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# Desorptive capacity and its impact on the external commercialization of knowledge

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# DESORPTIVE CAPACITY AND ITS IMPACT ON THE EXTERNAL COMMERCIALIZATION OF KNOWLEDGE


## ABSTRACT

Companies may not only apply their knowledge assets internally, i.e. in own products and/or services, they may also exploit the knowledge assets externally, i.e. commercialize them in disembodied form. While the external acquisition of knowledge in general and the concept of absorptive capacity in particular have received great attention by researchers, the external exploitation of knowledge has long been neglected despite its increasing importance in practice. To bridge the resulting gaps in prior research, the concept of desorptive capacity as a complement to absorptive capacity is proposed by taking a capability-based approach to the external knowledge exploitation. Building on this theoretical concept, measures are developed, and data from a questionnaire-based study in 136 European companies across industries is used to examine various hypotheses relating potential sources of desorptive capacity to the success of firms in externally commercializing disembodied knowledge. Thus, this work also constitutes the first large-scale study that intends to empirically identify success factors of externally leveraging knowledge assets. The findings of the study provide strong support for the desorptive capacity concept, which helps to explain the discrepancies between the very positive view on the external knowledge commercialization in most works in the literature and the considerable difficulties with managing these activities that are often perceived in practice.



KEYWORDS: desorptive capacity, absorptive capacity, external knowledge commercialization, external knowledge exploitation, knowledge transfer.

## INTRODUCTION

Increasingly, knowledge is regarded as a major determinant of company performance in many industries (Amesse & Cohendet, 2001; Lane & Lubatkin, 1998). This view has been reflected and stimulated by a large variety of contributions in the literature on corporate strategy and on competitive advantage. Various approaches to the theory of the firm, such as the evolutionary view (Nelson & Winter, 1982), the resource-based theory (Wernerfelt, 1984), the dynamic capabilities approach (Teece et al., 1997) and the technology-based view (Granstrand, 1998) emphasize the critical function of knowledge in the process of economic value creation. Some researchers have even adopted a distinctly knowledge-based view (Grant, 1996; Spender, 1996) by regarding companies as distributed knowledge systems (Tsoukas, 1996). All these largely complementary approaches underline the importance of knowledge in general and of an adequate knowledge management in particular for gaining and sustaining a competitive advantage.

Apart from generating, accumulating and exploiting knowledge inside a firm, knowledge may be regarded as an economic good itself (Granstrand, 2000). Therefore, many companies have not only started internal knowledge management initiatives (Nonaka & Takeuchi, 1995; Teece, 2000), but they also make increasingly use of the external acquisition and external exploitation of knowledge in order to complement and capitalize their knowledge bases (Kurokawa, 1997; Rivette & Kline, 2000b). Despite the imperfections of the knowledge markets (Arora et al., 2001; Teece, 1981), an active external knowledge acquisition may be considered a rather common strategic move since the end of the 1980s (Granstrand et al., 1992; Veugelers & Cassiman, 1999).

However, the external knowledge exploitation, i.e. the direct commercialization of disembodied knowledge as the opposite type of knowledge transactions either exclusively or in addition to the internal application, has been growing only recently (Amesse & Cohendet, 2001; Rivette & Kline, 2000b). Increasingly, firms consider the external knowledge commercialization through various contractual forms, such as licensing agreements and alliances, 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 (Chesbrough, 2003; Kline, 2003). With regard to the monetary dimension of the external knowledge exploitation, this increase may be illustrated by the intellectual property revenues of IBM, which amounted to more than US$ 1.9 billion in 2001, up from merely US$ 30 million in 1990 (Chesbrough, 2003; Kline, 2003).

These numbers reflect the rather enthusiastic view on the commercialization of disembodied knowledge, which has been adopted in most works in the literature (Davis & Harrison, 2001; Rivette & Kline, 2000a). However, there is the contradictory situation that, apart from the enormous benefits of some pioneering companies, the majority of firms faces considerable difficulties in managing the external knowledge exploitation activities which has often led to a more reluctant attitude to the external knowledge commercialization (Elton et al., 2002). "[C]ompanies trying to imitate the success story of for example IBM's licensing program, often fail to initiate such an (sic!) deployment program due to market imperfections and the necessary high initial financial commitment" (Escher, 2003, p. 215). Especially the identification of potential knowledge customers is regarded as a major difficulty by many companies (Birkenmeier, 2003; Ford, 1985). This apparent contradiction underlines the strong need for research into the commercialization of disembodied knowledge, particularly regarding the ability of companies to manage the external knowledge exploitation process, because the current increase is rather a trend from practice than a movement initiated by academic research.

In the literature on knowledge transactions, most contributions focus on the external acquisition of knowledge (Arora et al., 2001; Granstrand, 2000), where a consistent theoretical approach was developed during the last years. In this context, the concept of absorptive capacity (Cohen & Levinthal, 1989, 1990) may be regarded as one of the fundamental concepts to emerge in organizational research over the past decades (Lane et al., 2002). Following the seminal work of Cohen and Levinthal (1990), the absorptive capacity construct has received enormous attention by researchers, including both conceptual works and a large variety of empirical studies (e.g. George et al., 2001; Lane & Lubatkin, 1998; Lane et al., 2001; Lenox & King, 2004; Mowery et al., 2002; van den Bosch et al., 1999). Recently, absorptive capacity has been reconceptualized as a dynamic organizational capability by Zahra and George (2002).

Despite the fact that the concept of absorptive capacity includes the application of knowledge in general, most researchers in the field assume either explicitly or by implication that the knowledge is exploited internally, i.e. applied in new products and/or services of the company (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Zahra & George, 2002). Although these internal innovation processes constitute the predominant mode of knowledge commercialization in most companies, this exclusive focus on internal innovation disregards the large potentials that may be realized by externally leveraging and transferring knowledge, which has been developed internally or has been acquired from external sources. In contrast,

research into knowledge transfer focuses, in addition to absorptive capacity, on the characteristics of the knowledge to be transferred, on contingency factors and on the form of transfer (e.g. Bozeman, 2000; Szulanski, 1996). Apart from some exceptions (Amesse & Cohendet, 2001; Lane & Lubatkin, 1998; Martin & Salomon, 2003), the ability of the sender to identify such external commercialization opportunities and to transfer the knowledge has mostly been neglected.

However, prior empirical research has shown that companies that take advantage of the external knowledge exploitation are usually also deeply involved in the external knowledge acquisition (Ford, 1985; Lowe & Taylor, 1998) which may be explained, among other reasons, by the ability of these companies to build up organizational competencies in knowledge transactions. Accordingly, this article is aimed at bridging the gaps in prior research that have been described above by developing the concept of desorptive capacity as a complement to absorptive capacity in the area of external knowledge commercialization. To overcome the purely conceptual stage and to validate the construct, we develop measures and analyze what influence a firm's level of desorptive capacity has on its success in the external knowledge commercialization. As to our knowledge prior empirical studies into the external knowledge exploitation have mostly been limited to descriptive aspects (e.g. Ford, 1985; Vickery, 1988), this work also constitutes the first large-scale study that intends to empirically identify success factors of externally leveraging knowledge assets.

We therefore believe that studying desorptive capacity and its impact on the performance of firms in externally leveraging knowledge assets is most relevant from an academic and a managerial perspective against the background of an increasing external knowledge commercialization in practice. After presenting the theoretical concept, we derive hypotheses relating various potential sources of desorptive capacity to the success of firms in externally commercializing knowledge. Applying newly developed measures, we test these hypotheses with data from a questionnaire-based study in European companies across industries. Finally, implications of the study for both theory and practice as well as directions for future research are presented.

## THEORY AND HYPOTHESES

### The concept of desorptive capacity

The basic assumption in Cohen and Levinthal's (1990) work on absorptive capacity is that "prior related knowledge confers an ability to recognize the value of new information,

assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 128). Building on this notion of prior related knowledge and on distinctions proposed in various other works (e.g. Adner & Levinthal, 2002; Brockhoff, 1997; Iansiti, 1997; Kogut & Zander, 1992; Martin & Salomon, 2003; Shane, 2000; van den Bosch et al., 1999), it is essential to differentiate between the following two knowledge components: the actual knowledge to be acquired or exploited on the one hand and the knowledge about its application on the other. The knowledge to be acquired or exploited refers to the knowledge assets themselves that a company plans to absorb or to commercialize, whereas the application knowledge refers to the knowledge about potential markets and applications for these knowledge assets. In the literature on technological knowledge, this distinction has been made by various authors. Adner and Levinthal (2002), for example, differentiate in their speciation view on technological change between technology and application domains, thus pointing to the need of having both technological knowledge, i.e. knowledge to be exploited, and application knowledge deriving from various potential application domains.

In the external acquisition of knowledge, a company looks for potential knowledge sources starting from a function that the knowledge should fulfill which is why it may be assumed that the company has sufficient application knowledge but is lacking relevant knowledge to be absorbed and exploited. Therefore, the original notion of prior related knowledge mainly refers to the knowledge to be absorbed and exploited which corresponds to Cohen and Levinthal's (1990) operationalization of absorptive capacity by using a firm's R&D expenditures. In the external commercialization of knowledge, in contrast, it may be assumed that a company which has developed the knowledge internally or which has absorbed it has an in-depth understanding of the knowledge to be exploited. However, it may lack sufficient application knowledge. The company owns a potential solution for certain problems and faces the challenge of identifying possible applications and potential knowledge customers which is particularly difficult in application areas that are far from the firm's own product business. Therefore, a firm with a relatively small knowledge base may be able to identify a large number of external knowledge exploitation opportunities due to its high level of application knowledge in various business areas. In contrast, a firm may also fail to commercialize a large knowledge base due to lacking application knowledge (Brockhoff, 1997; Shane, 2000).

In order to adequately manage the commercialization of disembodied knowledge, it has been suggested in prior works that firms adopt a process perspective (Ford, 1985). In a first step, companies have to recognize the knowledge assets in their knowledge base that could be externally commercialized. Furthermore, they have to identify potential knowledge customers

which is often considered the most difficult task due to the imperfections of the knowledge markets (Elton et al., 2002; Sullivan & Fox, 1996). Finally, the knowledge assets have to be transferred to the recipient. Concerning all these major external knowledge exploitation tasks, application knowledge is either helpful or even constitutes a prerequisite for their successful realization. For example, application knowledge is essential for identifying possible partners for the knowledge transactions, and it is also necessary for determining appropriate transaction conditions. It has been shown that many firms attempt to externally leverage knowledge assets but that they have difficulties with identifying external exploitation opportunities which is often a result of lacking application knowledge (Birkenmeier, 2003; Ford, 1985).

Thus, it is not sufficient to have the knowledge to be exploited, e.g. a particular technology, but it is also necessary to have the relevant application knowledge, which represents the critical prior knowledge component in the commercialization of disembodied knowledge and constitutes the basic notion in the concept of desorptive capacity. As absorptive capacity has recently been reconceptualized as a dynamic capability (Zahra & George, 2002), we conceptualize desorptive capacity as a dynamic organizational capability by adopting a capability-based perspective on the external commercialization of knowledge. The term 'desorptive capacity' is used because in science 'desorptive' refers to the process of 'desorbing', which constitutes the reverse of absorbing (Webster's, 1981). Accordingly, desorptive capacity as a complement to absorptive capacity in the area of external knowledge exploitation is defined as the ability of organizations to (1) recognize the external exploitation potential of their knowledge assets, (2) identify and contact potential users and establish appropriate transaction conditions and (3) adequately transfer the knowledge assets to the recipient.

As the desorptive capacity of a company refers to certain knowledge and application areas, it is path-dependent. Thus, the analysis of a firm's desorptive capacity cannot be realized in an isolated way, but it has to take into account a firm's general business activities, which largely determine a firm's level of prior knowledge in particular application areas. Moreover, developing desorptive capacity in one period will permit its more efficient development in the next which is reflected by conceptualizing desorptive capacity as a dynamic organizational capability (Kogut & Zander, 1992; Teece et al., 1997). With a high desorptive capacity, a large number of external exploitation opportunities will be identified and, due to learning effects and potential economies of scale, the transaction costs of the knowledge commercialization activities will decrease (Lane et al., 2002; Teece, 1981).

As the external knowledge exploitation in turn will enhance a firm's application knowledge and desorptive capacity, this path-dependent nature may finally lead to a self-reinforcing cycle, which may be intensified by the fact that a critical level of external knowledge exploitation activities is necessary for investments in developing desorptive capacity to pay off. In addition, the aspiration level of firms with a high desorptive capacity may be defined in terms of the external knowledge exploitation opportunities (Cohen & Levinthal, 1990; March & Simon, 1958) which may further strengthen the self-reinforcing cycle. Due to the same reasons, however, lock-out effects may emerge consistent with the external acquisition of knowledge (Cohen & Levinthal, 1990) which will keep firms from actively addressing the external exploitation option.

Thus, firms will only be able to reduce the transaction costs in the markets for knowledge if they take into account the path-dependent nature of desorptive capacity. Again, the licensing activities of IBM provide a vivid illustration of these dynamic and path-dependent characteristics. As the annual licensing revenues of IBM were below US$ 30 million at the end of the 1980s, the company started an active licensing-out program in 1989. Despite an absolutely outstanding technology and intellectual property portfolio – since 1993, IBM is the company worldwide with most patents granted each year consecutively – it took IBM over a decade to realize the enormous intellectual property revenues of more than US$ 1.9 billion in 2001 (Chesbrough, 2003; Kline, 2003; Shuchman, 2004; Sullivan & Fox, 1996).

Apart from the path-dependency of desorptive capacity, its conceptualization as a dynamic organizational capability indicates that it may be influenced by managerial action. Over time, desorptive capacity has to be developed and reconfigured by the management of a company in order to address the rapidly changing environment and external knowledge commercialization opportunities. Only by constantly aligning desorptive capacity with the firm's external knowledge exploitation strategy and the overall corporate strategy, it will help companies to achieve a competitive advantage by successfully leveraging their knowledge assets in disembodied form. In order to increase their desorptive capacities, firms may choose from a variety of actions. Due to the importance of application knowledge in the external knowledge exploitation, firms may invest in the optimization of individual tasks along the commercialization process or in the development of application knowledge as a process-spanning precondition. In this first work on desorptive capacity, we focus on application knowledge and derive hypotheses relating various potential sources of application knowledge to the success of firms in externally commercializing knowledge assets.

**The impact of desorptive capacity on the external knowledge commercialization**

Application knowledge is essential for all major tasks along the external knowledge commercialization process, such as the identification of external exploitation opportunities. Accordingly, the level of application knowledge may be expected to directly influence and reflect a firm's level of competence in these activities. Thus, a thorough measurement of the level of application knowledge and its use seems to be an appropriate operationalization of desorptive capacity which allows us to validate the concept's focus on this knowledge component. Such an operationalization is consistent with various empirical works on absorptive capacity (e.g. Cohen & Levinthal, 1990; Szulanski, 1996; Veugelers, 1997; see also Zahra & George, 2002). In these works, different measures of absorptive capacity have been employed, which, however, all focus on the existence of prior related knowledge. Based on an analysis of the possibilities to increase absorptive capacity that have been proposed in the literature from different fields of research and have partly been tested empirically, we have identified various potential sources of application knowledge and desorptive capacity.

In the original work on absorptive capacity, Cohen and Levinthal (1990) state that the prior knowledge to be exploited may be acquired as a byproduct of a firm's own R&D activities. Accordingly, these authors use a firm's R&D expenditures as an operationalization of its absorptive capacity. Thus, the operationalization of desorptive capacity corresponding to the work of Cohen and Levinthal (1990) would be a firm's business diversification. This product-oriented diversification reflects the application knowledge that a company acquires as a byproduct of its own production and sales by being active in a number of markets for products and/or services (Abernathy, 1978).

Due to the path-dependent nature of desorptive capacity, a firm's level of application knowledge cannot be analyzed separately from the firm's other activities because it is cumulative and related to the other operations. As being active in the relevant product markets is the best way to gain application knowledge, commercialization performance will be greatest when the area of commercialization is close to the areas that are familiar to the firm (Kogut & Zander, 1992; Lane & Lubatkin, 1998). While companies generally may commercialize knowledge inside and outside their own industries, they will often lack the necessary application knowledge in other industries which complicates the use of the external exploitation option. Therefore, a firm's business diversification, i.e. the number and scope of product areas in which the company is active (Granstrand, 2000), may be expected to

positively influence the firm's external knowledge commercialization performance. This leads us to the following hypothesis:

***Hypothesis** 1. The more diversified a firm is, the more successful it is in the external knowledge commercialization.*

For making effective use of a firm's entire application knowledge, it is necessary that the knowledge is communicated across the organization, which may be regarded as a distributed knowledge system (Tsoukas, 1996). Besides the knowledge of the employees that may be dedicated exclusively to the external knowledge commercialization, a firm has to ensure that the application knowledge which is gained as a byproduct of own production and sales is actually utilized inside the organization. Thus, a firm's desorptive capacity does not only depend on its interface with the external environment but also on the knowledge transfers across and within subunits (Cohen & Levinthal, 1990). If every subunit of a company only makes use of its own application knowledge, the potentials inherent to an adequate communication of the application knowledge between different subunits, particularly in a diversified firm, will remain unrealized.

One business unit, for example, may have developed a particular technology, which it could leverage externally. For a successful external commercialization, however, it might need the application knowledge of a different business unit in order to identify potential knowledge customers. Apart from the communication between different business units, the pooling of the knowledge bases also has to overcome functional barriers, e.g. the R&D and marketing interface (Brockhoff & Chakrabarti, 1988). The potential positive effects of knowledge sharing among the different subunits inside a firm by establishing adequate communication routines and an appropriate knowledge management lead us to the following hypothesis:

***Hypothesis** 2. The better the intraorganizational communication in a firm is, the more successful the firm is in the external knowledge commercialization.*

Consistent with the concept of absorptive capacity (Zahra & George, 2002), a company may not only develop application knowledge as a byproduct of its own production and sales, but a firm may also directly invest in desorptive capacity by initiating actions to enhance its application knowledge. The most obvious of these actions is to allocate resources, particularly dedicated employees, exclusively to the external commercialization of knowledge assets. Regarding the causal relation between this action and the extent of a firm's external knowledge exploitation activities, it may be argued that the number of employees rises with the extent of these activities. As the work of the dedicated employees comprises, among other

tasks, the coordination of external knowledge exploitation transactions, which also includes operational tasks, this argument is partly valid.

However, prior works (Davis & Harrison, 2001; Escher, 2003; Ford, 1985; Sullivan & Fox, 1996; Tschirky et al., 2000) and the exploratory interviews that we conducted in the beginning of this study indicate that the main tasks of dedicated external knowledge commercialization employees are the planning of the transactions and particularly the identification of external knowledge exploitation opportunities. This view is supported by the examples of various pioneering companies, such as IBM, which first initiated an active external knowledge exploitation strategy including the assignment of employees before the extent of these activities rose significantly (Chesbrough, 2003; Kline, 2003; Koruna, 2004). Thus, we have sufficient grounds for positing as the predominant causal relation that the number of dedicated employees has a positive influence on the extent of a firm's external knowledge commercialization activities. Due to the option to actively invest in desorptive capacity by building up specific resources, we suggest the following hypothesis:

***Hypothesis 3.*** *The more resources a firm dedicates to the external knowledge commercialization, the more successful it is in these activities.*

Beyond creating an adequate intraorganizational communication and dedicating specific resources to the external knowledge commercialization, it seems beneficial to establish a participatory approach to these activities which will result in a broader knowledge architecture (van den Bosch et al., 1999). As the resources of the dedicated external knowledge exploitation employees are limited, an active involvement of the organization's other members seems appropriate. Researchers in the absorptive capacity field have called for a broad range of potential receptors (Cohen & Levinthal, 1990; van den Bosch et al., 1999). Regarding desorptive capacity, this view corresponds to a large number of persons that actively try to identify external knowledge exploitation opportunities.

In addition to marketing staff, it appears to be particularly helpful to draw on the knowledge of R&D employees, which have often developed new knowledge assets themselves and may have interesting ideas for their potential external commercialization, either exclusively or in addition to the internal application. Although we propose an active involvement of these persons, we acknowledge their limited resources for the external commercialization activities, which usually do not constitute a firm's core business. Similar to absorptive capacity, however, the identification of external exploitation opportunities may be realized by these persons along with their ongoing work without major resource requirements (Allen, 1977;

Cohen & Levinthal, 1990). As such an active and participatory approach to the external commercialization of knowledge may considerably enhance the use of a firm's application knowledge, we postulate the following hypothesis:

***Hypothesis 4.*** *The more participatory the external knowledge commercialization approach of a firm is, the more successful it is in these activities.*

In addition to relying on its internal knowledge base and on other internal instruments, a company may draw on its interorganizational relationships to develop sufficient application knowledge for its external knowledge commercialization activities. Interorganizational ties, which today may be regarded as commonplace (Dyer & Singh, 1998; Gulati, 1998), may be attributed to a large degree to underlying knowledge strategies of the firms, particularly in knowledge-intensive industries (Grant & Baden-Fuller, 2004; Mowery et al., 1996). Various empirical studies have highlighted the important informational advantages that may be derived from a firm's embeddedness in interorganizational relationships (Ahuja, 2000; Stuart, 1998), which may lead to network resources (Gulati, 1999). In this context, Gulati (1999) has found that the network of accumulated prior alliances of companies is influential in their decision to enter into new alliances. From other works (Bidault & Fischer, 1994; Elton et al., 2002; Hoegl & Wagner, 2005; Koruna, 2003), it may be concluded that particularly close relationships with both buyers and suppliers will help to develop a firm's desorptive capacity.

As the overall network structure of a company's relationships is unique, these idiosyncratic interorganizational ties may be an important source of competitive advantage (Gulati et al., 2000; Lorenzoni & Lipparini, 1999). Particularly, they may provide excellent opportunities for gaining additional application knowledge, either as a byproduct of relations that have been established for other purposes or as the result of an intended strategic move to develop that application knowledge in a specific relationship. Due to the possibility of enhancing a firm's internal knowledge base by initiating interorganizational relationships, we posit the following hypothesis:

***Hypothesis 5.*** *The higher a firm's involvement in interorganizational networks is, the more successful it is in the external knowledge commercialization.*

Up to now, we have not explicitly considered the international dimension in our analysis of potential sources of application knowledge. In addition to business diversification, however, we may take into account market diversification and particularly internationalization as a special case (Granstrand, 1998). In this context, it may be assumed that internationalization will have a positive effect on desorptive capacity. Due to the additional application

knowledge that is acquired through business activities in foreign markets (Contractor et al., 2002), new external exploitation opportunities may be identified, which may lead to additional knowledge transactions in the specific foreign market and in all other markets.

Moreover, the international dimension generally expands the external knowledge commercialization potential because knowledge may be externally commercialized in foreign countries which is often done in the beginning of the internationalization process to a particular country, e.g. through licensing-out agreements (Root, 1994). However, we focus on international business activities that include a continuous presence in the foreign markets, e.g. by establishing affiliates in these countries. Based on the assumption that this type of internationalization will increase a firm's application knowledge and desorptive capacity, we postulate the following hypothesis:

***Hypothesis 6.*** *The more international a firm is, the more successful it is in the external knowledge commercialization.*

An effective use of a firm's application knowledge in general and an active participatory approach in an international environment in particular will only be achieved in a company whose employees are open to the external exploitation. Employees who have negative attitudes to the external knowledge commercialization and who do not regard it as an equivalent exploitation option to the internal knowledge application will not only be reluctant to actively participate in these processes, they may even tend to resist to the external exploitation. While in the area of the external knowledge acquisition such attitudes are well known as the 'Not-Invented-Here syndrome' (Katz & Allen, 1982), the 'Only-Use-Here syndrome' in the external knowledge exploitation (Boyens, 1998; Brockhoff, 1998) has received only little attention despite its potentially high importance as some examples indicate (Chesbrough, 2002).

Beyond the attitudes of individuals, such behavior is usually deeply rooted in the organizational culture of a company, which itself may be influenced by industry-specific aspects. In the chemical industry, for example, markets for knowledge have already existed for over 100 years (Lamoreaux & Sokoloff, 1998), whereas in other industries knowledge transactions are still rather exceptional. Similar to desorptive capacity itself, these cultural factors are strongly path-dependent. Thus, a firm's prior experience in this area may be expected to have a strong influence on its external knowledge commercialization approach. The assumption that an open climate regarding the external exploitation option will enhance the use of a firm's application knowledge leads to the following hypothesis:

***Hypothesis** 7. The more favorable a firm's climate is to the external knowledge commercialization, the more successful the firm is in these activities.*

Firms with a lot of experience in the external knowledge exploitation may in addition take a rather different approach to increasing their desorptive capacities. They may try to lower the transaction costs in the knowledge markets and to increase the market pull by building up a strong image as a knowledge provider (Stuart, 1998). This way of building up desorptive capacity may be assumed to be feasible mainly for firms in high-technology industries with a strong technological reputation and an active involvement in the markets for knowledge.

As it alleviates some of the main imperfections inherent to the knowledge markets, this approach may help to reduce the need to develop application knowledge, which, however, is still necessary for various of the tasks along the commercialization process. As a reputation of being a valuable knowledge provider requires prior external knowledge exploitation activities, developing application knowledge appears to be inevitable. Nevertheless, a good reputation in general and a good reputation as a knowledge provider in particular may help to overcome major difficulties in the external knowledge exploitation process. Thus, we posit as our final hypothesis:

***Hypothesis 8.** The higher a firm's reputation in the area of the external knowledge commercialization is, the more successful it is in these activities.*

Companies will usually not only use one of the potential forms of developing desorptive capacity that have been described above, but they will use different forms simultaneously. Accordingly, considering these different methods of developing application knowledge and making adequate use of it seems to constitute a detailed representation of a firm's level of desorptive capacity. The eight hypotheses regarding the influence of the potential sources of desorptive capacity on a company's performance in the external knowledge commercialization will be tested in the subsequent empirical analyses.

## METHODS

### Sample and Data Collection

After a detailed analysis of the existing literature, exploratory interviews in numerous firms were conducted, often with more than one person per company. We focused on technology-oriented companies because nearly all of their external knowledge commercialization activities refer to technological knowledge (Ford, 1985; Vickery, 1988) instead of the

commercialization of a broad range of knowledge assets and other intangible assets. This approach provided a homogeneous setting for our study. Another advantage was that transactions of technological knowledge usually include patents which is why normally in all technology transactions, i.e. transactions comprising patents or not, the intellectual property department of a company is involved. This organizational approach further increases the interfirm comparability of the findings. Due to the fact that there are strong similarities between companies from different industries regarding the questions on which our study focuses and due to the lack of prior large-scale studies, we opted for a cross-industry study.

Furthermore, we decided to conduct the empirical analyses at the firm level and not for individual business units or individual projects because we learned that most of the external knowledge exploitation activities are coordinated at the corporate level. Moreover, the critical question at the current state of research seems to be how companies may make adequate use of the external exploitation option in general and not how individual transactions may be optimized. Furthermore, general insights in managing the external knowledge commercialization at the project level may be gained by transferring results from other research fields, such as research into alliances. An additional reason for the firm-level approach was the fact that some of the potential sources of application knowledge, such as diversification or cultural aspects, can be examined more appropriately at the firm level.

Due to the importance of the intellectual property department in the external knowledge commercialization process, we identified the heads of these departments as key informants. In the companies that had a dedicated external knowledge commercialization unit the head of this unit was our key informant. These persons have a broad perspective on their firms' overall external knowledge exploitation activities, and they were the only ones with sufficient knowledge to participate in the survey. Usually, they were already involved in these activities for several years. Due to the confidentiality of many of the questions in the survey, it was important to sufficiently legitimate our study. Therefore, we sought the support of the Licensing Executives Society, which is an organization of practitioners that are active in the licensing area. Apart from lawyers, many heads of the intellectual property departments of industrial companies are members of this society.

Accordingly, we contacted industry members of the Licensing Executives Society in Germany, Switzerland and Austria. As we aimed at analyzing a cross-section of middle and large industrial companies in these countries, we additionally considered companies ranked among the 500 largest firms in Germany and among the 100 largest firms in Switzerland and

the 100 largest firms in Austria based on revenues. Thus, we have analyzed firms whose main business is the internal knowledge exploitation, i.e. the application of knowledge in own products and/or services. We have not analyzed the knowledge exploitation activities neither of start-up companies (e.g. Pisano & Mang, 1993) nor of firms that mainly provide R&D services (e.g. Chiesa et al., 2004). Due to our focus on technology-oriented industrial companies and due to a considerable overlap between the member firms of the Licensing Executives Society and the top 500 or top 100 firms, we identified 412 companies as potential participants for our study. Although the firms may not have been selected completely randomly, the sample is more random than the samples in many other studies, and the firms represent a cross-section of middle and large industrial companies in the three countries. As the Licensing Executives Society comprises members from companies that are very active in the external knowledge commercialization but also members from companies that are rather passive in this regard, we do not have to expect a strong positive bias in the sample, which would make the generalization of the results difficult.

Data collection was undertaken via a detailed questionnaire, which comprised additional elements to the constructs used in this study and which was pre-tested with 15 persons. Moreover, critical terms and expressions used in the questionnaire, such as the specific understanding of external knowledge commercialization, were defined in the questionnaire. At the beginning of the data collection process, the key informants were contacted personally by the researchers via telephone to inform them of the goals, scope and confidentiality of the study. Furthermore, they were told that all participants received a detailed summary of the results of the study, which facilitated benchmarking analyses. Also, they were asked if they would like to get the questionnaire as a paper copy or as an attachment to an email, which could be filled out electronically. In addition, all respondents had the opportunity to contact the researchers directly whenever questions arose while completing the questionnaire. This procedure ensured that all of the questions were fully understood. Four weeks after sending the questionnaire, the participants received a reminder via email, another two weeks later they were again contacted via telephone.

A total of 155 firms participated in the study which corresponds to a response rate of 37.6 percent. In comparison with similar studies, this is a very high response rate taking into account that external knowledge commercialization activities in general and exact data, such as licensing revenues, in particular are usually treated extremely confidential. Of the 155 questionnaires, data were sufficiently complete from 136 firms to allow them to be included in the analysis that is presented in this article. After processing the data, additional interviews

were carried out with participants from numerous firms. In these interviews, we could discuss the results with the practitioners in order to be able to better interpret our findings.

## Measures

Despite the data collection in Germany, Switzerland and Austria, the questionnaire was administered in English. As the members of the Licensing Executives Society regularly receive a members' journal in English and as most of the participating companies are rather international companies with headquarters in one the three countries, the language did not constitute a barrier. Due to the complete lack of prior empirical success factor studies on the external commercialization of knowledge, almost all items were specifically generated for this study.

### *Dependent variable*

Due to the fact that only the heads of the intellectual property department or of the dedicated external knowledge commercialization unit were able to complete the questionnaire, we took a key informant approach. In order to avoid common source bias, we used a firm's annual licensing and knowledge sale revenues as an objective success variable. This variable comprises revenues from licensing-out agreements as well as revenues derived from the sale of knowledge assets, which, in contrast to licensing-out agreements, includes a transfer of ownership. By applying this measure, we focus on the monetary success dimension of the external knowledge exploitation and on the contractual forms of licensing agreements and knowledge sales. In the pretests, we were told that, due to the usually high confidentiality of this number, we could measure the licensing and knowledge sale revenues only in the following five classes: EUR 0-5 million, EUR 5-20 million, EUR 20-50 million, EUR 50-100 million, over EUR 100 million. For cross-validation purposes, we further correlated the licensing revenues measure with the subjective measure 'The return on our investments in the external technology exploitation is high', which was measured on a 1-7 Likert-type scale. The correlation coefficient is .823 ($p < .01$). This leads us to conclude that firms which actively invest in developing desorptive capacity regard their investments as adequate in relation to the monetary results derived from these activities.

***Hypothesized variables***

In the cases in which constructs are used for the application knowledge variables, the items are listed in the appendix; all items have been measured on a 1-7 Likert-type scale. The measurement scale for *product diversification* (Cronbach's alpha = .934) consists of three items on the size and diversity of a firm's product portfolio. Thus, the items on business diversification reflect the scope of application knowledge that a firm may gain as a byproduct of its own production and sales in different product and application areas. The measurement scale for *intraorganizational communication* (Cronbach's alpha = .754) comprises three items on the communication between a firm's subunits in the identification of external knowledge exploitation opportunities and on the functioning of a firm's knowledge management in general. Accordingly, the items capture how well application knowledge that exists in one subunit of a firm may be accessed by other subunits in the external knowledge commercialization process.

Regarding dedicated external knowledge exploitation *employees*, we asked for the number of persons that are occupied full-time with the external knowledge commercialization at the corporate level and at the business unit level in all business units together. For our analyses, we used the sum of the employees at the corporate and the business unit level. The construct *participatory approach* was measured on a three-item scale (Cronbach's alpha = .913). It measures if, in addition to dedicated external knowledge commercialization employees, a large number of persons tries to identify external knowledge exploitation opportunities. Due to the importance of marketing and R&D employees for accessing application knowledge and in order to facilitate the understanding of the items, the construct focuses on the participation of marketing and R&D employees in the identification of external knowledge exploitation opportunities.

The four-item scale assessing a firm's embeddedness in *interorganizational networks* (Cronbach's alpha = .931) addresses how strong a firm's involvement in interfirm networks is and to what degree a firm actually uses these networks to gain application knowledge. Again, the value of Cronbach's alpha is very high for this construct which leads us to conclude that firms which are strongly involved in interorganizational networks are also able to derive high value from these networks by successfully accessing the knowledge inherent to them. The measurement scale for a firm's degree of *internationalization* (Cronbach's alpha = .900) consists of three items on the importance of the international business activities and on the number and diversity of a firm's affiliates in foreign countries, thus focusing on the

continuous presence in the foreign markets. Therefore, the construct captures if a company may gain additional application knowledge by being active in a variety of foreign markets.

The measurement scale for a firm's external knowledge exploitation *climate* (Cronbach's alpha = .882) consists of three items on the general attitude of a firm's employees to the external knowledge commercialization and on a firm's experience in these activities. The high value of Cronbach's alpha supports our view of the path-dependent nature of an open external knowledge commercialization culture. The construct external knowledge exploitation *reputation* (Cronbach's alpha = .789) measures on a three-item scale if a company is able to establish an image as a good knowledge provider and to initiate market pull effects based on this image. If potential knowledge customers contact a company due to its reputation, these inquiries may diminish some of the difficulties in the external knowledge commercialization process which are a result of the imperfections of the knowledge markets.

***Control variables***

Apart from the explanatory variables for which hypotheses have been formulated, we have taken into account four sets of control variables. First, the size of a company may be expected to have an impact on the external knowledge commercialization success because it may influence a firm's external knowledge commercialization potential, i.e. the volume of knowledge that may be externally leveraged. Therefore, we have included in our analyses the *revenues* of the companies in billion EUR as a measure of their size. Due to the higher external knowledge commercialization potential and due to our focus on technological knowledge, also a company's R&D intensity may influence its external knowledge commercialization success. Thus, we have included a firm's *R&D intensity*, i.e. the percentage of R&D expenditures/sales, as an additional control variable.

Due to our cross-industry approach, we also controlled for the *industry* in which the firms are active. Based on prior works on the external knowledge commercialization (Arora, 1997; Birkenmeier, 2003; Davis & Harrison, 2001; Grindley & Nickerson, 1996; Grindley & Teece, 1997; Nickerson, 1996; Rivette & Kline, 2000b), which reported considerably different functions and purposes of the external knowledge exploitation in these industries, we grouped the companies into the following four classes: automotive/machinery, chemicals/pharmaceuticals, semiconductors/electronics and remaining. For the first three classes, we included a dummy variable (1 = pertaining to this industry; 0 = not pertaining to this industry) in our analyses. The same method was applied to the *country of origin* of the

companies. For Switzerland and Austria, we also included dummy variables (1 = headquarters in that country; 0 = headquarters not in that country) in our analyses.

## RESULTS

Table 1 shows the descriptive statistics and correlations, table 2 presents the results of the multiple regression analyses using the classification of the firms' annual revenues from licensing out and selling disembodied knowledge as the dependent variable. Five models were tested consisting of the control variables and different numbers of application knowledge variables. All five models are highly significant at $p < .001$ and explain a large amount of the variance in licensing revenues (adjusted $R^2$ of .392 – .750). The levels of significance of the control variables shift slightly depending on the number of variables included in the models. As it could be expected, the levels of significance of some of the hypothesized variables decrease when additional variables are included in the models. Overall, however, the patterns of association displayed by the models are stable.

Taking into account the large number of independent variables regarding the external knowledge commercialization, the potential for multicollinearity exists. Accordingly, we calculated the square root of variance inflation factor for the independent variables. In all models, the highest values referred to the three control variables concerning the different industries. The highest value across all models and variables referred to the variable 'chemicals/pharmaceuticals' in model 5 and amounted to 1.734. The highest square root of variance inflation factor for the hypothesized variables referred to the variable 'reputation' in model 5 and amounted to 1.623. Thus, the values are within an acceptable range (Fox, 1991) which allows us to keep all variables in the models.

--- Please insert Table 1 about here ---

Model 1 considers exclusively the four sets of control variables, which in sum comprise seven variables. Apart from the significant positive impact of the variables 'chemicals/pharmaceuticals' and 'electronics/semiconductors', which becomes insignificant in the latter models, we find the expected positive influence of R&D intensity, which, however, is not significant in the first model. The most important finding in model 1 is the strong positive influence of the company size measured by a firm's revenues which considerably contributes to the high adjusted $R^2$ of .392 of the first model. On the one hand, the company size will usually impact the external knowledge commercialization potential, i.e. the volume of knowledge assets which may be externally commercialized, which helps to

explain a part of the strong impact of the 'revenues' variable. On the other hand, the company size may be expected to determine to a large degree the attention that the external commercialization of knowledge receives in a firm, particularly regarding an active strategic approach and a systematic process for these activities. The correlation analyses show high and strongly significant correlations of the 'revenues' variable with the 'number of dedicated employees' ($r = .494$) and the external knowledge commercialization 'climate' ($r = .400$) which support our additional explanation of the strong influence of company size and of the high $R^2$ of the first model.

--- Please insert Table 2 about here ---

In addition to the control variables, we have introduced in model 2 the variables concerning the first two potential sources of application knowledge. By considering these variables, the adjusted $R^2$ strongly increases to .559. The product diversification variable has a strong positive and highly significant impact on a firm's licensing revenues, thus providing strong support for hypothesis 1. Obviously, firms may considerably increase their application knowledge by being active in different product markets. Moreover, this finding shows that firms usually do not take actual 'keep-or-sell' decisions in exploiting knowledge, i.e. they do not commercialize knowledge either internally or externally. Rather, this result underlines that firms which are active in a variety of internal knowledge exploitation activities also tend to be more active in the external exploitation. Despite potential economies of scope in the internal knowledge application, there are still opportunities in the external exploitation, which can be realized by making use of the application knowledge that is gained in the internal activities.

It could be argued that the licensing revenues of large and diversified companies may be attributed to a large degree to international licensing agreements as an instrument to enter into foreign markets which would undermine the explanation based on application knowledge that has been given above. To control for this potential effect of international market entry via licensing agreements, we calculated additional models to the ones described above, which are not presented in this article. These models are nearly the same as the ones that are reported, they only include as an additional explanatory variable the respondents' answers to the statement 'The share of licenses to foreign countries in all licensing-out agreements is high' measured on a 1-7 Likert-type scale. However, this additional variable did not have any significant effect. Thus, the firms' licensing revenues are not mainly determined by revenues from foreign licensing agreements which emphasizes that our findings go considerably beyond research into international licensing. In addition to product diversification, the

variable 'intraorganizational communication' has a significant positive impact on a firm's licensing revenues in model 2. Thus, hypothesis 2 is also confirmed by the data. Obviously, the communication between different subunits inside a firm has a considerable influence on the extent of its external knowledge commercialization activities.

In model 3, we have further included the variables concerning the 'number of dedicated employees' and a 'participatory approach' to the external knowledge commercialization. As expected, the variable measuring the 'number of dedicated employees' has a strong and highly significant impact, thus providing strong support for hypothesis 3. Firms may not only acquire application knowledge as a byproduct of their internal knowledge exploitation activities, they may also build up application knowledge directly by assigning employees to the external knowledge exploitation tasks. As it has been shown above, we have sufficient grounds for positing as the predominant causal relation that the number of dedicated employees has a positive influence on the licensing revenues and not vice-versa. Moreover, we find a positive and highly significant effect of the variable concerning a 'participatory approach' to the external knowledge commercialization. Thus, hypothesis 4 is also confirmed by the data. The difference in the adjusted $R^2$ of .171 between the second and the third model underlines the strong positive influence of dedicated employees and of a participatory approach on a firm's external knowledge exploitation success.

An interesting additional result in model 3 is that the influence of the variable 'intraorganizational communication', which had a strong and significant impact in model 2, becomes considerably weaker and insignificant and remains insignificant in all later models. A plausible explanation for this finding is that, due to the strong and highly significant impact of the variables concerning the 'number of dedicated employees' and 'participatory approach', the importance of the general communication among different subunits inside a firm decreases. Dedicated employees will usually serve as contact persons for the external knowledge commercialization, thus forming a communication hub with regard to these issues. Moreover, a participatory approach to the external knowledge exploitation strengthens the support that the dedicated employees receive from other employees across the firm. This explanation is further backed by the considerable change in the coefficient of 'intraorganizational communication' when additionally introducing the variable 'climate' in model 5. Accordingly, companies with a relatively weak 'intraorganizational communication' may obviously offset the potential negative consequences of this lack of general interunit communication by assigning dedicated employees and adopting a participatory approach to the external knowledge exploitation.

In model 4, we have further included the variables 'interorganizational networks' and 'internationalization'. Regarding the possibility to build up application knowledge via ties with other firms, we find a significant positive influence of the 'interorganizational networks' variable, thus confirming hypothesis 5. Accordingly, we find support for the view on interfirm relations as an external mode of knowledge accumulation because companies may use their networks to access the application knowledge inherent to them. It is beneficial for firms to not only rely on their internal knowledge bases to develop their desorptive capacities but to take additionally into account the knowledge gained in their interorganizational relations. Moreover, hypothesis 6 concerning the positive impact of a firm's degree of 'internationalization' is confirmed. Besides the application knowledge that is developed via product diversification, firms appear to be able to also make use of the additional application knowledge derived from being active in various countries. In this context, it has to be underlined again that the operationalization of the 'internationalization' construct explicitly refers to international activities via affiliates and thus to foreign direct investments. Accordingly, internationalization via foreign licensing agreements, which of course would have a direct impact on the dependent variable, does not affect this measure.

In model 5, we have taken into account all explanatory variables, including 'climate' and 'reputation'. We find a strong positive impact of the variable concerning the external knowledge commercialization 'climate' which provides strong support for hypothesis 7. Non-negative attitudes of a firm's employees towards the external knowledge exploitation considerably enhance its success in these activities. It has to be highlighted that the construct 'climate' does not refer to the attitudes of intellectual property specialists or of dedicated external knowledge commercialization employees but to the attitudes of a firm's employees in general and therefore to a component of a firm's corporate culture. Furthermore, the operationalization of the construct shows a strong relation between this cultural aspect and a company's experience with the external knowledge commercialization which provides strong support for the path-dependent nature of desorptive capacity. Moreover, we find a positive but not significant impact of the external knowledge 'reputation' of firms. Hypothesis 8 is therefore not supported by the data which shows that companies are obviously not able to significantly reduce their needs of application knowledge by developing a good reputation as a knowledge provider. At the current state of the external knowledge exploitation in practice, a potential explanation for this lack of significance could be that companies which are often contacted by other firms might tend to approach the external knowledge commercialization rather passively, thus foregoing external commercialization potentials that are not based on

inquiries from potential partners but on an active identification of external commercialization opportunities. A further explanation may be the fact that currently a considerable part of inquiries is declined by many firms due to their rather reserved approaches towards the external knowledge exploitation.

A comparison of model 1 and model 5 leads to various interesting findings. First of all, company size seems to be an essential advantage when externally commercializing knowledge. As a part of this influence may be expected to derive from the potential volume of knowledge assets that may be leveraged externally, large companies do not necessarily have to be more successful from a relative perspective, i.e. relating their licensing revenues to their external knowledge commercialization potential. This potential, however, is extremely hard to measure if it may be measured at all. Moreover, a high external knowledge exploitation potential obviously facilitates decisions to actively invest in developing desorptive capacity due to the higher potential return on these investments. Nevertheless, smaller firms may also be successful in the external commercialization of knowledge although they often have to overcome additional barriers, such as limited product diversification. Assigning dedicated employees, making use of interorganizational networks and building up a participatory approach and an adequate external knowledge commercialization climate constitute well-defined starting points for increasing desorptive capacity also in smaller firms.

Moreover, comparing model 1 and model 5 shows a difference in the adjusted $R^2$ of .358. Thus, the variables concerning application knowledge explain over 35 percent of total variance which underlines that desorptive capacity has a major impact on the monetary success of firms in the external knowledge commercialization. Seven of the eight variables, i.e. product diversification, intraorganizational communication, number of dedicated employees, participatory approach, interorganizational networks, internationalization and climate, have a significant impact on a firm's external knowledge commercialization success. This strong influence of the desorptive capacity variables is particularly remarkable as we have focused in our analyses on the ways of increasing desorptive capacity via increasing a firm's application knowledge as a process-spanning precondition along the external commercialization process. We have not taken into account further potential sources of desorptive capacity, such as methods to improve individual process steps. By establishing a capability-based and path-dependent view on the external commercialization of knowledge, desorptive capacity appears to be a helpful concept for explaining the activities and the success of firms in leveraging knowledge assets externally.

## DISCUSSION

After developing the theoretical concept of desorptive capacity, this study has analyzed the influence of potential sources of application knowledge on the monetary success of firms in the external commercialization of knowledge assets. Accordingly, this article represents the first work to introduce the concept of desorptive capacity, to propose appropriate measures for the concept and to test its relevance in an empirical study. Moreover, the study is to our knowledge the first work that has tried to identify potential success factors of the external knowledge exploitation in a large-scale empirical approach. Therefore, the study has bridged some major gaps in prior research which is particularly important against the background of an increasing external knowledge commercialization in practice. While the empirical results lead to important implications for both theory and practice, also some limitations of the analyses will be pointed out at the end of this section.

Regarding the theoretical implications of the study, the results show that application knowledge constitutes a major factor of influence on a firm's success in the external knowledge exploitation. Thus, the focus on prior application knowledge in the desorptive capacity concept as the equivalent to prior knowledge to be exploited in the absorptive capacity concept is strongly supported by the empirical data. The variables concerning application knowledge and its use explain a considerable part of the variance in the monetary success dimension of the external knowledge exploitation. This high explanatory value is particularly remarkable as the study has focused exclusively on the variables related to application knowledge and has not considered variables concerning, for example, a firm's process for these activities, which have been found to significantly influence the success in the internal knowledge exploitation, above all in new product development (Brown & Eisenhardt, 1995; Ernst, 2002). It may be assumed, however, that these aspects, e.g. establishing a systematic process, strongly correlate with the size of a firm which would help to explain the high influence of this variable.

Beyond proving the importance of application knowledge and confirming its appropriateness as an operationalization of desorptive capacity, our findings strengthen the capability-based approach to the external knowledge commercialization that is proposed in the desorptive capacity concept. Obviously, the successful firms have developed desorptive capacity as their external knowledge commercialization capability by building up and utilizing their application knowledge. In this context, it has to be underlined that the capability-oriented variables have a strong impact on a firm's success although we have controlled for variables

that influence a firm's external knowledge exploitation potential, such as firm size and R&D intensity. While these control variables rather influence the potential volume of the external knowledge commercialization, desorptive capacity seems to determine whether companies are able to realize these potentials or not.

Furthermore, the path-dependent nature of desorptive capacity, which is cumulative and should not be analyzed independently of a firm's other activities, has received strong support by the significant influence of different variables, such as diversification and the external knowledge exploitation climate. Moreover, the results of the study confirm the conceptualization of desorptive capacity as a dynamic organizational capability, which may be actively influenced by managerial action, such as assigning employees to the external knowledge commercialization tasks. Above all, the path-dependent and capability-based approach of desorptive capacity helps to explain the discrepancies between the very positive view on the external knowledge commercialization in most works in the literature and the considerable difficulties with managing these activities that are often perceived in practice.

Apart from applying the desorptive capacity construct in the area of externally leveraging knowledge assets, the concept may also be transferred to other fields of research. Application knowledge and desorptive capacity in general are not only important for the identification of external knowledge exploitation opportunities but also for the realization of the transactions including the outward transfer of knowledge. Accordingly, research into knowledge transfer should not only take into account, among other factors, the absorptive capacity of the recipient but also the desorptive capacity of the knowledge source. This is especially important in situations involving bi-directional knowledge transfers, which are rather common in practice (Grindley & Teece, 1997; Koruna, 2004).

With regard to the managerial implications of the study, the most important result is that firms may increase their desorptive capacities by actively building up application knowledge. At least in the short to medium term, assigning employees to the external knowledge commercialization tasks may seem to be the easiest way of increasing desorptive capacity. This is particularly important as they may help to overcome communicational barriers inside a firm due to their role as contact persons for issues concerning the external knowledge exploitation. However, it has to be underlined that dedicated employees need to have sufficient insight into the firm's knowledge assets as well as into potential applications and markets for these assets. Thus, firms should try to benefit from the T-shaped skills of selected employees (Iansiti, 1993; Madhavan & Grover, 1998). Due to the path-dependent nature of

desorptive capacity, an initial learning period nevertheless appears to be inevitable until the investments in developing desorptive capacity pay off. Therefore, it also seems to be difficult to completely rely on the expertise of external consultants, who might rather be used as a complement to a firm's internal activities.

Desorptive capacity is not a capability that is resident in some individual employees. Instead, the necessary application knowledge will usually be distributed among the firm's subunits. As the significant influence of the variables concerning diversification and internationalization on a firm's external knowledge commercialization success has shown, companies should attempt to make use of their distributed knowledge bases. As an extension of their internal knowledge bases, companies should also access the knowledge inherent to their relations with other organizations. The significant influence of interfirm networks provides further support for the knowledge and information accumulation in such networks, which has been found in prior works (Grant & Baden-Fuller, 2004; Gulati, 1999; Mowery et al., 2002).

One major way of accessing these distributed knowledge bases seems to be the development of a participatory external knowledge commercialization approach and of an organizational climate that is favorable to the external exploitation option. A corporate culture that is open to the external knowledge exploitation will also help to change the potentially negative attitudes of individuals who may be subject to the 'Only-Use-Here syndrome' (Boyens, 1998; Brockhoff, 1998). An open external knowledge exploitation climate may help firms to additionally draw on informal structures in the external knowledge commercialization process, such as participatory processes and external knowledge exploitation champions (Allen, 1977; Cohen & Levinthal, 1990; Ernst & Lechler, 2003). Furthermore, an open climate will generally facilitate a broader knowledge architecture (van den Bosch et al., 1999). Thus, assigning dedicated employees may be more effective in the short to medium term, whereas the more informal cultural factors may be expected to have a longer term and more sustainable effect on desorptive capacity.

In addition to the implications of the study, some limitations should be emphasized, which open up further research opportunities. By choosing to use a firm's revenues from licensing out and selling disembodied knowledge as an objective success variable, we have focused exclusively on the monetary dimension of the external knowledge exploitation. Thus, we have not taken into account strategic benefits that may be derived from these activities, such as establishing a particular technology as an industry standard. By focusing on licensing revenues, we also did not take into account a firm's external knowledge commercialization

activities in interorganizational alliances and other contractual forms, in which the impact of desorptive capacity may be expected to be equally strong. Moreover, the sample represents a cross-section of middle and large industrial companies in the three countries. Therefore, the results may not be directly transferable to very small companies, such as biotechnology start-up firms, although most results are highly significant suggesting that the findings have generalizable implications. Nevertheless, it may be worthwhile to conduct similar studies for small knowledge-intensive companies, which often are highly specialized and lack the application knowledge derived from diversification and dedicated external knowledge exploitation employees.

Furthermore, the importance of the desorptive capacity construct may not only be tested for other contractual forms and in other types of firms but also in completely different organizations, such as universities or research institutes, which are in a very similar situation to small knowledge-intensive companies in the external knowledge exploitation. In addition, we suggest to analyze desorptive capacity not only at the organizational level but also at the project and business unit level and particularly in dyad-level settings. In such dyad-level settings, e.g. knowledge-intensive strategic alliances, it might also be helpful to refine and extend the general desorptive capacity concept by developing partner-specific measures, which are comparable to the concept of partner-specific absorptive capacity (Dyer & Singh, 1998; Lane & Lubatkin, 1998; Mowery et al., 1996, 2002).

While we have focused in this first empirical study on application knowledge to validate the desorptive capacity concept, future works may test other possibilities to increase desorptive capacity because application knowledge constitutes a condition but not the only way of developing high levels of desorptive capacity. In this respect, the different approaches for measuring absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002) provide researchers with well defined starting points for their work. Based on the multi-dimensional definition of the concept and a process view on the external knowledge commercialization, desorptive capacity could be operationalized in such studies with multiple components which would correspond to the reconceptualization of absorptive capacity by Zahra and George (2002) and to the relative absorptive capacity approach by Lane and Lubatkin (1998). This would allow researchers to develop an instrument comparable to the efficiency factor in absorptive capacity (Zahra & George, 2002), which might show that there are companies that identify a large number of external knowledge exploitation opportunities but fail to make use of them and vice versa. Despite different operationalizations, however, application knowledge may be expected to remain the fundamental factor of influence on a firm's desorptive capacity

because it usually represents a prerequisite for the successful realization of many tasks along the external knowledge exploitation process.

## CONCLUSION

The findings of this study provide strong support for the notion of desorptive capacity, which has been conceptualized as a complementary construct to absorptive capacity in the external knowledge exploitation. Companies may significantly increase their success in commercializing disembodied knowledge by developing desorptive capacity as a dynamic organizational capability in this area. Based on the differentiation between the actual knowledge to be exploited and application knowledge, it has been shown that, in contrast to absorptive capacity, application knowledge is the critical knowledge component for desorptive capacity. As desorptive capacity refers to specific knowledge and application areas, it is related to a firm's organization and operations. Accordingly, desorptive capacity is cumulative and path-dependent, but at the same time it may be actively influenced by managerial action which is especially important against the background of an increasing external knowledge exploitation in practice. Particularly, developing application knowledge as a process-spanning requirement in the external knowledge exploitation process constitutes an important way of increasing desorptive capacity, which will allow organizations to fully leverage their knowledge assets.

Thus, the capability-based approach of desorptive capacity helps to explain the discrepancies between the very positive view on the external knowledge commercialization adopted by most researchers and consultants on the one hand and the major difficulties with managing these activities that are perceived by many practitioners on the other. Similar to absorptive capacity, however, the potential use of the desorptive capacity concept is not limited to the field of external knowledge exploitation from the perspective of a single company. Instead, it may also lead us to rethink our understanding of other research areas, such as research into knowledge transfer and alliances, which have often focused rather exclusively on the recipient of the knowledge assets. As much remains to be explored, there are great opportunities for further research into desorptive capacity, particularly regarding additional empirical studies. The detailed findings of research into absorptive capacity provide excellent starting points for future work.

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## TABLE 1
## Descriptive statistics

| Variables | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Licensing revenues° (1) | 1.45 | .980 | | | | | | | | | | | | | | | |
| Revenues (2) | 4.07 | 8.952 | .582*** | | | | | | | | | | | | | | |
| R&D intensity (3) | 6.77 | 5.511 | .103 | -.058 | | | | | | | | | | | | | |
| Automotive/machinery (4) | .42 | .495 | -.131† | -.029 | -.134† | | | | | | | | | | | | |
| Chemicals/pharma (5) | .26 | .439 | .195* | -.021 | .083 | -.500*** | | | | | | | | | | | |
| Electronics/semiconductors (6) | .20 | .400 | .092 | .081 | .167* | -.423*** | -.293*** | | | | | | | | | | |
| Switzerland (7) | .19 | .395 | -.089 | -.115† | -.015 | .042 | -.030 | .039 | | | | | | | | | |
| Austria (8) | .11 | .314 | -.162* | -.112† | -.018 | -.014 | .061 | -.058 | -.171* | | | | | | | | |
| Product diversification (9) | 3.28 | 1.647 | .565*** | .303*** | -.090 | -.067 | .059 | .169* | -.065 | -.132† | | | | | | | |
| Intraorganizational communication (10) | 3.63 | 1.435 | .365*** | .185* | .069 | -.149* | .335*** | -.054 | -.047 | .087 | .192* | | | | | | |
| Number of dedicated employees (11) | 2.64 | 5.109 | .749*** | .494*** | .012 | -.192* | .273** | .053 | -.065 | -.026 | .410*** | .301*** | | | | | |
| Participatory approach (12) | 3.76 | 1.595 | .380*** | -.046 | .001 | .042 | .340*** | -.241** | .090 | -.035 | .254** | .477*** | .266** | | | | |
| Interorganizational networks (13) | 3.86 | 1.796 | .504*** | .136† | .121† | -.076 | .230** | -.146* | -.034 | -.080 | .346*** | .405*** | .342*** | .571*** | | | |
| Internationalization (14) | 5.38 | 1.633 | .311*** | .223** | -.131† | .125† | -.125† | -.062 | .133† | -.110 | .381*** | -.031 | .147* | .137† | .245** | | |
| Climate (15) | 2.77 | 1.263 | .639*** | .400*** | .009 | -.105 | .246** | -.016 | -.099 | -.023 | .462*** | .503*** | .533*** | .467*** | .452*** | .134† | |
| Reputation (16) | 3.25 | 1.325 | .490*** | .235** | -.002 | .022 | .265** | -.170* | .011 | .051 | .303*** | .411*** | .391*** | .598*** | .699*** | .223** | .508*** |

n = 136

° Dependent variable

†p < .1; *p < .05; **p < .01; ***p < .001

**Table 2**
**Results of multiple regression analyses**
**(Dependent variable: classification of annual revenues from licensing out and selling disembodied knowledge)**

| Variables | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Control variables | | | | | |
| Revenues | .062*** (.008) | .047*** (.007) | .032*** (.006) | .029*** (.006) | .026*** (.006) |
| R&D intensity | .017 (.012) | .025* (.011) | .022** (.008) | .019* (.008) | .019* (.008) |
| Automotive/machinery | .274 (.212) | .075 (.183) | -.014 (.145) | .069 (.144) | .073 (.144) |
| Chemicals/pharmaceuticals | .729** (.228) | .328 (.205) | -.045 (.166) | .072 (.166) | .073 (.167) |
| Electronics/semiconductors | .441† (.242) | .079 (.213) | .067 (.167) | .206 (.168) | .209 (.168) |
| Switzerland | -.112 (.171) | -.043 (.146) | -.111 (.115) | -.135 (.114) | -.121 (.114) |
| Austria | -.349 (.215) | -.259 (.185) | -.269† (.146) | -.248† (.142) | -.256† (.143) |
| Hypothesized variables | | | | | |
| Product diversification | | .233*** (.038) | .136*** (.031) | .100** (.033) | .083* (.034) |
| Intraorganizational communication | | .112* (.043) | .025 (.037) | .021 (.037) | .002 (.038) |
| Number of dedicated employees | | | .084*** (.011) | .082*** (.011) | .077*** (.011) |
| Participatory approach | | | .132*** (.036) | .087* (.039) | .067† (.040) |
| Interorganizational networks | | | | .073* (.032) | .066† (.038) |
| Internationalization | | | | .054† (.031) | .059† (.031) |
| Climate | | | | | .101* (.049) |
| Reputation | | | | | .003 (.052) |
| $R^2$ | .424 | .589 | .752 | .770 | .778 |
| $R^2$ adjusted | .392 | .559 | .730 | .746 | .750 |
| F | 13.457*** | 20.025*** | 34.205*** | 31.438*** | 28.048*** |
| Number of observations | 136 | 136 | 136 | 136 | 136 |

†p < .1; *p < .05; **p < .01; ***p < .001; standard errors in parantheses

## APPENDIX

Product diversification ($\alpha$ = .934)
- The company's product portfolio comprises a large number of different products.
- The diversity of the product portfolio is high.
- The company is active in various industrial areas.

Intraorganizational communication ($\alpha$ = .754)
- The business units closely collaborate in the identification of external technology commercialization opportunities.
- The different functional areas closely collaborate in the identification of external technology commercialization opportunities.
- Knowledge management is functioning well in our company.

Participatory approach ($\alpha$ = .913)
- R&D or marketing employees often propose technologies for potential external commercialization.
- Many external technology commercialization transactions that are initiated by the company are based on ideas from R&D or marketing employees.
- For identifying external technology commercialization opportunities, the external technology commercialization employees closely collaborate with R&D or marketing employees.

Interorganizational networks ($\alpha$ = .931)
- We are involved in a large number of collaborations and networks with other organizations.
- A large part of the collaborations and networks includes partners from other countries.
- Many external technology commercialization opportunities are identified through information that has been acquired in collaborations and networks.
- With many external technology commercialization customers, we had prior contact through collaborations and networks.

Internationalization ($\alpha$ = .900)
- The company has affiliates in a large number of countries.
- The company's affiliates are distributed worldwide.
- A large part of the company's sales is generated abroad.

Climate ($\alpha$ = .882)
- We used the external technology commercialization a lot during the last years.
- In general, our employees regard the external technology commercialization as an equivalent exploitation option to the application of technologies in own products and/or services.
- Many of our employees have negative attitudes to the external technology commercialization.$^{R}$

Reputation ($\alpha$ = .789)
- We are often contacted by other organizations that are interested in acquiring our technology.
- A large part of our external technology commercialization transactions is initiated by the external technology commercialization customers.
- Often, more than one external technology commercialization agreement is set up with a particular external technology commercialization customer over time.

$\alpha$ = Cronbach's alpha. $^{R}$ = reverse coded item.

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