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**External commercialization of knowledge:
review and research agenda**

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Abstract

Companies increasingly make use of the external knowledge exploitation, i.e. the commercialization of disembodied knowledge, although they often perceive considerable difficulties in managing the external commercialization tasks. These difficulties are partly due to the imperfections of the markets for knowledge, which, however, may be mastered by an adequate management as the examples of various well-known companies show. In combination, these facts point to the need of research into the external exploitation of knowledge. A thorough analysis of past research confirms this need and shows that the existing literature is highly fragmented. By integrating the main findings of the different research streams, we establish a detailed overview on the literature on external knowledge exploitation. The key characteristics and the main forms of externally commercializing knowledge are presented. Then, major imperfections in the markets for knowledge are examined, and the increasing importance of the topic in practice as well as primary reasons for this trend are described. Afterwards, major strategic and monetary objectives and the risks of commercializing disembodied knowledge are identified before turning to the management of the external knowledge exploitation, particularly regarding strategies, processes and structures. Apart from reviewing the literature, a research agenda, which describes promising paths for future research, is set up based on past research results and findings from other fields, particularly the internal knowledge exploitation and the external knowledge acquisition.

Introduction

As competition has become increasingly knowledge-based (Amesse and Cohendet 2001), a firm needs to develop a detailed understanding of its knowledge and its knowledge management competencies (Lane and Lubatkin 1998). Drawing on the view that the scope of a firm may be defined in terms of its product range and its knowledge range (Grant 1996a), an efficient use of a firm's knowledge requires congruence between its knowledge base and its range of products or services which, however, usually does not exist in practice (Grant 1996b). This lack of congruence leads to the markets for knowledge, in which knowledge is regarded as an economic good itself (Granstrand 2000a) and in which firms may act as suppliers and buyers of knowledge (Teece 1981). Thus, companies should not only attempt to be successful on the markets for products or services on which they compete but they should adopt a multi-level perspective including end products, intermediate output and disembodied knowledge (Bidault and Fischer 1994; Tschirky *et al.* 2000; Koruna 2004).

Accordingly, companies do not only have to build up the ability to manage knowledge internally, i.e. the internal generation, accumulation and exploitation of knowledge, but also need the ability to manage the acquisition and emission of knowledge in order to realize the potentials inherent to their knowledge assets and to adequately manage the knowledge transactions (Ford 1988). Due to the imperfections of the markets for knowledge, such transactions of disembodied knowledge are much more difficult and complex than transactions on product markets (Teece 1981; Bidault and Fischer 1994; Arora *et al.* 2001b).

Despite these difficulties, many firms actively use the external acquisition of knowledge since the 1990s (Granstrand *et al.* 1992; Kurokawa 1997; Veugelers and Cassiman 1999). Only in recent years, also the external exploitation of knowledge has become a growing phenomenon in practice (Arora 1997; Gans and Stern 2003; Kline 2003). Increasingly, firms consider the external knowledge commercialization a proactive activity, which is part of their overall business strategy and may include all company knowledge going far beyond a residual activity of commercializing unused knowledge assets (Rivette and Kline 2000b; Amesse and Cohendet 2001). As the increase in the external exploitation of knowledge is rather a trend from practice pioneered by firms, such as IBM (Kline 2003), than a movement initiated by academic research, scientific interest in the external exploitation of knowledge has grown only recently (Tschirky *et al.* 2000; Granstrand 2004; Koruna 2004). The external exploitation of knowledge is understood as the direct commercialization of disembodied knowledge including tasks prior to the actual knowledge transfer, such as the identification of

commercialization opportunities. This perspective draws a much more comprehensive picture of the activities and capabilities that are required for a proactive commercialization of company knowledge than the mere examination of knowledge transfer as the final step of the external knowledge commercialization process.

After some early research approaches (e.g. Teece 1981; Ford 1985, 1988), there has not been a continuous research stream concerning external knowledge exploitation, and the relevant literature is highly fragmented, corresponding to the different forms of commercialization and the different types of knowledge to be transferred. Therefore, important results of past research into the external exploitation of knowledge may be found in research fields, such as alliances or markets for knowledge although many of the papers in these areas take a knowledge acquisition perspective (Bozeman 2000; Arora *et al.* 2001b). In recent years, interesting insights have emerged from research into intellectual assets, intellectual capital and intellectual property. While the literature on intellectual assets has been focusing mostly on the internal aspects of knowledge management (Bontis 2001), at least some works among the literature on intellectual capital and intellectual property explicitly include the option to commercialize knowledge externally (Granstrand 2000a, b; Teece 2000). Often, however, the external exploitation of knowledge is only seen as a side aspect.

Today, two facts underline the need for further research into external knowledge exploitation: on the one hand, the external commercialization of knowledge is increasing against the background of the imperfections of the markets for knowledge (Kline 2003; Guilhon *et al.* 2004; Koruna 2004); on the other hand, many companies experience considerable difficulties in managing these activities, especially regarding the identification of external commercialization opportunities (Sullivan and Fox 1996; Elton *et al.* 2002; Birkenmeier 2003). As to our knowledge no review of past research into the external exploitation of knowledge exists, we examine in this article both theoretical foundations and major empirical studies in this area. We consider the literature that adopts the perspective of external knowledge exploitation and knowledge marketing but also take into account relevant results from other fields, such as knowledge transfer and alliances. The review focuses on the external knowledge commercialization of companies whose main business is the internal knowledge exploitation, i.e. the application of technologies in own products and/or services, and not of firms that mainly provide R&D services (e.g. Chiesa *et al.* 2004).

By compiling essential results of the fragmented literature, we hope to establish a detailed overview on the state-of-the-art of research into external knowledge commercialization, to

provide an adequate framework and basis for future research and to encourage further academic work on this important issue. Beyond reviewing past research, we attempt to establish a research agenda by indicating the areas where major theoretical and empirical work is required and by proposing promising paths for future research. Obviously, the research questions that are presented may not constitute a comprehensive description of issues to be analyzed but are rather aimed at pointing out various aspects of high relevance, which have been identified by comparing the current state of research with other research areas and with the trends and difficulties perceived in practice.

The remainder of the paper is structured as follows. In the next section, we define external knowledge exploitation and describe its various forms. Then, we examine major imperfections in the markets for knowledge and show the relevance and increasing importance of external knowledge commercialization. Afterwards, the objectives and risks of commercializing disembodied knowledge are analyzed. The section on the management of the external knowledge commercialization addresses the strategy and integration of external knowledge exploitation activities in a firm as well as processual and organizational challenges. Eventually, empirical studies into the external knowledge exploitation are highlighted, and an agenda for future research is presented before arriving at a conclusion in the final section.

Definition and forms of external knowledge commercialization

The perspective of actively managing the external knowledge exploitation as the commercialization of disembodied company knowledge was first adopted in the 1970s (Ford and Ryan 1977; Anderson 1979; Lien 1979; Marcy 1979) mainly in the field of technology management. Particularly through the works of Ford (Ford and Ryan 1977, 1981; Ford 1985, 1988), who coined the term ‘technology marketing’, a holistic approach to the external exploitation of knowledge was established going beyond prior research, which primarily considered specific aspects, such as international licensing agreements (e.g. Lee 1958). Many articles concerning technology marketing, however, do not refer to the commercialization of disembodied knowledge but rather to the commercialization of technology-based products (e.g. Nevens *et al.* 1990). Overall, the perspective of technology marketing or the external exploitation of knowledge was adopted only in few works until the end of the 1990s which is why findings from other research streams have to be considered as well.

We use the term ‘external knowledge commercialization’ instead of ‘technology marketing’ or ‘knowledge marketing’ because it permits to integrate the external knowledge commercialization activities into a more comprehensive approach to a company’s knowledge management activities. Regarding technological knowledge, such an approach has been established by Brockhoff (1999), who differentiates between the acquisition, accumulation and exploitation of knowledge, which can all be realized either internally or externally (Fig. 1). From the field of technology, this approach may be directly transferred to other knowledge areas, where similar classifications of the knowledge management tasks have been used (e.g. Nonaka and Takeuchi 1995; Grant 1996b; Spender 1996; Probst *et al.* 2000).

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Fig. 1: Different knowledge management tasks on internal and external level (Source: adapted from Brockhoff 1999a, p. 153)

This approach shows the complementary roles of internal and external knowledge commercialization in a firm’s knowledge exploitation strategies and the opposite roles of external knowledge exploitation and external knowledge acquisition in a firm’s knowledge transaction strategies. While external knowledge exploitation describes the commercialization of disembodied knowledge, internal knowledge exploitation refers to a firm’s activities of innovation, i.e. the internal application of knowledge in the firm’s own products and/or services, which are then commercialized. The external knowledge acquisition, in contrast, describes the tasks of absorbing existing knowledge from outside the firm. In some works on technology marketing, both the external acquisition and exploitation of knowledge are taken into account when using in the expression ‘technology marketing’ (Tschirky *et al.* 2000; Escher 2001). However, we focus on the exploitation perspective because it has received considerably less attention than the acquisition perspective which was studied rather intensely during the 1990s (e.g. Granstrand *et al.* 1992; Kurokawa 1997; Veugelers and Cassiman 1999).

The concept of external knowledge commercialization goes beyond the mere outward transfer of company knowledge, which only represents the final stage of the commercialization process. Apart from the transfer of knowledge, external knowledge commercialization includes management tasks, such as the identification of potential customers, which have often been neglected in research on knowledge transfer. As most companies perceive major difficulties in carrying out the tasks prior to the actual knowledge transfer, especially when they try to proactively commercialize knowledge (Ford and Ryan 1977; Bidault and Fischer 1994; Birkenmeier 2003), the perspective of external knowledge commercialization

constitutes in this respect a more adequate framework than the mere consideration of knowledge transfer.

While in past research approaches, the external commercialization of knowledge is often not exactly defined and various differences in the conceptualization of external knowledge exploitation may be identified, there are various major aspects that the approaches have in common and that may be regarded as a theoretical foundation for both this article and future work. Thus, in the following, important characteristics of the external mode of knowledge commercialization are described, pointing out differences that exist in their conceptualization according to different approaches in the existing literature.

In the external exploitation of knowledge, *the economic good is the knowledge itself*, which is commercialized in disembodied form (Granstrand 2000a). In this context, it is important to distinguish between companies that are offering a service and those that are externally commercializing knowledge. A company offering a service provides an intangible product, e.g. consulting services, based on its knowledge and competencies, which are not imparted to the customer. A company that externally exploits its knowledge, in contrast, directly commercializes its knowledge and transfers it to the customer (Ford and Ryan 1977). While this perspective is common to all works in the existing literature, Tschirky et al. (2000) additionally include in their framework the commercialization of production processes through the material results of the technologies used. The definition in this article, however, only refers to the commercialization of disembodied knowledge.

Regarding *the type of knowledge to be commercialized*, many works in past research limit their analysis either to particular knowledge areas, mainly to technological knowledge (e.g. Ford and Ryan 1981) or to knowledge in a particular form, mainly to knowledge protected by intellectual property rights (e.g. Anderson 1979). By broadly referring to knowledge as the object to be commercialized, a holistic perspective is taken in this article. Since the focus of the external knowledge exploitation perspective is on managing the external commercialization activities, such an integrated approach seems appropriate because the managerial challenges are largely the same in the commercialization of different types of knowledge.

Consistent with the commercialization of embodied knowledge, which includes the transfer of goods and/or services, the external knowledge exploitation involves *interorganizational knowledge transfer* (Ford 1985), i.e. the transfer of knowledge to another legally and economically independent organization. While the transfer of knowledge between different

company units may represent an external exploitation from a business unit point of view, this does not constitute a commercialization of knowledge from a corporate perspective.

Furthermore, the external exploitation of knowledge is regarded as a *deliberate action of the company*. Accordingly, it refers to the intended transfer of knowledge and thus does not take into account the unplanned loss and leakage of information (Granstrand and Sjölander 1990). Due to the focus on the management tasks of the external exploitation option, knowledge leakage is mostly excluded in past research (Ford and Ryan 1981; Granstrand 2004).

Usually, the external knowledge exploitation is assumed to include some type of *contractual obligation*. While informal ways of externally exploiting knowledge, such as informal know-how trading, are important in practice (von Hippel 1987; Schrader 1991), they are normally initiated by individuals and often do not follow an explicit strategic intent of the company (Boyens 1998). As such, these informal types of deliberate external knowledge exploitation can hardly be integrated into a company's knowledge exploitation strategy and are therefore excluded from the further analysis.

A contractual obligation already indicates that the company will usually receive some type of *compensation* for the transfer of knowledge. While in the commercialization of products or services monetary compensation is by far the most common form, the direct commercialization of knowledge offers various other possibilities, such as bi-directional knowledge transfers, which are frequently used in practice (Koruna 2004). Examples are cross-licensing agreements or the mutual exchange of knowledge in alliances (Grindley and Teece 1997).

Finally, most research approaches adopt explicitly or by implication a *process perspective* (Ford and Ryan 1981; Tschirky *et al.* 2000; Escher 2001). As it has already been stated above, the external knowledge exploitation perspective puts emphasis on the management tasks in the process stages prior to the actual knowledge transfer. Particularly, it includes the planning of the external knowledge exploitation activities as well as the identification of external commercialization opportunities and potential knowledge customers (Ford 1988; Tschirky *et al.* 2000).

Having identified the major characteristics of the existing concepts of external knowledge exploitation, we now specify the meaning of the term 'external knowledge commercialization' on the company level. Drawing on elements of the definition by Boyens (1998) and the approach of Ford and Ryan (1981), we define external knowledge exploitation as follows. *External knowledge commercialization describes an organization's deliberate*

actions of directly commercializing disembodied knowledge to another legally and economically independent organization involving a contractual obligation for compensation in monetary or non-monetary terms.

Thus, the external commercialization of knowledge represents a complementary exploitation mode to the internal exploitation option. "It must be emphasized that exploitation methods are not 'either-or' decisions" (Ford 1988, p. 93) and do not exclude each other. Due to the attribute of non-rivalry of knowledge (Cornes and Sandler 1986; Grant 1996b), mostly no clear 'keep-or-sell' decisions have to be taken in the commercialization of knowledge. Sometimes, the internal exploitation of a technology may even be a necessary condition for its successful external commercialization (Arora *et al.* 2001a) and vice-versa. Therefore, a company should develop a general knowledge exploitation strategy, in which the internal and external exploitation options are coordinated (Ford and Ryan 1981). This is particularly important as in recent years many companies have started to proactively commercialize knowledge instead of viewing the external exploitation merely as a residual activity (Rivette and Kline 2000a; Kline 2003).

Accordingly, companies should not only consider the external exploitation option starting from their current knowledge base. The external form of knowledge exploitation should be taken into account already in decisions on building up particular knowledge and in the 'make-or-buy' decisions on developing that knowledge. "[A] company must not base its development decisions on the projected returns from product sales alone. Instead, it should consider potential returns from the technology as a whole" (Ford and Ryan 1981, p. 121). For example, it might be appropriate to develop knowledge internally rather than acquire it from external sources or further develop existing knowledge inside the corporation in order to realize external exploitation potentials.

The holistic perspective that is adopted in research into the external commercialization of knowledge is aimed at facilitating an integrated management approach to all of a firm's external knowledge exploitation activities. Thus, the analysis is not limited to specific types of knowledge transactions, such as licensing agreements, but includes different forms of knowledge transfer in order to guarantee an adequate coordination among the transactions as well as an appropriate coordination of the transactions with the overall corporate strategy and knowledge strategies. While various empirical studies have taken one type of transactions as an example, usually licensing agreements (e.g. Fu and Perkins 1995; Arora 1997), many theoretical approaches and some empirical studies include various forms of outward

knowledge transfer (e.g. Ford 1988; Vickery 1988). In these cases, rather different classifications of the forms of the external knowledge exploitation have been applied. While a part of the differences is a result of the different scope of the external exploitation perspective that is adopted, another part simply arises from the different degrees of detail of the classifications and, as a result, the different number of forms of transfer that are distinguished. Table 1 presents an overview on different classifications used in selected studies in past research and shows the systematization which is applied in this article based on the integration of prior classifications.

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Tab. 1: Selected classifications of the forms of knowledge commercialization in past research

The internal use refers to knowledge application in a company's own products or services. The expression 'collaboration' is used for all types of interorganizational cooperations that include the exploitation and outward transfer of knowledge as one of their main functions. Thus, not only strategic alliances but also cooperations, such as contract R&D, may be regarded as external knowledge exploitation since the commercialization phases present similar managerial challenges. A license, in contrast, is a permission to practice all or a part of a proprietary right that is granted by the licensor, who remains owner of the knowledge (Brooke and Skilbeck 1994). Licensing agreements with monetary compensation may be differentiated from cross-licensing agreements referring to the mutual transfer of licenses and grant-back agreements obliging the licensee to share all improvements that it develops based on the licensed knowledge with the licensor (Mordhorst 1994; Chiesa *et al.* 2003b). Apart from licensing out, any knowledge may be sold which involves the transfer of ownership (Chiesa *et al.* 2003b). In contrast to selling knowledge, the divestment of company units does not only include the transfer of knowledge but also the sale of – at least part of – the rights of disposal of a unit of the firm including physical assets, among others (Chesbrough 2003b; Gassmann *et al.* 2003).

The different forms of external knowledge commercialization have different consequences for a company using them. Particularly, they differ regarding the ownership after the transaction, the risk involved, post agreement implications (Chiesa *et al.* 2003b) and the requirement of complementary assets and competencies. Therefore, the different forms may be systematized based on their degree of organizational integration as shown in Fig. 2, limiting the scope of the external knowledge exploitation to the formal types of commercializing disembodied knowledge.

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Fig. 2: Systematization of the types of knowledge exploitation

Inhibiting and driving forces of external knowledge commercialization

Inhibiting forces

In history, the creation of markets has been a main driver of economic development (Arora *et al.* 2001b). In contrast to the markets for most products and services, however, the markets for knowledge have remained far from functioning well (Teece 1981; Caves *et al.* 1983; Arora *et al.* 2001b). As knowledge has usually been embodied in products and services for commercialization, markets for disembodied knowledge are still not common (Gambardella 2002). At the same time, there are many imperfections inherent to the knowledge markets (Teece 1981). These two phenomena are mutually dependent because a reduction of the imperfections will lead to a more intense use of these markets, which in turn will diminish some of the markets' deficiencies.

The main weakness of the markets for knowledge is their lack of transparency regarding essential market information, e.g. about buyers, suppliers and the knowledge that is traded. In general, these imperfections lead to the absence of a well-defined demand and supply and to high transaction costs in the markets for knowledge (Ford and Ryan 1981; Teece 1981; Caves *et al.* 1983; Brockhoff 1992; Guilhon 2001). Thus, the imperfections of the knowledge markets constitute the main external barrier that inhibits an easy commercialization of disembodied knowledge and that may not directly be influenced by a single company. In the following, we will not address the individual imperfections of the knowledge markets (see e.g. Teece 1981; Caves *et al.* 1983; Teece 1998; Arora *et al.* 2001b), but we will focus on the implications that these imperfections have for an active external knowledge exploitation.

For a company trying to externally commercialize knowledge, the imperfections of the markets have the effect that the *identification of potential knowledge customers* constitutes a highly complex task, which is often considered the essential problem in the proactive external commercialization of knowledge (Sullivan and Fox 1996; Elton *et al.* 2002). A company that attempts to commercialize a particular knowledge asset owns a potential solution for certain problems by providing one or more functions that the knowledge may fulfill. Starting from these functions, the firm faces the difficulty of identifying possible applications, which may be in completely different contexts than the firm's own business. Thus, the 'marketing' of

disembodied knowledge (Ford and Ryan 1977; Tschirky *et al.* 2000) by firms whose main business is the internal knowledge exploitation will often not follow the supply side's explicit focus on the needs of the knowledge customers, which is proposed in marketing management for product and service markets (Kotler 2003) because the external knowledge commercialization is usually only seen as a complement to the internal knowledge exploitation.

In addition to the difficulties in identifying potential partners, considerable problems arise in the *actual commercialization of knowledge*. Many of the imperfections of the knowledge markets can be traced back to the nature of knowledge as the good that is traded. First, a lot of knowledge is tacit and thus very difficult to transfer (Polanyi 1962) which can only partly be compensated through the codification of certain knowledge components (Teece 1981). Second, the mere act of marketing knowledge comprises the risk of disclosing its relevant aspects to potential buyers (Arrow 1971), who may usually apply the knowledge at close to zero marginal cost (Grant 1996b). These appropriability issues do not only emerge during negotiations but also during the subsequent stages of the external knowledge commercialization (Teece 1981). This superiority of firms over knowledge markets in the integration and transfer of knowledge has long been emphasized in literature (e.g. Williamson 1975; Klein *et al.* 1978) and is central to various knowledge-based approaches to the theory of the firm (e.g. Grant 1996b). Some of the problems of transferring knowledge may be mitigated through intellectual property rights (Teece 1986; Arora and Gambardella 1994; Arora and Fosfuri 2000). However, companies that commercialize disembodied knowledge still face considerable difficulties because the appropriability problems cannot be overcome completely and most knowledge transactions include the transfer of additional knowledge, which is not protected by property rights (Birkenmeier 2003).

Apart from the characteristics of knowledge as the good itself, various problems in knowledge transactions arise from issues regarding an adequate *compensation for the knowledge transfer* (Bidault 1989; Chiesa *et al.* 2003a). While it may already be difficult to demarcate the transfer object (Bozeman 2000), the knowledge to be transferred often is rather unique (Contractor 1981), which leads to difficulties in establishing an adequate price by comparing the current situation with prior knowledge transactions. Especially in the area of technological knowledge, there is in addition often a high uncertainty regarding the technical and economic performance of the knowledge (Caves *et al.* 1983). Furthermore, the value of the knowledge will depend on its application, i.e. the particular function that it fulfills, which is why the realizable price will differ between potential customers. Thus, knowledge transactions are

often characterized by a high indeterminacy with regard to price (Teece 1981) which goes beyond the difficulties in determining the value of intellectual assets (Arrow 2002; Chiesa *et al.* 2003a; Reitzig 2003). For example, if the knowledge transfer is accompanied by the supply of related products or services, these additional transactions influence the price of the knowledge itself (Contractor 1980; Bidault 1989). Moreover, compensation is often non-monetary; particularly, it may also consist of transferring knowledge (Koruna 2004). These situations of bi-directional knowledge transfer or collaborative knowledge development represent considerable managerial challenges and increase the lack of transparency of the knowledge markets.

Besides the difficulties in the identification of potential knowledge clients and in the negotiations, the market imperfections often lead to problems in the *realization of the external knowledge exploitation* projects (Sullivan and Fox 1996; Granstrand 2000a; Elton *et al.* 2002). When firms initiate external knowledge commercialization activities, they often need to cope with negative attitudes towards the external exploitation option among their employees (see the section on the risks of the external knowledge commercialization). Furthermore, as knowledge transactions often go far beyond the arm's length transactions of most product markets (Teece 1981, 1986; Bidault 1989), companies need to develop the capability of adequately managing these more complex and long-term relations, such as alliances (Kale *et al.* 2002). Apart from the capabilities of the company itself, the overall success of such relationships strongly depends on the knowledge customer, e.g. its absorptive capacity, and on the characteristics and similarities of both partners (Teece 1981; Bidault and Fischer 1994; Lane and Lubatkin 1998; Brockhoff 1999b). Moreover, a company has to guarantee a holistic view on its external knowledge exploitation projects which is essential in order to avoid the risks inherent to external knowledge commercialization but which is also rather difficult to achieve due to the specific characteristics of the different transactions, which are not as standardized as product market transactions (Teece 1981; Tschirky *et al.* 2000).

It has been shown that some of the imperfections of the knowledge markets are inherent to the knowledge itself, e.g. its tacitness, which will prevent a functioning of the markets in an ideal economic way (Teece 1998). Some imperfections, however, were at least reduced during the last years and might be further reduced in the future. One driver of this development has been the rise of new information and communication technologies (Granstrand 2000b), another one has been the growing external acquisition of knowledge, which has led to a higher demand on the knowledge markets. A further aspect may be seen in the trend towards a pro-patent era

(Granstrand 2000a, 2004), which may help to diminish some of the appropriability problems. While all these factors refer to developments in the environment of a company that is carrying out external knowledge exploitation activities, the most important factor is internal to the company. The commercialization of disembodied knowledge constitutes a complex task (Ford and Ryan 1981; Bidault and Fischer 1994), which, however, may be handled through adequate management (Ford and Ryan 1981; Birkenmeier 2003) as many prominent examples show (e.g. Kline 2003). Thus, in analogy to the external acquisition of knowledge (Cohen and Levinthal 1989; Lane *et al.* 2001), a company should build up a capability of managing the external exploitation of knowledge. Developing an external knowledge exploitation capability may lead to lower transaction costs in commercializing disembodied knowledge and to new opportunities that arise from an active use of the external knowledge exploitation.

Driving forces

It is difficult to make clear judgements on the scope and development of corporate external knowledge exploitation activities because the available information is highly fragmented (Arora *et al.* 2001b). While there is anecdotal evidence that the external commercialization of knowledge by firms increased during the 1990s (e.g. Kline 2003), hardly any broad empirical data on the company level exist. Only on an aggregated industry or country level there are data that show the existence of markets for knowledge (e.g. Arora *et al.* 2001b). Furthermore, the growing external knowledge acquisition (e.g. Veugelers and Cassiman 1999) points to an increasing external exploitation by companies although this trend may partly be due to a more effective knowledge commercialization of universities and other research institutions (Agrawal 2001).

The external commercialization of knowledge is not a new phenomenon. It has been shown that there was an organized market for technological knowledge prior to the growth of in-house R&D of larger companies at the beginning of the 20th century (Lamoreaux and Sokoloff 1998). During a long time, however, the external exploitation option was mainly used as an entry mode to foreign markets (Contractor 1980), as a result of the industry structure and the intellectual property regimes of particular markets, e.g. in the chemical industry (Arora 1997), and partly also as a response to anti-trust laws (Chesbrough 2002; Shuchman 2004).

At the beginning of the 1990s, this attitude changed as various firms across industries became interested in the external knowledge commercialization as an alternative exploitation option

beyond using it in the specific settings described above. These pioneering firms, such as IBM and Texas Instruments, started to actively manage their external knowledge exploitation, which they pursued mainly for monetary purposes (Alster 1988; Dwyer 1989; Kline 2003). Interestingly, various of these firms, such as IBM, initiated the proactive use of the external commercialization when they faced financial difficulties (Rivette and Kline 2000b). Since the end of the 1990s, a broader interest in the topic can be observed, and slowly also the strategic potentials inherent to the external knowledge exploitation were considered more systematically by various firms from different industries (Rivette and Kline 2000b; Davis and Harrison 2001). In parallel to the growing managerial attention, a renewed interest by researchers and consultants could be noted, which led to a rise in the managerial and academic literature on the topic (e.g. Rivette and Kline 2000a; Tschirky *et al.* 2000; Davis and Harrison 2001; Arrow 2002; Elton *et al.* 2002; Chiesa *et al.* 2003a; Koruna 2004).

Data from various sources (e.g. Arora *et al.* 2001b) confirm that the markets for knowledge have grown considerably during the 1990s, especially in some high-technology areas. Arora *et al.* (2001) compare estimates on an aggregated level from three different data sources, which are subject to numerous caveats but lead to rather consistent results. Limiting their analysis to technological knowledge, their estimates indicate a current worldwide market for technologies in the range of US\$ 35-50 billion per year. Other sources estimate that the overall U.S. patent licensing revenues have skyrocketed from below US\$ 15 billion per year at the beginning of the 1990s to around US\$ 100 billion a year in 2002 (Elton *et al.* 2002; Kline 2003).

On the company level, Elton *et al.* (2002) state that only a small number of the more than 40 larger companies that they studied earned more than 0.5 percent of their operating income from licensing although their knowledge base usually would allow this rate to be between 5 and 10 percent. Various sources show that often 70-90 percent of corporate technology assets are not used in the internal knowledge exploitation (Katz 2001; Sakkab 2002; Kline 2003). Although normally not all of a company's unused knowledge assets may be externally exploited, at least about ten percent of a firm's patent portfolio may usually be commercialized for monetary purposes alone (Elton *et al.* 2002). Due to the lack of empirical data, it is hard to compare these numbers with the results of earlier studies (e.g. Ford 1985; Vickery 1988), which are often hard to generalize as well. The most popular example of a company that realizes enormous monetary and strategic benefits through its external knowledge exploitation activities is IBM, whose intellectual property revenues amounted to more than US\$ 1.7 billion in 2000, up from US\$ 30 million in 1990 (Rivette and Kline 2000b;

Chesbrough 2003c; Kline 2003). These revenues were realized with a 98 percent profit margin, which, however, is hard to calculate, and made up roughly 20 percent of IBM's net income in that year (Kline 2003).

For the rise of the external knowledge commercialization during the last decade, many reasons may be identified. Analyzing the reasons in detail reveals that they may be classified into four broad groups. First of all, due to the intensification of the trend towards the knowledge-based economy (Harris 2001), knowledge is now recognized as the main driver of economic growth which has led to a new focus on the role of knowledge and learning in society (OECD 1996). This *growing knowledge awareness in society* has also influenced the awareness of corporate management regarding the knowledge assets in most companies (Bontis 2001). Recognizing that often a large part of a firm's knowledge assets is unused in internal operations, the external exploitation represents an appropriate way of making use of these knowledge assets. In parallel, the strengthening of intellectual property regimes (Teece 1998), which has been termed 'pro-patent era' by Granstrand (2000), has mitigated some of the appropriability concerns.

Along with the growing knowledge awareness in society, management science in general and research into business strategy in particular started to *focus on resource-based and knowledge-based perspectives*. Apart from renewed interest in the resource-based view of the firm (Wernerfelt 1984; Barney 1991), the dynamic capabilities approach (Teece *et al.* 1997), the knowledge-based view (Grant 1996b; Spender 1996) and the technology-based theory (Granstrand 1998) were developed in the 1990s, which all put emphasis on the generation but also on an adequate exploitation of a firm's knowledge. While these theoretical approaches themselves stimulated a more effective knowledge application, their implications, such as the concentration on core competencies (Prahalad and Hamel 1990) and the resulting lack of complementary assets which would have been necessary for the internal exploitation of non-core knowledge, intensified the trends towards externally commercializing knowledge (Cesaroni *et al.* 2004). Further theoretical inputs, such as research into intellectual property and intellectual assets (e.g. Granstrand 2000a) and into possibilities of its measurement (e.g. Bontis 2001), contributed to the emergence of a trend towards externally exploiting knowledge. New value-based management techniques, such as the shareholder value approach, and initiatives to organize corporate R&D departments as profit centers represent additional reasons for the surge of external knowledge exploitation. Thus, it can be stated that the external knowledge exploitation itself is mainly a trend from practice, which however, has been influenced by more general academic work.

Furthermore, the growth of the overall knowledge markets during the 1990s, which was partly based on the increasing external acquisition of knowledge, might be interpreted as a kind of *market pull effect* for disembodied knowledge. While a broader use of the knowledge markets itself contributed to their improvement, the simultaneous advance of information and communication technologies (Granstrand 2000b) alleviated at least some of the traditional problems of the knowledge markets. The rise of specialized intermediaries, particularly internet platforms, such as yet2.com, further stimulated this trend (Tschirky *et al.* 2000). Today, however, it seems that the firm's high expectations in these web-enabled tools have not been met (Birkenmeier 2003). Another important factor for the tendency towards exploiting knowledge externally are the examples of well-known companies which demonstrated the enormous potentials that an adequate intellectual asset management and particularly a proactive external knowledge commercialization may have (Shuchman 2004).

Finally, the internal inventive and innovative activities of companies led to a kind of *knowledge push effect* for commercializing disembodied knowledge. The increasing R&D expenditures accompanied by shorter product and technology life cycles and a more intense competition (Ford 1985; Vickery 1988; Grindley and Teece 1997; Chesbrough 2003a; Cesaroni *et al.* 2004; Granstrand 2004) did not only result in a growing external acquisition of knowledge in order to cope with these challenges but also supported a stronger external commercialization of knowledge to increase the returns on a firm's knowledge base. The simultaneous intensification of knowledge convergence and knowledge fusion (Kodama 1992; Levinthal 1998; Grant and Baden-Fuller 2004) has resulted in the situation that many large companies have high competencies outside their core areas (Granstrand *et al.* 1997; Patel and Pavitt 1997) which underlines the high external knowledge exploitation potential that firms may realize by commercializing knowledge beyond their industry borders. The experience that many companies gained in externally acquiring knowledge, the increasing importance of network externalities in various industries (Grindley and Teece 1997; Ehrhardt 2004) and the growing presence of private venture capital (Chesbrough 2003c) constituted additional reasons for a more proactive external commercialization of knowledge.

Regarding the current state of the external knowledge exploitation, it may be concluded that despite the lack of recent large-scale data on the company level, a clear trend towards a more intense use of the external exploitation option may be observed, which has been started by some pioneering firms at the beginning of the 1990s and has subsequently become of broader interest. As many of the drivers of this development are expected to further intensify in the future, the external exploitation of knowledge may in some years not only represent a

supplementary way of commercializing knowledge but may constitute an equivalent exploitation option, whose adequate use may be critical for the success of a firm and may represent an essential source of competitive advantage.

Objectives and risks of external knowledge commercialization

Objectives

In comparison with other aspects of external knowledge commercialization, the opportunities that it may provide have been studied in relative detail. Nevertheless, the analysis is mostly limited to conceptual approaches, which often address either specific objectives or the potentials that the external knowledge exploitation offers in a particular industry, e.g. Grindley and Teece' (1997) study into semiconductors and electronics or Arora's (1997) analysis of the chemical industry. Only very few authors, such as Koruna (2004), have attempted to establish a comprehensive overview. Generally, it has to be highlighted that the external commercialization of knowledge offers both financial and strategic opportunities. As various works in past research (e.g. Arrow 2002; Elton *et al.* 2002) and many companies (Arrow 2002; Chesbrough 2003a) have focused on the monetary dimension, they have missed the strategic opportunities, which may be realized especially through a proactive use and an integrated management of the external commercialization of knowledge. In the following, we will give a brief overview on the six main objectives of the external knowledge exploitation identified by Koruna (2004) introducing the works of other authors into the classification. However, the systematization only represents the current state of research, which shows that further work is required, particularly regarding a more comprehensive overview on the strategic objectives taking into account additional factors, such as the timing and the proactive use of the external knowledge exploitation, which strongly influence a firm's approach to the commercialization of disembodied knowledge.

- ***Generating revenues:*** This dimension refers to the purely financial aspects of the external knowledge commercialization (e.g. Vickery 1988; Arora 1997; Davis and Harrison 2001; Kline 2003).
- ***Gaining knowledge access:*** In many cases, knowledge and particularly intellectual property may be the only possibility to obtain access to another company's knowledge base (Grindley and Teece 1997; Rivette and Kline 2000b; Birkenmeier 2003). Thus, the external commercialization may be directed primarily at the acquisition of external knowledge.

- *Setting industry standards*: Sometimes, a company may have to actively find external adopters of its knowledge because only by this adoption the commercialization of its products will be successful (Conner 1995; Reitzig 2004). Particularly, this refers to the need to establish an industry standard, which may be achieved by licensing the firm's particular technology (Rosenbloom and Cusumano 1987; Ehrhardt 2004). In this context, 'positive network externalities' describe the fact that the value of a network may be growing at an exponential rate with the number of the network's members (Katz and Shapiro 1985). This example underlines that often the internal and external exploitation mode of knowledge are complementary and do not represent 'either-or' decisions (Ford 1988).
- *Profiting from infringements*: Because of the advance of today's information and communication technologies (Granstrand 2000b), intended or unintended infringements of intellectual property can be detected more easily than ever before (Rivette and Kline 2000a; Davis and Harrison 2001). Due to the trend towards a 'pro-patent era' (Granstrand 2000a, 2004), companies can also rely more than ever on courts in case of violation of their intellectual property rights to ensure the appropriation of innovation rents. These developments facilitate the use of external knowledge exploitation as a reaction to other companies' actions, which is usually called 'stick licensing' by practitioners and refers to identifying infringers of a firm's intellectual property, proving the infringements and offering the infringers a license (Bramson 2000).
- *Realizing learning effects*: The external commercialization of knowledge can be a means to increase the speed of a firm's R&D activities. The focus here is on learning, resulting in the compression of the firm's learning curve (Argote 1999). The transfer of new knowledge that is developed by the recipient back to the original knowledge source may be formally laid down in a 'grant back' clause of a licensing agreement (Bragg and Lowe 1989; Mordhorst 1994; Birkenmeier 2003). If the original knowledge source wants to benefit from the knowledge developed by the recipient, it has to ensure sufficient absorptive capacity (Cohen and Levinthal 1990).
- *Guaranteeing freedom to operate*: This aspect refers to a specific type of cross-license agreements, in which intellectual property rights are used as 'bargaining chips' usually without any transfer of knowledge (Reitzig 2003). Despite the lack of actual knowledge transfer, this use of licensing represents a formal external knowledge commercialization transaction (see section 2). The main reason for this type of external knowledge

exploitation is to avoid potential patent infringement lawsuits, which would prevent the firm from commercializing its products (Hall and Ham Ziedonis 2001; Reitzig 2004). Such agreements can be found mainly in industries where companies have large patent portfolios with a high degree of technology overlap, e.g. in semiconductors and electronics (Grindley and Teece 1997).

In practice, most of the objectives of external knowledge commercialization will not be found in their pure form but rather as a combination of various objectives (Grindley and Teece 1997; Koruna 2004). Furthermore, the importance of the different objectives varies substantially from industry to industry, e.g. guaranteeing freedom to operate is primarily important in some well-defined high-technology industries. The relevance of the objectives also depends on the characteristics of the knowledge to be commercialized, e.g. its degree of novelty (Ford 1988), and on contextual factors, e.g. the rate of technological change (Jaworski and Kohli 1993; Koruna 2004). Although in research and practice, there has often been a focus on monetary aspects, strategic objectives, such as realizing learning effects, become increasingly important (Rivette and Kline 2000b; Davis and Harrison 2001). The main objectives that a firm is pursuing with the external knowledge exploitation will usually have strong effects on its commercialization strategies and on the processes and organizational structures for carrying out the external commercialization tasks (Birkenmeier 2003).

Risks

Basically, there is a trade-off between realizing the monetary and strategic potentials inherent to the external knowledge exploitation on the one hand and protecting a firm's knowledge base and idiosyncratic competencies on the other (Prahalad and Hamel 1990; Boyens 1998). While for most knowledge-intensive companies the external knowledge exploitation provides great opportunities, there is also the risk of negatively affecting the firm's current or future internal knowledge exploitation potentials, which constitute the core business of most firms. This may result in strengthening competitors and intensifying the difficulties to gain and sustain a competitive advantage in flexible markets of hypercompetition (Eisenhardt and Martin 2000).

These potential negative consequences of externally commercializing knowledge are a main reason why most companies concentrated on the internal exploitation option in the past. Due to the fear of giving away 'corporate crown jewels' (Kline 2003), the external exploitation option has often been used relatively little (Ford 1985; Vickery 1988; Elton *et al.* 2002;

Birkenmeier 2003). As a result of the historical focus on internally exploiting knowledge and a simultaneous emphasis on the external commercialization's potential negative effects, which over time influenced corporate culture, externally commercializing knowledge has not been considered an equivalent exploitation option in many firms. This negative attitude towards the external exploitation of knowledge may be regarded as a complement to the 'not-invented-here' syndrome in the external acquisition of knowledge (Katz and Allen 1982; Kanter 1983). While such an attitude was already described in early research approaches (Ford and Ryan 1981; Ford 1985), Boyens (1998) coined the expression 'only-use-here' syndrome. Following his definition, a firm is subject to the 'only-use-here' syndrome if its attitude towards the external commercialization of knowledge is more negative than an ideal economic attitude would be.

This negative attitude towards externally exploiting knowledge, which still exists in many companies, contrasts the very positive perspective that is often adopted in the academic and managerial literature (e.g. Ford and Ryan 1981; Kline 2003; Koruna 2004). Complementary to the 'only-use-here' syndrome, Boyens (1998) proposed the term 'sell-out' syndrome, which describes a more positive than ideal attitude towards the external commercialization of knowledge. Such an overly optimistic approach may lead to externally exploiting knowledge to an extent that aggravates the firm's position regarding idiosyncratic competencies as it has been described above.

Regarding the positive and negative effects of externally exploiting knowledge, it is necessary to differentiate between the commercialization of knowledge inside a firm's own industry (to competitors, suppliers or customers) and in other industries. The simultaneous use, i.e. in the same markets at the same time, of internal and external knowledge exploitation will be beneficial only in some situations, e.g. if there are network externalities. If a firm's core competencies are involved in the generation and application of the relevant knowledge assets, particular attention has to be paid to the competitive effects of the knowledge transfer and to an adequate appropriability of the rents that may be realized by commercializing these knowledge assets. Therefore, many companies are reluctant to externally commercialize such knowledge inside their own industries which is why the external commercialization potential is often diminished by the internal exploitation. It has to be emphasized, however, that most knowledge-intensive firms still have broad opportunities for commercializing disembodied knowledge (Ford 1985; Rivette and Kline 2000a). Regarding technological knowledge, Patel and Pavitt (1997) show that most large firms are diversified in their product fields but have an even broader range of technological competencies which is mainly a result of the increasing

knowledge convergence and knowledge fusion (Kodama 1992; Patel and Pavitt 1997; Levinthal 1998; Grant and Baden-Fuller 2004). These trends underline the high external knowledge exploitation potential that firms may realize by commercializing knowledge inside their own industries as well as beyond industry borders.

The final decision which technologies to commercialize externally is not only company-specific but even depends on the individual situation and should be based on a variety of factors, such as the company's long-term corporate strategy, its product and innovation strategies and industry characteristics, e.g. network externalities. While in general all knowledge assets may be externally commercialized, an appropriate assessment and evaluation of the knowledge and its role in the broader context of the firm's strategy is crucial to avoid potential negative consequences of the external commercialization. Taking explicitly into account the opportunity costs of a particular external knowledge exploitation project may help to improve individual 'keep-or-sell' decisions. Due to the multi-project situation, a company should have an overall external knowledge exploitation strategy which serves as a basis for deciding on each potential project individually. Establishing a strategy and beyond that developing an organizational competence of managing the external knowledge exploitation may help companies to overcome the 'only-use-here' or 'sell-out' syndrome and to arrive at a more realistic evaluation of the external exploitation opportunities, i.e. taking advantage of their positive monetary and strategic effects and avoiding a loss of the firm's critical knowledge and core capabilities. Moreover, such an organizational competence will facilitate an adequate management of the company's external knowledge exploitation activities and may therefore itself be a source of competitive advantage.

Management of external knowledge commercialization

The previous section has shown that the external commercialization of knowledge may provide great opportunities but also contains considerable risks. The imperfections inherent to the markets for knowledge further increase the need of an adequate management, by which many problems encountered during knowledge transactions can be solved or at least reduced (Farr and Fischer 1992; Forrest and Martin 1992; Hakanson 1993). The fact that companies which follow the trend towards actively commercializing disembodied knowledge often perceive severe difficulties in carrying out these activities underlines the requirement of an appropriate management. Three managerial key issues, i.e. the external knowledge

exploitation strategy, the external knowledge exploitation process and the organization of the external knowledge exploitation, will be analyzed in the following.

Strategy

To realize the potentials that an external exploitation of knowledge offers, a company should consider its activities in this area not only as ad-hoc operations, but it should develop a specific external knowledge commercialization strategy (Ford and Ryan 1981; Ford 1988; Grindley and Teece 1997). To make the external commercialization a truly strategic activity, companies should take an integrated view comparing their knowledge assets with both internal and external exploitation opportunities (Ford and Ryan 1981). This approach will facilitate an adequate use of the two complementary exploitation modes and will permit a more effective integration of the firm's knowledge about particular markets and applications. If the external exploitation is an integral part of the overall business strategy, the identification ideally does not only consider knowledge that has already been developed and is used or not used inside the company, but it will already start during the internal or external knowledge acquisition in order to take the external exploitation option into account in all major decisions regarding company knowledge (Ford and Ryan 1981).

An integrated management of the internal and external knowledge exploitation will also facilitate an adequate control of the risks inherent to the external commercialization. Furthermore, it will help to adopt a holistic management of the different external exploitation activities, such as alliances and licensing-out agreements, which is considered a main advantage of the external knowledge commercialization perspective (Ford 1985). The specific managerial challenges that result from carrying out multiple external knowledge commercialization projects simultaneously are common on the corporate level in practice (Ford 1985; Vickery 1988; Escher 2003). A holistic management approach will permit a more efficient realization of the tasks on single-project level as well as a better coordination of the tasks on multi-project level (Dyer *et al.* 2001; Bamford and Ernst 2002). These aspects indicate that coherent to the external acquisition of knowledge (Cohen and Levinthal 1989; Lane *et al.* 2001) a company may realize economies of scale and learning effects in the external commercialization of knowledge which might lead to a reduction of the transaction costs in the markets for knowledge.

Despite the complementary roles of internal and external exploitation, a company does not only have to develop an overall external knowledge commercialization strategy but also has

to take a 'keep-or-sell' decision for each potential external exploitation project, i.e. the decision to externally commercialize a particular knowledge asset or not. Usually, a company will start to look for potential knowledge customers and will take a decision only after negotiating with the possible partners (Hakanson 1993; Lichtenthaler and Lichtenthaler 2004). While the opposite decision, the make-or-buy of knowledge has received considerable attention of researchers including empirical work (e.g. Kurokawa 1997; Veugelers and Cassiman 1999), the keep-or-sell issue has been addressed in detail only in few conceptual works on the marketing of technology (Ford and Ryan 1981; Ford 1988; Birkenmeier 2003).

These approaches acknowledge that it is impossible to take general decisions on the external commercialization of knowledge and thus adopt contingency perspectives. While Ford and Ryan (1981) focus on the technology life cycle concept, Ford (1988) takes a broader approach by further considering the company's relative standing in the technology, the urgency of exploitation, the need for support technologies, the investment involved, potential applications and the category of the technology, i.e. its distinctiveness. Based on these factors, the author proposes four different methods of exploitation: application in own production, contracted-out manufacture or marketing, joint venture and license-out. This framework represents a considerable advance from earlier approaches because it does not only focus on the characteristics of the knowledge to be commercialized but also takes into account factors referring to complementary assets and potential applications. Despite its more general approach, however, the concept neglects various factors, such as the role of the potential partner or geographic aspects, and only indirectly considers industry-specific influences.

Teece (1986) and Arora *et al.* (2001a) highlight the importance of the strength of the appropriability regime but put the main focus in the keep-or-sell issue on the importance of the complementary assets needed for the commercialization of knowledge assets. If a firm lacks the complementary assets to commercialize a specific knowledge asset, its external commercialization appears particularly attractive. Koruna (2004) further details the analysis of the knowledge to be commercialized by differentiating between product and process technologies, whereas Birkenmeier (2003) proposes the functional relevance of knowledge as an additional factor of influence on the keep-or-sell decision by distinguishing between core knowledge assets, support knowledge and functionally irrelevant knowledge. This concept represents an improvement over past approaches as it does not focus on the general characteristics of a knowledge asset, e.g. its position in the technology life cycle, but establishes a connection between the knowledge and the firm's strategy by referring to the function of the knowledge in the firm. This concept is particularly helpful for determining the

risk that a company takes regarding its idiosyncratic competencies by commercializing a particular knowledge asset. However, the concept only constitutes an additional factor of influence on the keep-or-sell decision and not a general framework because depending on the situation it may be appropriate to externally commercialize all three types of knowledge assets.

In conclusion, it has to be stated that no adequate framework for the keep-or-sell decision has emerged yet. While the role of the particular knowledge asset has been addressed in relative detail, other factors, especially the influence of the potential partner, have mostly been ignored. Due to the high complexity and context-dependency of the decision, it will be difficult or even impossible to develop a comprehensive framework as intended by Ford (1988). In our opinion, it is more important that companies establish an overall external knowledge exploitation strategy, which is closely coordinated with the firm's corporate strategy and with the internal knowledge exploitation strategies. Based on this general strategy and the objectives of the multi-project external knowledge exploitation program, individual keep-or-sell decisions may be taken based on factors of influence which partly have been developed in the existing literature and partly have not been addressed at all. In this context, especially a firm's level of competence and prior experience with external knowledge commercialization deserves more attention in future research. Furthermore, there is a strong need to test the existing theoretical assumptions in empirical studies.

Process

With regard to the process of externally commercializing knowledge, empirical research results indicate that successfully managing knowledge transactions requires a process view, in which all process phases are critical to obtaining successful results (Doz 1996; Chiesa and Manzini 1998; George and Farris 1999). An implicit process view on the external commercialization of knowledge was adopted already in early research approaches (e.g. Ford and Ryan 1977). In some subsequent and recent works on the commercialization of disembodied knowledge, explicit process perspectives were applied (Mittag 1985; Escher 2001; Birkenmeier 2003; Escher 2003). Similar approaches may be found in research into specific forms of knowledge transfer, above all in the literature on alliances, particularly on alliances involving knowledge or technology transfer and generation (e.g. Forrest and Martin 1992; Chiesa and Manzini 1998; Lane and Lubatkin 1998; George and Farris 1999; Reid *et al.* 2001; Lichtenthaler and Lichtenthaler 2004). In many of these works, a knowledge

acquisition perspective is taken, which is complemented by comparable process perspectives in the works that take an integrated approach to all forms of external knowledge acquisition (Sheen 1992; Durrani *et al.* 1999). However, not only in the literature on inward knowledge transfer as opposed to the external commercialization but also in research into internal knowledge exploitation, i.e. innovation and new product development, as the complementary exploitation mode, process views have received considerable attention (Ernst 2002).

Regarding the content and phases of the process perspectives in the literature on external knowledge exploitation, particularly two authors present process views that are sufficiently detailed and at the same time allow to take into account the differences that emerge from the different forms of external knowledge exploitation. Based on existing research results, Mittag (1985) differentiates between three overall process phases: planning, realization and control. The planning phase is further divided into activities that represent actual planning tasks (e.g. definition of general objectives) and activities of identifying external knowledge exploitation opportunities and potential customers. The realization phase comprises the negotiations with potential partners and the implementation of the agreement that has been set up. Based on existing research results and interview data, Escher (2001 and 2003) proposes a similar process model consisting of the following five stages: identification of exploitation opportunities, evaluation, identification of communication channels, negotiations and knowledge transfer.

Beyond considering the tasks that are required for commercializing a single knowledge asset, the specific requirements of the multi-project perspective of the external knowledge commercialization should be taken into account when developing a process model. Thus, it seems to be appropriate to distinguish between the actual planning tasks, which will usually include continuous and discontinuous planning activities as well as tasks on single-project and multi-project level, and the continuous identification of external commercialization opportunities, which is directed at all possible projects (Dyer *et al.* 2001; Lichtenthaler and Lichtenthaler 2004). The process phases of negotiation and realization are rather common in process models of interorganizational collaboration (e.g. Forrest and Martin 1992; Lorange and Roos 1993; Chiesa and Manzini 1998), and also an explicit control stage has been considered in various works (e.g. Brockhoff and Teichert 1995; Doz 1996; Chiesa and Manzini 1998; Dyer *et al.* 2001). In conclusion, the analysis of the theoretical and empirical literature on the external knowledge exploitation and on interorganizational collaborations in general suggests that a process model consisting of the five stages planning, identification, negotiation, realization and control may represent an appropriate segmentation of the external

knowledge commercialization process. However, the process phases will usually not follow each other sequentially but iteratively with feedback loops and may have to be reiterated (Lichtenthaler and Lichtenthaler 2004).

Organization

The organization of external knowledge exploitation processes has been addressed in various works in the existing literature (e.g. Ford 1985; Tschirky *et al.* 2000), which, however, mostly represent theoretical approaches (Mittag 1985; Birkenmeier 2003), give anecdotal evidence (Sullivan and Fox 1996; Rivette and Kline 2000b; Elton *et al.* 2002; Cohen 2004; Shuchman 2004) or describe single case studies (Sakkab 2002). Large-scale empirical work is mostly limited to the analysis of the tasks of general intellectual property departments (e.g. Bertin and Wyatt 1988; Granstrand 2000a) without explicitly considering the external commercialization of knowledge. Some recent case studies and anecdotes (Escher 2003; Kline 2003) show how selected companies currently organize their external knowledge exploitation activities. These studies describe an increasing systematization of the external commercialization activities but also report difficulties of the companies in organizing and coordinating the different tasks during the external exploitation process.

A main problem of the organization of the external knowledge exploitation can be seen in the diversity of the tasks inherent to the commercialization process, such as the identification of external exploitation opportunities and the realization of the knowledge transactions. As a result of this diversity, the commercialization tasks are usually carried out by employees who specialize in certain tasks and are organized in particular units in a company-specific way, normally according to functions or internal processes (Dyer *et al.* 2001). Among them are, for example, employees from the R&D and marketing departments, intellectual property experts, knowledge managers, top management and technology intelligence specialists (Bidault and Fischer 1994; Sullivan and Fox 1996; Lichtenthaler and Lichtenthaler 2004). In addition to the coordination of the internal units, the interfaces with the knowledge transaction partner and maybe with an intermediary have to be managed (Bidault and Fischer 1994; Brockhoff 1999b; Dyer *et al.* 2001; Elton *et al.* 2002).

In order to facilitate an adequate management and particularly an appropriate organization of the external knowledge exploitation, various authors propose a dedicated external knowledge commercialization unit (Ford 1985; Mittag 1985; Tschirky *et al.* 2000; Escher 2003), which has been established by several companies and is termed, for example, 'Licensing group' or

‘Corporate Technology Transfer Group’ (Bidault and Fischer 1994; Sullivan and Fox 1996; Davis and Harrison 2001; Birkenmeier 2003). This dedicated unit may be regarded as an equivalent to knowledge acquisition units that were often set up in the 1990s as a result of the increasing external knowledge acquisition (Tschirky *et al.* 2000). Other companies have transferred the idea of key account managers to the knowledge level by specifying contact persons for key knowledge clients (Birkenmeier 2003).

Similar findings may be derived from the literature on interorganizational cooperations, where recent research has shown that firms attempt to actively develop an alliance capability and therefore establish dedicated alliance functions (Gulati 1999; Dyer *et al.* 2001; Kale *et al.* 2002; Draulans *et al.* 2003; Lichtenthaler and Lichtenthaler 2004). Along the external knowledge commercialization process, which usually runs across the firm’s internal processes, a specialized unit will usually take a superior perspective with a focus on coordination requirements and will support the managers or teams of the individual knowledge transactions (Sullivan and Fox 1996; Lichtenthaler and Lichtenthaler 2004). Through these institutionalized approaches, firms try to better manage their current external commercialization activities but also attempt to effectively accumulate experience in the external knowledge commercialization in order to realize possible learning effects (Sullivan and Fox 1996; Dyer *et al.* 2001; Draulans *et al.* 2003).

Apart from structural approaches to the organization of the external knowledge exploitation, many authors suggest a project organization for the individual knowledge transactions (e.g. Birkenmeier 2003). The project team will be responsible for the operational management and will focus on the realization and coordination of the tasks on single-project level (Fricke and Shenhar 2000). Furthermore, research into the external acquisition of knowledge and technology intelligence suggests that in addition to structural and hybrid, i.e. project-based, forms of organization a firm should also rely on informal structures (Allen 1977; Cohen and Levinthal 1990). In analogy to an innovation culture, which supports the internal commercialization of knowledge (Ernst 2004), these informal structures may be further transformed and extended into an ‘external knowledge exploitation culture’, which may constitute a fundamental step in overcoming the strong limitations of applying knowledge only internally.

Besides merely relying on internal organizational mechanisms and directly commercializing knowledge, firms may also use intermediaries (Bidault and Fischer 1994; Elton *et al.* 2002). These specialized companies may help firms to cope with some of the problems during the

commercialization process, such as the identification of applications and potential partners and the pricing of the knowledge, which result from the imperfections of the knowledge markets. Ideally, the use of intermediaries would lead to the creation of a market pull for the firm's knowledge. However, it seems that knowledge commercialization via intermediaries and particularly via internet market places has not met the companies' high expectations (Bidault and Fischer 1994; Birkenmeier 2003).

In conclusion, it has to be underlined that the importance of an appropriate organization for a successful external exploitation of knowledge is widely acknowledged. However, prior research has not detailed the tasks and competencies of a dedicated external knowledge commercialization unit and its interaction with other organizational approaches although many companies experience considerable difficulties in coordinating and organizing the different activities. To overcome the limitations of prior work and the problems perceived in practice, further research is required. As the existing literature points to a trend away from external knowledge exploitation as an ad-hoc operation (Fu and Perkins 1995) towards its consideration as a strategic and proactive process (Kline 2003), these studies may lead to very interesting results.

Empirical research into external knowledge commercialization

Although the review in the last sections has already taken into account both conceptual and empirical findings, we will additionally highlight prior empirical studies into the external knowledge exploitation to clearly demonstrate the state-of-the-art of empirical research into this area. The focus is on empirical studies that adopt an explicit external knowledge commercialization perspective, whereas further studies, which touch this area and which have been mentioned in the earlier sections, e.g. surveys on international licensing on the project level, will not be covered in detail. Applying these criteria leads us to six major studies, whose methods and main results with regard to the external commercialization of knowledge are presented in table 2.

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Tab. 2: Major empirical studies on the external knowledge commercialization

In the following, we will not repeat the contents of the table, but we will point out some particularly interesting results. First of all, caution is required with regard to comparing the studies. While Birkenmeier (2003), whose survey, however, was obviously carried out in

1996¹, states that most companies lack a dedicated external knowledge commercialization function, Ford (1985) found already in the 1980s general technology transaction units (directed at external technology acquisition or external technology commercialization) in 29 percent of the companies that he studied. However, one may assume that a large part of these units was primarily directed at the external acquisition of technologies, which has relatively early been considered an important strategic move (Ford 1985). Moreover, various of the studies (Vickery 1988; Brodbeck 1999; Elton *et al.* 2002; Birkenmeier 2003) show an increasing importance of the external knowledge exploitation, but the recent study of Elton *et al.* (2002) underlines that most companies still fail to capture the value inherent to potential external commercialization activities.

The works also show that companies that are involved in one particular form of the external knowledge commercialization, e.g. licensing-out activities, tend to be more active in other contractual forms as well, e.g. in alliances (Ford 1985; Birkenmeier 2003). Furthermore, Birkenmeier (2003) states that there is a positive relation between a structured external knowledge exploitation process and the extent of a firm's external commercialization activities and that firms with a structured approach are usually also more satisfied with their activities than other companies. However, these statements are based on the analysis of frequencies; no statistical methods are applied to prove the validity of the relations. Finally, the identification of potential knowledge customers, the pricing of the knowledge assets and the management capacity that is required for these activities are considered main difficulties when realizing external knowledge exploitation transactions (Ford 1985; Elton *et al.* 2002; Birkenmeier 2003).

Common to all studies is their focus on descriptive aspects, such as the importance of the external knowledge commercialization, the extent of these activities and general company characteristics. Nevertheless, descriptive company-level data, which give an overview on the increase in these activities in recent years, do hardly exist. Regarding the management of the external exploitation, various studies analyze on which organizational level keep-or-sell decisions are taken (Ford 1985; Brodbeck 1999; Birkenmeier 2003). Further insights into the managerial challenges and possible responses, however, are rather superficial, such as Birkenmeier's (2003) findings on the impact of a structured external knowledge exploitation process. Concerning the success in these activities, there is mostly a complete focus on the number of external knowledge commercialization transactions and on licensing revenues as the monetary success dimension. Only Ford (1985) and Birkenmeier (2003) consider the general satisfaction with the external exploitation activities as an additional success variable.

Along with the lack of conceptualizing and operationalizing the success of the external knowledge exploitation, a lack of success factor studies, i.e. studies which are aimed at identifying factors that are critical for success, has to be stated. Although a lot of managerial works give recommendations on how to enhance primarily the monetary success of the external knowledge exploitation (Rivette and Kline 2000b; Cohen 2004; Shuchman 2004), none of the potential success factors that are recommended in these works has been proven in a large-scale empirical study. This lack of empirical studies stands in sharp contrast to the extensive empirical research into the internal knowledge exploitation, particularly into new product development (Ernst 2002).

Finally, the extremely limited use of statistical methods has to be emphasized. Nearly all of the existing studies are limited to the analysis of frequencies and percentages; more sophisticated methods are hardly applied. Again, this fact is contrasted by the use of statistics in the internal technology exploitation (e.g. Cooper and Kleinschmidt 1995; Ernst 2002) and the external technology acquisition (e.g. Granstrand *et al.* 1992; Veugelers and Cassiman 1999). Apart from these studies, also empirical works in the other research areas that have been described in the earlier sections (e.g. the analysis of alliance capability by Kale *et al.* 2002), may provide helpful insights although they are not specifically directed at the external knowledge exploitation. All things considered, a severe lack of sound empirical research into the external commercialization of knowledge has to be stated which provides great opportunities for future research.

Agenda for future research

The previous sections have shown that despite taking into account literature from various fields of research there are severe limitations of the existing literature on external knowledge commercialization. This lack of research becomes obvious if the existing literature on the external exploitation of knowledge is compared with the detailed findings of research into the internal exploitation of knowledge, i.e. new product development and innovation, as the complementary exploitation mode and with research into the external acquisition of knowledge as the opposite direction of knowledge transactions. Accordingly, there are great opportunities for future research both on a theoretical and empirical level. Some promising paths for research into the external exploitation of knowledge will be outlined in the following.

The external commercialization of knowledge is increasingly considered a strategic activity, which has been reflected in some theoretical approaches. While the internal exploitation of knowledge has long been considered a core capability of the firm (e.g. Brown and Eisenhardt 1995) and similar approaches have been adopted in the literature on external knowledge acquisition, particularly through the concept of absorptive capacity (Cohen and Levinthal 1990; Zahra and George 2002), a competence-based view on the external commercialization of knowledge, which might serve as an appropriate basis for future research, is lacking. Such an approach would contribute to a sound theory of the external knowledge exploitation and might help to explain the discrepancies between, on the one hand, the mostly very positive attitude towards the external exploitation in the literature and the enormous benefits that some well-known companies realize with these activities and, on the other hand, the considerable difficulties and problems that many other companies experience in their operations.

Furthermore, researchers may analyze how such an external knowledge exploitation capability may be built up and if it requires a critical size of the external knowledge commercialization activities as well as sufficient prior experience with commercializing disembodied knowledge in general or in particular knowledge areas. Another aspect in this capability-based research direction may be the study of the effects that the development of an organizational capability would have, e.g. the question if some of the imperfections of the knowledge markets may be mitigated.

A critical component of studies on the effects of developing an organizational capability and of many other examinations in the area of external knowledge exploitation is a comprehensive understanding of the success that companies may achieve through carrying out these activities and of actually measuring the success or failure. To our knowledge, there are no empirical studies that go considerably beyond measuring the financial returns, such as licensing revenues, and try to capture the strategic dimensions of the external knowledge commercialization. Nearly all publications – academic and managerial – focus rather exclusively on the monetary effects of external knowledge commercialization activities. Naturally, the financial results achieved in these activities will be an essential – or even the essential – measure for success. Nevertheless, this unidimensional approach neglects a variety of strategic effects that may even exceed the positive financial impact of the external exploitation, e.g. by gaining freedom to operate or access to external knowledge in cross-licensing agreements (Grindley and Teece 1997; Reitzig 2004). A precondition for developing adequate success dimensions and variables is a detailed understanding of the objectives of commercializing knowledge. To date, the objectives have mainly been analyzed theoretically,

and the systematizations that have been proposed do not seem to represent the variety of strategic dimensions inherent to a proactive external knowledge exploitation. In this context, particularly the study of industry differences appears to be a promising path for future research.

After developing a more detailed and differentiated understanding of the objectives, risks and the success of commercializing disembodied knowledge, researchers might focus on potential success factors in the management of the external knowledge exploitation. An adequate management appears to be critical for realizing the potentials and simultaneously avoiding the negative consequences of the external knowledge commercialization. Following the outline of the section on the management of the external exploitation, promising areas of research may be particularly a firm's external knowledge exploitation strategy as well as the processes and organization of the external commercialization. As the external exploitation option is increasingly becoming a strategic activity, researchers may analyze if the distinction between an overall strategy on program level and a keep-or-sell decision on single-project level is appropriate and what such an overall strategy may be composed of. Particular emphasis should be put on the scope of the external exploitation activities and on the aspect of integrating the external knowledge commercialization strategy in the overall corporate strategy and coordinating it with the firm's internal exploitation strategies. Concerning the process view on the external knowledge exploitation, a more detailed and empirically tested process model is necessary to study the implementation of the commercialization strategies and its organizational integration.

With regard to the organization of the external knowledge exploitation, past research has shown that various firms have established a dedicated external knowledge commercialization unit. Future research should address the consequences of this institutionalization on the external commercialization activities and on the firm's success in these activities. Moreover, the internal structure of the external knowledge commercialization units, their competencies and their integration into the overall organizational structure of the company present interesting research opportunities. Furthermore, researchers may study the interfaces between these units and the project organization that is established in many companies for carrying out the individual knowledge transactions. In this context, it might be helpful to differentiate between the organization of the identification of external knowledge exploitation opportunities and the organization of the realization of the individual projects. In a broader study, the organization of the activities in diversified companies with various business units on the one hand and the interdependence of external knowledge acquisition and exploitation

and their possible integration on the other present great opportunities for future research. The use of intermediaries for different tasks along the commercialization process and the coordination of their services with the internal activities constitute further essential research questions regarding the organization of the external knowledge exploitation.

Apart from these formal organizational mechanisms, possible informal structures, such as external knowledge exploitation gatekeepers, provide great research opportunities. Beyond setting up a broad range of employees as informants about knowledge commercialization opportunities, a company may develop an 'external knowledge exploitation culture'. Apart from studying the effects that such a culture may have, a detailed investigation of the 'only-use-here' syndrome might lead to very interesting research results. As an equivalent to the 'not-invented-here' syndrome, the 'only-use-here' syndrome has only been proposed as a theoretical concept and has not been examined empirically at all. Apart from an external knowledge exploitation culture and a well-developed external exploitation capability, the reputation of the company (Stuart 1998) may represent an additional possibility to alleviate some of the problems inherent to the knowledge markets, e.g. it may facilitate the identification of potential partners by creating a 'knowledge market pull'.

In addition to the internal aspects of managing a firm's activities of commercializing disembodied knowledge, the role of the partner in the knowledge transaction presents great opportunities for future research. These issues range from the effects that a limitation of the potential partners, e.g. excluding direct competitors, may have on a firm's external knowledge exploitation success to the study of dyad-level settings of knowledge transfer. Furthermore, the characteristics of the knowledge to be commercialized and the effects that these characteristics have on the external knowledge exploitation success may be examined in more detail, particularly in empirical studies. Finally, researchers do not have to limit their studies to the firm as the object of analysis, which has been the focus of the present article, but may expand the field of research to universities and other research institutions. While there are some conceptual differences due to the lack of internal knowledge commercialization of these institutions, many of the findings concerning companies will also be applicable to this special context. There are some works regarding the external knowledge commercialization of universities (e.g. Davenport *et al.* 2002) but most of the literature in this field focuses on the final stage of actually transferring knowledge (Bozeman 2000; Agrawal 2001).

At last, we would like to underline again the lack of empirical research in the area of external knowledge exploitation. The existing studies that have been described above have mainly

addressed descriptive research questions and have often not led to results that may actually help companies to improve their external knowledge exploitation activities. While detailed descriptive data about the extent of the external knowledge commercialization in practice are needed, there is a greater need of empirical work in this second area of research, i.e. studies on the management of the external knowledge exploitation. Such studies should include the development of measures for the different success dimensions and should apply these measures to large-scale studies of the strategies, processes and structures that firms have in place to externally commercialize knowledge. As it has been stated above, a comparison with empirical research into the internal exploitation of knowledge and the external acquisition of knowledge does not only reveal the large deficits of empirical research into the external exploitation of knowledge but may also be helpful for developing adequate research designs.

Conclusion

It has been shown that many companies experience considerable difficulties when they try to commercialize disembodied knowledge. Despite these difficulties, a substantial increase in the external commercialization of knowledge could be observed during the last years. In combination, these two facts point to a strong need of research into this area. A detailed analysis of the existing literature has confirmed this need of research and has led to many interesting findings. Although the recent increase in the external knowledge exploitation is rather a trend from practice than a movement initiated by academic research, there is a considerable number of works on the commercialization of disembodied knowledge. However, the literature is highly fragmented, and there is not a continuous stream of research into the external exploitation of knowledge. Nevertheless, we believe that research into external knowledge commercialization, which includes tasks prior to the actual knowledge transfer, may lead to research results that constitute an essential complement to existing studies on knowledge transfer, particularly for companies that try to proactively commercialize knowledge.

Thus, the present article may serve as a basis for further conceptual and empirical work. We have identified the key characteristics of the external exploitation of knowledge, described the main imperfections of the knowledge markets and presented data to underline the growing importance of the commercialization of disembodied knowledge as well as reasons for this increasing importance. After analyzing the objectives and risks of the external knowledge exploitation, an overview on the past findings regarding the management of the relevant

commercialization tasks has been given. Above all, the review has revealed a severe lack of empirical studies on the commercialization of disembodied knowledge, especially with regard to success factors of the external knowledge exploitation.

Based on past research and findings from other areas, particularly the internal exploitation of knowledge and the external acquisition of knowledge, a research agenda has been established. Such a research agenda can hardly be comprehensive, but we hope that the large number of promising paths for future research and the great variety of research questions will encourage researchers to increasingly address the external exploitation and not to limit their studies to the external acquisition of knowledge. Especially research into the strategies, processes and structures of the external knowledge exploitation may lead to results that are critical for a deeper theoretical understanding but also directly applicable in practice. Thus, future research may considerably contribute to a more effective knowledge exploitation in companies. As much remains to be explored, further research into external knowledge exploitation will be essential against the background of an increasing commercialization of disembodied knowledge in practice.

Notes

¹ Although not explicitly mentioned in Birkenmeier (2003), the data of the study appears to be from the same survey as the data of Brodbeck (1999).

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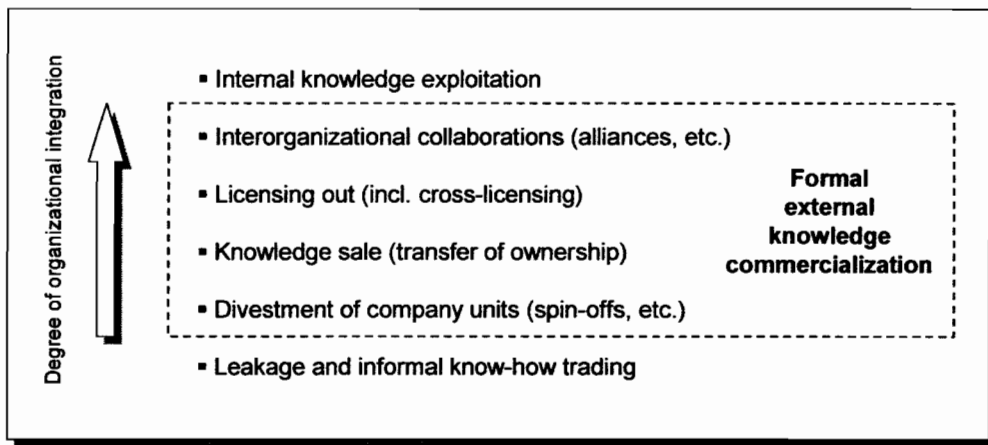
Fig. 1: Different knowledge management tasks on internal and external level (Source: adapted from Brockhoff 1999a, p. 153)

	Knowledge acquisition	Knowledge accumulation	Knowledge exploitation
Internal			
External			External knowledge commercialization

Tab. 1: Selected classifications of the forms of knowledge commercialization in past research

	Birkenmeier (2003)	Granstrand (1999)	Boyens (1998)	Vickery (1988)	Ford (1985/1988)
Internal use	Internal use	Internal use	Internal use	Internal use	Internal use
Collaboration	Joint venture	Joint venture	—	Joint venture	Joint venture
	Strategic alliance	Contract R&D		Management contract or technical service	
Licensing out	Licensing out to other regions	Licensing out	Licensing out	Licensing out	Licensing-out
	Licensing out to other industries		Cross-licensing		
	Licensing out to competitors		Grant-back	Turn-key plant	Contracted-out manufacture or marketing
	Licensing out to suppl./custom.		Supply of goods as compensat.		
Knowledge sale	Patent sale	Technology sale	Patent sale	Technology sale	Technology sale
	Technology sale				
Divestment of company units	Spin-off	Creation of innovative firm	—	—	—
	Sale of company unit	Divestment			
Informal knowledge trade and leakage	—	Storage and leakage	Informal know-how trading	—	—
			Lectures, etc.		

Fig. 2: Systematization of the types of knowledge exploitation



Tab. 2: Major empirical studies on the external knowledge commercialization

Study	Method	Major results
Ford (1985)	Questionnaire on technology marketing and technology purchasing in n=152 U.S. companies probably in the beginning of the 1980s	<ul style="list-style-type: none"> ▪ Number of technology transactions is usually small; revenues through technology transactions normally below 5% of total revenues ▪ Technology transactions increase with company size, R&D expenditures and international orientation of the companies ▪ Positive relation between intensity of technology purchasing and technology marketing activities; positive relation between technology marketing agreements and number of joint ventures ▪ 29% of companies have a dedicated technology transaction unit (for purchasing and selling technologies), in 24% of companies the top management decides on technology transactions ▪ 66% of the technology marketing transactions were initiated by the technology customer; intermediaries were used in 21% of the transactions ▪ Most technologies that are externally commercialized are also used internally ▪ Main problems during the realization of technology marketing activities (not considering prior process phases): low prices achieved for technologies, long negotiations, more manpower required than expected
Mittag (1985)	Questionnaire on licensing-in and licensing-out activities of n=276 German companies in 1981 (only 98 firms with licensing-out activities)	<ul style="list-style-type: none"> ▪ Licensing-out to foreign countries predominates ▪ Licensing-out activity (also to national licensees) increases with company size and size of patent portfolio ▪ Licensing-out agreements mainly with other independent companies and mainly with companies in the same industry ▪ Mixed licenses (incl. patents and know-how) predominate ▪ Most technologies that are licensed out are also used internally
Vickery (1988)	Questionnaire on importance and difficulties with technology licensing-out activities in n=119 companies worldwide in 1985-1986	<ul style="list-style-type: none"> ▪ Extent of licensing-out activities varies strongly among the companies ▪ Importance of licensing-out is increasing ▪ Licensing-out agreements mainly with other independent companies ▪ Most technologies that are licensed out are also used internally ▪ Companies with licensing-out activities usually carry out also a variety of other technology transfer activities, such as alliances ▪ Licensing-out is important mainly for a sub-sample of companies with high R&D expenditures

Tab. 2: Major empirical studies on the external knowledge commercialization (continued)

Study	Method	Major results
Brodbeck (1999)	Questionnaire on technology choice, acquisition and exploitation in n=281 German and Swiss companies in 1996	<ul style="list-style-type: none"> ▪ Importance of external technology commercialization has increased slightly, but it is less important than external technology acquisition; internal technology exploitation predominates ▪ ETC processes are not as structured as external technology acquisition processes ▪ Large companies use external technology commercialization more intensely ▪ Decisions on external technology exploitation usually taken on the board level ▪ Main reasons for using the external technology exploitation to a limited degree: fear of losing competitive advantage, lack of knowledge about the opportunities inherent to it, lack of management capacity
Elton (2002)	Study of more than 40 companies; research design not described (probably interviews)	<ul style="list-style-type: none"> ▪ Not all companies carry out external knowledge commercialization projects ▪ Most companies fail to capture the full value of their technologies due to lack of managerial attention to the external exploitation; usually they only earn below 0.5% of their operating income from licensing although often 5-10% would be possible ▪ Identification of technology customers is the main difficulty in proactive external exploitation activities ▪ Recommendation to use external networks and different types of intermediaries
Birkenmeier (2003)	Questionnaire on technology choice, acquisition and exploitation in n=281 German and Swiss companies probably in 1996	<ul style="list-style-type: none"> ▪ Importance of external technology exploitation has slightly increased, but internal technology exploitation predominates; foreign licensing-out agreements most important form of the external exploitation ▪ The most important motives for external exploitation are: extension of the product/market-portfolio, reduction of entry costs into new markets, amortization of R&D expenditures, strengthening of technological leadership ▪ Main barriers to the external commercialization: fear of losing competitive advantage, lack of knowledge about the opportunities inherent to it, lack of management capacity ▪ External technology exploitation is regarded as a complex task; often, decisions and processes of the external commercialization are not integrated into the strategic technology management but rather handled situationally; decisions on externally commercializing technologies usually taken on the board level; the decision level is usually higher than for decisions on technology acquisition; in most companies, no dedicated unit exists ▪ Positive relation between structured external technology commercialization process and the extent of these activities; positive relation between intensity of external technology acquisition and external technology exploitation activities; no direct relation between R&D expenditures and extent of external exploitation activities ▪ In general, most companies are satisfied with their external technology commercialization activities; companies with a structured external exploitation process are more satisfied in average

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