of different rationales for collaboration with universities. However, the full scope of rationales for formal R&D interaction has, somewhat surprisingly, not been the object of systematic study.

3 Data collection

The Royal Institute of Technology (KTH) and the Karolinska Institute (KI) are among the most highly respected academic institutions in Sweden. The former specialises in engineering and science, the latter in medicine and biochemical sciences. From data supplied by these research universities, we identify all firms which paid at least 100.000 SEK (app. €9500) in connection to research collaboration with either one of these universities during the period 2003-2005. Each firm was subsequently identified in a public register containing employment statistics, and a small number of firms with less than 25 employees were removed from the sample, as it was believed that the rationale for cooperation among these firms may be too heavily related to the characteristics of key personnel at these firms to be meaningfully compared with the cooperation rationales at larger firms. In particular, we wanted to exclude recent start-ups with origins at either of these universities. 138 firms were identified in this manner. 37 firms collaborating with KTH and 33 firms collaborating with KI were randomly selected, giving us a stratified group of 70 firms. The relative sizes of the two strata correspond to the relative size of each group in our total sample.

For each of these firms, a university researcher collaborating with the firm was identified. The researcher was then asked to identify the proper contact person at the firm; a person who was both personally involved in the collaborative project and who had significant influence over the decision to enter into this particular university collaboration. The firm contacts were then asked to participate in semi-structured research interviews, lasting between 45 and 120 minutes (see questionnaire in Appendix I). About half of the interviews were conducted over the phone, and the rest through personal meetings. In view of the risk

that the views on rationales expressed by "operative" R&D managers may differ significantly from the views of senior managers (cf. Gann & Salter, 2000), top level managers from five of the largest organisations in the sample were interviewed for additional control. Most questions were phrased in an open-ended fashion. In the questions where the respondent was asked to assess a statement or an effect, a four-point Likert scale was used.

For 14 firms collaborating with KI, we were not able to conduct interviews (either the KI researcher or the identified person at the firm denied us to interview her/him, or the information about a proper contact at the firm could not be retrieved), giving us a final stratum of 19 firms. Attempts to contact 6 firms which worked with KTH also rendered negative results, leaving us with a final stratum of 31 firms. The data presented here thus represents 50 firms, which corresponds to 36 % of all collaborating firms with at least 25 employees and 71 % of all firms in the randomly selected sample. Reflecting the combined breadth of the universities, these firms represent a broad set of industries, albeit with an expected dominance (32 of 50 firms) for the manufacturing sector, which includes producers of drugs. Also included are R&D-performing consultancies, subsidiary sales offices of multinational enterprises and, interestingly, insurance companies. As shown in Table 1, most firms belong to multinational groups. 13 respondents were situated outside Sweden. For a fill list of firm names, see Appendix II.

The identified firms did together spend over € 42.000.000 in payments to KTH and KI over the period 2003-2005. KI received almost 80 % of this total sum. It should be noted, however, that the largest single spending comes from a Swedish insurance company collaboratively owned by unions and an employer's confederation. While operating as a private firm, this company's spending of almost € 15.000.000 at KI could be considered an outcome of political rather than straightforward business motives.

	First quartile	Second quartile	Third quartile
Quartiles, grouped by net payments to KTH + KI	€ 44.485	€ 138.287	€ 529.937
Quartiles, grouped by number of employees in group	751	13.577	49.380

Table 1: Net payments and number of employees of studied groups

4 A typology of rationales for cooperation

In this section, we present an analysis of the motives for cooperation and the effects from cooperation, as perceived by the firm respondents. For our purpose of delineating firm rationales for cooperation, we do not find it necessary (or even possible) to make a clear distinction between ex-ante motives and ex-post (experienced) effects. Since the respondents base their ex-ante expectations on the outcomes of a project on previous experience of ex-post effects of formalised interaction, the two are essentially one and the same – in particular for relations with a long history of repeated interactions.[1] We therefore use the word rationale in reference to the broader concept of gains from research related interaction with a university.

[1] 90 % of all respondents indicate that the collaborative project identified by us has been preceded by previous interaction between the firm and the academic research milieu.

Seven questions about the rationale for the interaction with university researchers were posed to all respondents (see Appendix I). The answers to these questions were analysed in search for distinct sets of rationales, suggesting four distinct categories of rationales for cooperation with universities on R&D. These are:[2]

1. *cooperation outcomes for product and process development*
2. *access to academic networks*
3. *human capital management*
4. *direct business opportunities*

Most firms or firm subunits have several rationales for cooperation that may cause the firm to either set up different projects to meet each need or to try to find project designs that allows them to benefit from several types of cooperation effects at the same time (in fact, the latter choice is richly illustrated by the material at hand). Similarly, a firm seeking effects in one category may find that the cooperation brought about unforeseen effects in other categories.

The first type of rationale, which is related to development, is found to be the most complex and the one with the greatest long-term economic potential. The remainder of this section will be dedicated to (1) a closer examination of the group of rationales related to cooperation outcomes for product and process development and (2) the delineation of the latter three of the above categories.

Rationale 1 - cooperation outcomes for product and process development: Analysing the interview material, we identify two dimensions seemingly defining the scope of the observed variety of rationales related to product or process innovation. The first dimension concerns the nature of cooperation outcomes. We find that in some cooperations, the firms report results of a type that are directly available as typical innovations: novel or improved products or processes (although some form of 'translation' to firm and market conditions generally is necessary).[3] Yet other cooperation projects which the respondents describe as successful and important cannot be linked to the introduction of "innovations", other than through the expectations of the respondents on the longer-term effects of the R&D efforts and as a driving motivation for the investment in collaborative R&D. We interpret this category of rationales as attempts to expand the dynamic capabilities of the firm (Teece et al., 1997/2000), and note that while some respondent discuss this intention in a context of formulated R&D strategy, other respondents give more vague account for how interaction outcomes will enable successful innovation.

The second dimension concerns the level of precision of the firm's engagement. We find that some cooperations are motivated by a hope that cooperative research shall create new innovation opportunities, while some cooperations are motivated by the will to work on a

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[2] We recognise that opportunities to leverage R&D budgets through public co-funding of collaborative research help some firms reduce risks and cost of R&D, and therefore can be considered a rationale in itself. However, since this paper seeks to establish a typology that can be used to discuss terms for public co-funding, we do not consider the pursuit of such funding as a separate rationale.

[3] In this context, we do not differentiate between physical products and services, but rather use the term 'product' in a more generalized fashion.

problem or a technological opportunity identified and defined by the firm. A similar dichotomy is found in the study by Cohen et al. (2002), where a difference between "ideas for project" and "project completion" is outlined. In the terminology of evolutionary economics, we would say that some collaborative efforts are motivated by ambitions to expand action (state) space, others are motivated by ambitions to reach an identified point in action (state) space (Loasby, 1999).

In figure 1, the two dimensions are presented as a two by two matrix. The four combinations that are revealed through this exercise each is a distinct observed rationale for interaction with university researchers

		Does the firm seek to develop a **defined** opportunity for innovation?	
		No	Yes
Is there a "**direct**" link between interaction outcomes and invented or improved products or processes	Yes	Rationale 1.4 - Commercialization of academic research	Rationale 1.3 – Problem solving
	No	Rationale 1.1 – Orientation, learning and broadened perspectives	Rationale 1.2 – Supportive research

Figure 1: Four sub-rationales related to product or process development

In the first quadrant, called **orientation, learning and broadened perspectives**, we find exploratory projects carried out with a relatively long perspective. The firm seeks orientation and competence development – an important form of dynamic capabilities – rather than innovation per se. For firms with innovation processes related to research and innovation, creating or maintaining absorptive capacity are important objectives for cooperation. But there are also forms of orientation which are related to identifying business opportunities and business threats rather than to the promotion of absorptive capacity. One form of orientation that firms seek in this category is knowledge about changing social and regulatory framework conditions (Scott, 2001). A related form of orientation is an ambition to find new applications for a firm's core competencies or technologies.

The second quadrant, entitled **supportive research**, represents rationales where the firm works on a defined task which is only indirectly associated with the firm's products or processes. A related set or observed rationales which fit into this category is the case where the firm has a clear objective, but one which nature is such that it cannot – due to the nature of the problem or to stakeholder demands – or shouldn't be translated into a project of type 1.3 (applied research).

Problem solving, where the firm commissions a university partner with a task which is directly linked to product or process innovation, is our third quadrant. This is the typical example of "applied" problem solving. Interaction may entail e.g. measurement tasks, validation of product characteristics, consultancy on specific aspects of product or process development or, in the medical case, of clinical trials.

Finally, we have interaction rationales related to the **commercialization of academic research.** This quadrant is meant to comprise rationales fitting with the 'linear model' of

knowledge transfer. A firm cooperates with a research group whose potential to create commerziable research they perceive as very high, hoping to acquire IP assets and/or to create technology transfer directly available for improving the firm's products or processes. In some cases, a new venture is created by the firm as the result of this type of commercialization.

Rationale		**Illustration 1**	**Illustration 2**
1.1	Orientation, learning and broadened perspectives	A large ICT firm which worked with KI to learn more about how the firm's core competencies and technologies could be used within a context of gene databanks – an application area that the firm believed to have a large commercial potential.	A consultancy which worked with KTH researchers to learn certain simulation programmes and technique, which the firm believed would give them an important advantage over competitors and help the firm maintain a reputation as business leader.
1.2	Supportive research	A large pharmaceutical firm which seeks new applications for its existing drugs, and therefore explored the pathology of a specific decease in collaboration with KI researchers.	A large ICT firm which worked with KTH in the field of behavioural sciences to understand how the services of the firm are used and perceived.
1.3	Problem solving	A large pharmaceutical firm for which KI and associated university hospitals were a valuable partner for clinical trials.	A research intensive medium sized firm needing to concrete (consultancy type) assistance in some areas where the firm lacked adequate competences.
1.4	Commercialization of academic research	A small firm specialised on the organisation of clinical trials which used its collaboration with KI to identify and commercialise (with external support and funding) university research results in collaboration with individual researchers.	An engineering firm which investigated opportunities for innovation in a consortia setting at KTH and ended up launching a spin-off firm based on research discoveries made in the consortium.

Table 2: Illustrative examples of rationales 1.1 – 1.4 from interviews

While much of the literature on university-industry relations is focused on outcomes in terms of innovations, our interviews reveal that formalised R&D interaction between firms and universities have a broader scope. Three further distinct rationales have been identified.

Rationale 2 - access to academic networks: The networks maintained by successful academics are part of the attractiveness of universities as cooperation partners. When working with a particular academic, the firm can benefit from some of the expertise of her or his contacts, as the academic discusses and learns from colleagues with special expertise. These types of benefits are part of all rationales related to cooperation outcomes for product and process development (type 1). However, we find that the prospect of gaining acces to academic networks can motivate firms to enter research collaborations with universities in

further ways, which are not directly related to the content of the cooperation project per se. First, for firms with continous needs for expert competences, contacts to academics outside the collaborating group may help the firm to identify important sources of expertise ("screening") and facilitate future search for critical competencies in academe. Second, we find many examples where firms who collaborate with universities through participation in a consortium with other firms benefit from this interaction. Around the academic project, discussion with competitors can be held on "neutral grounds" and new potential customers can be idenfied among the firms with similar interests participating in the consortium. Both benefits can be understood as increasing the dynamic capability of the firm (Zaheer & Bell, 2005). Furthermore, we note statements to the effect that working in university-lead consortia can offer significant opportunities to leverage R&D investments with funds from other firms, universities and through the co-funding of government.

Rationale 3 - human capital management: This group of rationales is related to recruiting and retaining qualified personnel, as well as to motivation to support academic groups to secure the availability of scientific cooperation partners in areas critical for the firm. Collaboration allows the firm to identify candidates for recruitment from the ranks of graduate and undergraduate students. Through allowing their researchers to interact with university departments, firms are also able to increase its attractiveness as employer for skilled professionals. Furthermore, by supporting research groups active in scientific areas of particular interest to the firms, firms can influence the university agenda, e.g. to promote activities of importance for the firm. The existence of a competent research group active in an important area can have a number of beneficial effects to the firm: it may (1) facilitate the recruitment of young researchers with fresh knowledge in important fields, (2) influence undergraduate education, which increases the availability of competent graduates that the firm may recruit and (3) secure the availability of scientific cooperation partners for the firm. Again, these benefits can be understood as increases in the dynamic capability of the firm.

Type 4 - direct business opportunities: In some cases, the rationales for cooperation follow a straightforward kind of business logic: the firm has direct business rationales for cooperation with a university. These kind of rationales may apply to firms who 're-package' and sell academic knowledge or special competencies and firms for whom academics are important opinion leaders. In the latter group, we find many firms in the biotechnical and pharmaceutical sectors, for whom judgements on drugs, methods and firms are extremely important. In highly specialized fields of knowledge, leading experts may play critical roles for such judgements. For some firms, finally, researchers and universities are important customer groups (laboratory equipment, new drugs, new software, etc).

Rationale		Illustration 1	Illustration 2
2	Access to academic networks	A large pharmaceutical firm for which screening is a daily activity taken very seriously and managed professionally.	An engineering firm which found important new clients through participation in a research consortium sponsored by the EU.
3	Human capital management	A large engineering firm which is very clear about their priorities in research cooperation with KTH: the prime objective is to secure long term recruitment and to support academic research competence in fields close to the core competencies of the firm.	A large pharmaceutical firm which saw cooperation with university researchers as important for making the firm an attractive employer for the skilled specialists it needed, since cooperation allows firm scientists to work with bright minds in academe and to pursue some of their academic interests in co-publications.
4	Direct business opportunities	A firm specialised in the organization of clinical trials, for which the conditions for clinical research in the Nordic countries was a considerable competitive advantage.	An engineering consultancy which produces technical overviews and outlooks to paying customers in cooperation with leading KTH researchers.

Table 3: Illustrative examples of rationales 2-4 from interviews

While rationales and effects for R&D cooperation with universities surely can be described under a different categorisation, we claim that the typology proposed in this section has certain attractive features. It is applicable to both medium-sized and large firms as well as to firms in a broad set of sectors. Furthermore, the typology is constructed in such a way as to allow an analysis of how each type of motive/effect can be promoted through public co-funding of cooperative research.

5 Driving strength of the respective rationales

While the above typology helps us conceptualise possible rationales for interaction with universities, the reader is yet to be convinced that all of these rationales are significant factors driving R&D interaction. In this section, we therefore briefly review the relative occurrence of each type of interaction rationale in our sample of interviews. Although the sample size is too small to allow rigorous inference analysis, we present the results as tentative indications of whether the observed rationales are important drivers of interaction, or mainly irrelevant or very unusual.

In our interviews, we asked respondents to identify a single most important rationale for interaction with the Swedish university. We also discussed the wider benefits of this R&D cooperation. As indicated by Table 4, rationales related to product or process development is found to be the dominating driver of university-industry R&D collaboration. However, there are notable exceptions. Three respondents in our sample state that rationales related to human capital management are more important than the actual content of the collaboration, and that the firm has such an interest in the production of human capital that this interest

alone motivates investments in collaboration. Eight further respondents state the main driver for cooperation in ways which we interpret as compliant with the fourth type of rationale (rationales related to direct business opportunities). For 23 further respondents, business opportunities not directly related to innovation are an important side-rationale for interaction – mainly in the form of branding and marketing effects. As this category of rationales is almost absent in the literature of university-industry relations, we find the high frequency of such responses to be a very interesting call for further efforts to understand the marketing value of formalised interaction with research universities and to study the firms with business models in symbiosis with academic environments. We also note that only one respondent described what was interpreted as a rationale of type 2 (access to academic networks) as a prime driver. For most cooperation projects in the type 1 rationales, however, access to academic networks is an important side effect and co-motivation.

Rationale		Single most important rationale[4]	Part of rationale
1	*Cooperation outcomes for product and process development*	36,5	46
1.1	*Orientation, learning and broadened perspectives*	15	-
1.2	*Supportive research*	7	-
1.3	*Problem solving*	12,5	-
1.4	*Commercialization of academic research*	2	-
2	*Access to academic networks*	1	35
3	*Human capital management*	3	16
4	*Direct business opportunities*	7,5	24

Table 4: Frequency of rationales for interaction

The literature on university-industry relations has a prevailing focus on innovation as the outcome of collaborative contacts. While our findings do not contradict the assumption that firms seek competitive advantages in the form of increased innovative output, they illustrate the complexity of linkages between investment and output and suggest that indirect mechanisms such as learning, competence creation and network building are at least as important as the direct results of collaborative R&D efforts with universities. These findings support previous assertions that the work of universities only rarely translates into new products or services (Pavitt, 2001) and contradict notions of university research as being ready to use "off the shelf" for collaborating firms (a case discussed as important by e.g. Colyvas et al., 2002 and Cameron & Wallace, 2007). Furthermore, these findings raise questions about to what extent the prevailing focus on measurement of patents, start-ups, etc in the literature evaluating the value of publicly supported university-industry partnerships are seriously biased (Siegel & Zervos, 2002).

6 Supporting university-industry interaction

Given the typology of rationales presented in the previous section, how can we understand the demands on the forms of public co-funding? In particular, to what extent are demands

[4] Of the 50 firm respondents interviewed, two were unable to identify an explicit priority for collaboration objectives, giving a sum total of 48 answers. In four cases, the respondents have been unable to set a priority between two types of rationales. In such cases we assigned 0.5 to each category.

on co-funding compliant with the standard norms and quality criteria of academic research? This question is at the centre of our interest, since it represents the clash between industrial and academic norms that is reported to be a leading barrier to interaction (Siegel et al., 2003).

As interpreted by Ziman (2000), the "Mertonian" or CUDOS norms of science (cf. Merton, 1942) state that research should be judged on universal, scientific criteria only and that no other interests than the scientific interest should guide research. A first deviation from standard academic norms is therefore when an external actor (in this case the firm) is involved in problem formulation tasks as a condition for funding. As reported by Benner & Sandström (2000), public co-funding schemes with funding terms meant to "internalize the interests of science based sectors" have been implemented in many countries. However, academics may hesitate to enter such collaborations (Lee, 1998).

A second, and perhaps more controversial deviation from standard academic research terms, is when other criteria than those of classic academic research are assigned importance in the allocation of research funds. In our case, it may be that certain effects can only be achieved with the support of public co-funding when this funding is rewarded on its merits in terms of application-oriented problem solving rather than fundamental understanding (cf. Gibbons et al., 1994; Stokes, 1997). However, since high demands on fundamentality of research generally are associated with spillover effects to the wider economy (Feldman & Kelley, 2006), funding "applied" projects may be considered an inefficient public policy (Mowery, 1998).

For each type of rationale identified in the typology of the previous chapter, we formulate two key questions:
1. Can firms interact with this type of rationale if it has no or very limited influence over the problem formulation task?
2. Can firms interact with this type of rationale when participating in projects where the academic value of the research in terms of fundamentality and novelty is the dominating norm?

To answer these questions, we examine the logic of the respective rationales. For the first question, answers for each rationale are straightforward. In particular, answers for the rationales related to innovation (types 1.1-1.4) follow directly from the definitions given in Section 4. For the second question, each answer is based on more of ad-hoc suggestions, which could be examined more closely in follow-up studies.

As shown in Table 5, these two questions have different answers for different interaction rationales. First and foremost, the four different rationales related to product and process development each have different configuration of demands on the two questions above. Rationales related to orientation, learning, and broadened perspectives (1.1), rationales related to commercialisation of academic research and rationales related to access to networks and to human capital management are found to be mostly "unproblematic", in the sense that they comply well with academic norms and standard quality criteria. We also note several interview statements pointing out that some kind of leveraged funding is more or less a prerequisite for being able to "afford" engagement in research belonging to these

categories – an argument that fits well with the "network failure" motivation of public support and with the findings of e.g. Link & Scott (2001). Rationales related to problem solving (1.3) and direct business opportunities are the most problematic types, in the sense that they fail to comply with both the norms of "freedom of research" and with standard quality criteria. Rationales related to supportive research stands out as an interesting "special case", in that it complies with academic quality criteria but stands in conflict with the standard academic norm, in which problem formulation is supposed to arise from within the academic community.

Rationale		Compliant with low firm influence over problem formulation?	Compliant with high demands on generalized results and novelty of research?
1	*Cooperation outcomes for product and process development*		
1.1	*Orientation, learning and broadened perspectives*	Yes	Yes
1.2	*Supportive research*	No	Yes
1.3	*Problem solving*	No	No
1.4	*Commercialization of academic research*	Yes	Yes
2	*Access to academic networks*	Yes	Yes
3	*Human capital management*	Yes	Yes
4	*Direct business opportunities*	No	No

Table 5: Conditions for public co-funding and different rationales for interaction

7 Conclusions

This study has reported a systematic enquiry of firm rationales for formalised interaction with two research universities in Stockholm. We find that the scope of rationales for university-industry R&D interaction is broader than what is usually captured in survey-based studies. A further finding of this study is that it is generally easier to find support for "indirect benefits" for innovation than for effects of a more "direct" kind among the respondents. For some firms, interaction with universities seems to be a way to generate dynamic capabilities rather than to create outputs traditionally understood as "innovations". Important mechanisms through which dynamic capabilities are generated include human capital management and increased access to academic networks. Furthermore, many firms enter formalised relations with university researchers in order to create internal abilities to recognize the value of external knowledge, assimilate it, and apply it to commercial ends (absorptive capacity). Previous research has found that ideas for innovations come from customers, clients and (to some degree) from competitors (Klevorick et al., 1995, Cohen et al., 2002). Our results suggest that for some firms, interaction with universities is a way to increase a firm's ability to translate market opportunities from these sources into technical or organizational problems. These problems may or may not be tackled in further interaction with universities – the greatest and most unique competence sought in academe is in many cases the overview and the commitment to problem solving.

The typology of rationales presented in this paper has been constructed to facilitate closer examination of what firm needs (which types of interaction rationales) that are served by

different kinds of public cooperation support schemes. In particular, we observe that some interaction rationales are compatible with co-funding terms close to the traditional norms of academic science, where demands of industry involvement are the strongest additional terms on funding. Three identified rationales, however, seem to conflict with the "purist" view of academic freedom of research. To comply with these rationales, co-funding schemes have to be designed in such a way as to allow "applied" results and/or industry participation in the formulation of research agendas.

Two main lessons for public policy emerge from our findings. First, if a large part of the benefits derived from university relations is of an indirect nature rather than related to more easily measurable "concrete" innovations it is hardly recommendable to restrict public co-funding of collaborative research to settings that emphasise outcomes of a concrete, direct nature (number of patents, number of spin-offs, etc) for funding distribution and evaluation. (D'Este & Patel, 2007). Second, to meet the broader needs of industry, it may be necessary to consider supporting collaborative R&D in forms that compromise academic standard norms to some extent. In particular, forms of co-funding where demands of fundamentality and novelty are combined with demands on industry participation in the formulation of research agendas can be considered a feasible form to meet an important part of industry demands while preserving the values of research funding for societies and national economies. Such arrangements would for instance be crucial in publicly stimulated development of generic, use-inspired technologies.

More generally, the findings on interaction rationales and the resulting framework for public co-funding can be seen as supporting Lundvall (2007), who suggests that the literature on university-industry relations and innovation policy suffer from a serious bias, in that "local tendencies in pharmaceuticals and biotechnology in the USA have been generalized to the relationships between university and industry in general". The findings of this study, which draws on two Swedish universities representing a wide range of academic disciplines, suggest that a wider perspective on both interaction rationales and possible policy responses are needed to further our understanding of the role of university-industry linkages in modern economies. While outside the scope of this article, the interview material of this study suggests that different interaction rationales are associated with different firm characteristics such as size and R&D intensity, and that demands on geographical proximity to the collaboration partner differ with interaction rationales. By using interaction rationales as a starting point, future studies can provide better understanding of the relationships between firm characteristics, geographic distances and the distribution of spillovers from publicly funded research.

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Appendix 1: Excerpt from Interview Guide

The following guide was used for the interviews in this study. The heading for each investigated area is denoted, but all questions not directly related to rationales for cooperation are removed.

A. Basic facts/information about the firm and its research

(A9) What university units have you been interacting with (centres, institutes, departments, research groups)?

(A15) Do you cooperate with *other firms* on research and innovation?

- ☐ Yes
- ☐ No

(A151) Around the same business problem areas as with [KI / KTH]?

- ☐ Yes
- ☐ No

B. The decision to cooperate

(B1) If you were forced to motivate to your board why you spend precious time and resources collaborating with this particular University, what would be you foremost answer?

- ☐ Recruitment
- ☐ Promotion of technological and/or product development*
- ☐ Sharing / access to equipment and laboratories
- ☐ Affecting the university agenda

(B11) *Promotion of technological and/or product development* →

(1) Do you demand concrete results that can be adopted by your internal R&D teams*

or

(2) is it more important to promote learning and to become informed about technical development ?

***concrete* → what is most important…**

(1) access to concrete ideas for business opportunities (*what* to do)

or

(2) concrete assistance in developing opportunities already defined by your firm (*how* to do it) ?

(B112) Are Universities mainly partners to perform R&D in a cost/risc effective way, or is cooperation with Universities mainly a complementary activity to internal R&D, fulfilling other functions?

- ☐ Cost / risc dominates (1)
- ☐ Other factors dominate (2)

(B2) Why did you choose to cooperate with this particular university (KTH/KI)? Is there an alumni effect?

(B3) Describe a typical innovation cycle (from ideas via tests and development to product on the market). What parts of this process are facilitated by university cooperation?

- ☐ Innovation ideas (identifying the possibility / opportunity)
- ☐ Innovation development / supplementation (supporting technology etc)
- ☐ Innovation completion (supporting technology etc)

(B4) When assessing potential research partners, what personal characteristics are important? What is important to assess?

(B5) Do you work *continuously* with the university (on research and innovation issues)?*

Continuous: active relations resulting in monetary and/or personnel exchanges that has wider span than a specific research issue and that (are intended to) last more than one year.

- ☐ Yes (in X projects)
- ☐ No (in X projects)

Yes → (B51) Why? (i.e. what would you loose if you only cooperated temporary, in times when you have special needs)

No → (B52) If not, how is a typical cooperation initiated?

C. Effects / evaluation of cooperation

(C1) We would like you to evaluate your cooperation. Please grade to what extent you can agree with the following statements on different effects using a four point scale where:

1 – not at all, 2 – to some extent, 3 - beneficial effects, 4 – great effects.

(If 1-2: did you expect better results within the area?)

- ☐ *Identifying* opportunities for innovation (C11)
- ☐ *Realisation* of innovation opportunities and development (C12)
- ☐ Enabling *further contacts* (C13)
- ☐ Outside-in-view of our technology/*broadened perspectives* (C14)
- ☐ Recruitment (C15)
- ☐ Branding of product and/or firm, *scientific legitimacy*. (C16)

D. Demands on the university

E. R&D Decision processes of the firm

(E3) Has collaboration with universities been *critical* to the firm's success? Do you see it as *critical* for future success?

Appendix 2: Respondents

Respondents from the following firms agreed to be interviewed about rationales for research interaction with universities, effects from interaction and attitudes towards different aspects of reform in universities.

ABB Corporate Research
ABB Robotics
ACADIA Pharmaceuticals
Advancesis
Aerocrine
Aerotech Telub
ÅF Infrastruktur
AFA
Alfa Laval
Arla Foods
AstraZeneca
Beltone
Biolipox
Biovitrum
Bombardier Transportation
Cenergie
Eka Chemicals
Ericsson
Fresenius Medical Care
Gambro
GlaxoSmithKline
Grundfoss
Höganäs
IBM
KaroBio
Linde Gas Therapeutics
Länsförsäkringar
Lundbeck
Medtronic
Merck
Nokia Research Center
Nordic Managment of Clinical Trials
Novozymes
OJI Paper
Opcon
Organon
Osaka gas
Q-med
Pfizer
Rieter Automotive
SAAB Bofors Dynamics
SAAB Ericsson Microwave Systems
SAAB Systems
SCA
Scania
Shell Research
Siemens Industrial Turbomachinery
Smerud Medical Research International
SUN Microsystems
TeliaSonera
UPM-Kymmene (United Paper Mills)
Volvo Aero
Volvo Technology
Wyeth