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**Desorptive capacity: a new perspective on the
external commercialization of knowledge**

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Abstract

As competition is becoming increasingly knowledge-based, companies do not only have to develop the competence of managing knowledge internally but also need the competence of managing the acquisition and emission of knowledge in order to appropriately leverage its value. Regarding the external acquisition of knowledge, a consistent theoretical framework has been developed with the concept of absorptive capacity probably being the most important construct. In research into absorptive capacity, it is assumed either explicitly or by implication that the knowledge is applied internally. However, companies may also directly commercialize disembodied knowledge which is a growing phenomenon in practice. This trend is especially remarkable against the background of the imperfections of the markets for knowledge, which make such external commercialization of knowledge a difficult task. Accordingly, a company should build up an organizational capability to adequately manage the external knowledge commercialization process. Therefore, we develop the construct of desorptive capacity as a complementary concept to absorptive capacity in the area of external knowledge exploitation. The construct is defined, and it is shown that desorptive capacity is path-dependent. Moreover, it is highlighted how a firm may actively manage its desorptive capacity. Finally, the issue of operationalizing desorptive capacity is addressed, and implications of the theoretical analysis for research and practice are presented.

Keywords: external commercialization/exploitation of knowledge, knowledge transfer, absorptive capacity, desorptive capacity, intellectual property.

1 Introduction

For over two decades, strategic management theorists have been paying increasing attention to the importance of knowledge in the context of corporate strategy (Nelson and Winter, 1982; Grant, 1996a; Spender, 1996; Amesse and Cohendet, 2001). Some researchers have adopted a distinctly knowledge-based perspective (Grant, 1996b; Tsoukas, 1996) but also in the resource-based view of the firm (Wernerfelt, 1984; Prahalad and Hamel, 1990), in the dynamic capabilities approach (Teece et al., 1997; Eisenhardt and Martin, 2000) and in the technology-based view (Granstrand, 1998) knowledge is considered one of the most important resources of a company. By emphasizing the influence of knowledge, these authors try to overcome the black box of the economist's production function as well as the focus on transaction costs and tangible resources of former theories (Spender, 1996; Grant, 1996b). As a result, there are various slightly different approaches, which are in many ways complementary and attempt to provide an understanding of sustaining competitive advantage against the background of an increasing importance of knowledge in today's economy.

Apart from the importance of the generation of knowledge and its application and value appropriation inside the firm, knowledge may be regarded as an economic good itself (Granstrand, 2000a). Companies may be characterized as both product domain and knowledge domain (Grant, 1996b), and an efficient use of a company's knowledge requires congruence between these domains. However, a perfect congruence usually does not exist in reality (Grant, 1996b) which gives rise to the markets for knowledge, in which a company may operate both as a supplier and buyer of knowledge (Teece, 1981). On the one hand, a firm therefore has to decide on the make-or-buy of knowledge. In most cases, companies cannot generate all relevant knowledge internally which is why the acquisition of knowledge is often not only an option but a necessity (Bidault and Fischer, 1994; Dyer and Singh, 1998). On the other hand, firms have to decide on the keep-or-sell issue, i.e. whether the rents from their resources, especially their knowledge resources, are commercialized best by integrating into related markets, by selling intermediate output or by selling the assets themselves (Teece et al., 1997).

As competition has become more knowledge-based (Amesse and Cohendet, 2001), a company should develop a detailed understanding of its knowledge and knowledge management capabilities (Lane and Lubatkin, 1998). In order to exploit its knowledge potential and to manage its knowledge operations efficiently, a company does not only have to develop the competence of managing knowledge internally, i.e. the internal generation, accumulation and exploitation of knowledge, but also needs the competence of managing the

acquisition and emission of knowledge in order to appropriately leverage its value (Ford, 1988). However, most of the literature on knowledge in the business context focuses on the internal aspects of knowledge management. If external aspects are taken into consideration, most existing studies focus on the external acquisition of knowledge (Granstrand, 2000a; Teece, 2000; Arora et al., 2001). In this area, a consistent theoretical approach was developed during the last two decades with the concept of absorptive capacity (Cohen and Levinthal, 1989; Cohen and Levinthal, 1990) probably being the most important theoretical construct (Lane et al., 2002). The concept of absorptive capacity includes the application of knowledge but most researchers in this field assume either explicitly or by implication that the knowledge is applied internally (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998; Zahra and George, 2002).

However, companies may also directly commercialize disembodied knowledge. As this option has often been neglected in past research, a sound theoretical framework regarding the external exploitation of knowledge is lacking, particularly concerning a theoretical construct equivalent to absorptive capacity in the area of external knowledge commercialization, which is an important trend in practice. Increasingly, large companies see the external exploitation of knowledge not only as a residual option but have established a proactive strategy to market their knowledge assets (Grindley and Teece, 1997; Rivette and Kline, 2000; Kline, 2003). They do not only transfer knowledge that is unused in their own operations but they generally consider the external commercialization of all knowledge that exists in the company. This trend is especially remarkable against the background of the imperfections of the markets for knowledge, which have been broadly addressed in the existing literature (Teece, 1981; Bidault and Fischer, 1994; Arora et al., 2001). This is a further proof of the need for research, especially regarding the ability of companies to manage the process of commercializing disembodied knowledge.

The objective of this article is therefore to develop the foundations of a multi-dimensional and dynamic construct in the area of external knowledge exploitation, which may serve as a complementary theoretical concept to absorptive capacity by focusing on the external commercialization of knowledge and particularly on the abilities that a company has to develop in the context of an increasing importance of external knowledge exploitation. These abilities will be collectively termed 'desorptive capacity'. The concept to be developed may be useful for both research and practice as it may be applied in a descriptive and normative way and helps to develop an understanding of a firm's ability to externally commercialize knowledge.

The remainder of the article is structured as follows: the next section describes past research into external knowledge commercialization and its increasing importance and highlights various concepts which are relevant for a solid understanding of the desorptive capacity construct. In section 3, the concept of desorptive capacity is presented. The construct is defined, and it is shown that desorptive capacity is path-dependent. Moreover, it is emphasized how a firm may actively manage its desorptive capacity. In section 4, the operationalization of the construct is addressed, whereas in section 5 implications of the theoretical analysis for research and practice are presented; the final section concludes and shows directions for future research.

2 Past research

Various approaches to corporate strategy underline the importance of knowledge which also includes its potential external exploitation. According to the dynamic capabilities framework, for example, a firm's competitive advantage is resident in its organizational processes, which are influenced by the firm's positions and evolutionary path (Teece et al., 1997). By position, the authors refer to a company's current assets, including knowledge and intellectual property. "Well-known companies ... appear to have followed a 'resource-based strategy' of accumulating valuable technology assets, often guarded by an aggressive intellectual property stance" (Teece et al., 1997, p. 515). Accordingly, companies should not only intend to be successful on the product markets on which they compete but they should adopt a multi-level perspective including end products, intermediate output and knowledge (Bidault and Fischer, 1994; Tschirky et al., 2000; Koruna, 2004). Apart from generating additional income, the external commercialization of assets on all levels, including the knowledge level, will enhance a company's competitiveness not only on the market of the specific transaction but also on the other levels because a strategy of multi-level competition will lead to organizational learning and will help to discover inefficiencies which affect the outcome on all levels.

Most companies have traditionally focused on competing on the product level. In order to achieve multi-level success, these companies need to develop the competence of absorbing and transferring knowledge which is more difficult than trading goods on 'spot' markets due to the imperfections of the markets for knowledge. These imperfections are quite diverse but most of them can be traced back to the nature of knowledge. First, a lot of knowledge is tacit and thus very difficult to transfer (Polanyi, 1962); second, the mere act of commercializing disembodied knowledge comprises the risk of disclosing its relevant elements to potential

buyers (Arrow, 1971). Apart from these characteristics inherent to knowledge, some perceived problems of the knowledge markets may be attributed to 'not-invented-here' (Katz and Allen, 1982; Kanter, 1983) or 'only-use-here' syndromes (Ford and Ryan, 1981; Ford, 1985; Boyens, 1998). Generally, these imperfections lead to the absence of a well-defined demand and supply and to high transaction costs in the knowledge markets (Ford and Ryan, 1981; Teece, 1981; Guilhon, 2001).

Despite these problems, many companies actively use the external acquisition of knowledge since the 1990s (Granstrand et al., 1992; Kurokawa, 1997; Veugelers and Cassiman, 1999). Some firms, however, are still quite reserved and cautious with regard to the external exploitation of knowledge, which, nevertheless, is a growing phenomenon (Arora, 1997; Gans and Stern, 2003; Kline, 2003). Increasingly, firms consider the external commercialization of knowledge a proactive activity, which is part of their overall business strategy and may generally include all company knowledge, rather than a residual activity of commercializing unused knowledge assets (Rivette and Kline, 2000; Amesse and Cohendet, 2001). There are various reasons for the rise in external knowledge commercialization, such as increasing competition on the product markets, increasing R&D expenditures, the focus on core competencies, the growing demand on the knowledge markets due to the increasing external knowledge acquisition and the lack of internal complementary assets (Ford, 1985; Vickery, 1988; Grindley and Teece, 1997). Another important reason for the surge of external knowledge exploitation are the examples of well-known companies, which have considerably increased their intellectual property revenues during the last years: IBM, for example, realized US\$ 1.7 billion in intellectual property revenues in 2000, up from US\$ 30 million in 1990 (Rivette and Kline, 2000; Kline, 2003). Many other examples and empirical data show the current relevance and the future importance of the external commercialization of knowledge.

In contrast to the growing importance of this topic, the external commercialization of knowledge has not received adequate attention in the existing literature, which has many deficits, particularly regarding a theoretical foundation and framework for the companies' activities in practice and for the few research approaches that have been proposed in past research (e.g. Teece, 1981; Ford, 1985; Ford, 1988). The relevant literature is fragmented, corresponding to different fields of research, and there is not a continuous research stream into the external exploitation of knowledge. This judgement is still valid if one includes research into alliances, knowledge transfer and other fields in the analysis because the majority of the papers in these areas takes a knowledge acquisition perspective (Bozeman, 2000; Arora et al., 2001). In recent years, interesting insights have emerged from the research

streams into intellectual assets, intellectual capital and intellectual property. While the literature pertaining to knowledge 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 include explicitly the option to acquire and to commercialize knowledge externally (Granstrand, 2000a; Granstrand, 2000b; Teece, 2000). Often, however, the external commercialization of knowledge is only seen as a side aspect which is a main reason why a broad literature stream on this topic does not exist. Some important aspects in this field, such as the capabilities that firms have to develop to adequately manage outward knowledge transactions, have received only very little attention.

As a result of the increasing importance of the external knowledge transactions, companies should develop a knowledge transaction capability. Due to the difficulties inherent to the markets for knowledge and the differences between the commercialization of products or services and the commercialization of knowledge, the management of knowledge transactions is rather complex. Therefore, the ability to adequately manage knowledge transactions is a critical component of a firm's knowledge management capability. Empirical research has shown that companies that take advantage of external knowledge exploitation are usually also deeply involved in external knowledge acquisition (Ford, 1985; Lowe and Taylor, 1998). This phenomenon may be explained by the ability of these companies – beyond overcoming the above mentioned 'not-invented-here' and 'only-use-here' syndromes – to build up an organizational competence regarding knowledge transactions. Such a competence will facilitate an adequate management of the company's external knowledge acquisition and knowledge exploitation processes and may therefore be a source of competitive advantage.

In this context, the concept of absorptive capacity has received a lot of attention in various fields of research. Cohen and Levinthal defined absorptive capacity as follows: "... prior related knowledge confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends. These abilities collectively constitute what we call a firm's 'absorptive capacity'." (Cohen and Levinthal, 1990, p. 128). Absorptive capacity has been used to address different units of analysis as well as different research questions in strategic management, knowledge management and organizational learning among others (Szulanski, 1996; Lane and Lubatkin, 1998; van den Bosch et al., 1999; Lane et al., 2002; Zahra and George, 2002) which has led to different interpretations and extensions.

Underlying the definition and research concerning the construct of absorptive capacity is the explicit or implicit assumption that the application of the knowledge occurs internally (Cohen and Levinthal, 1990; Zahra and George, 2002), i.e. that the company applies the knowledge in

new products or services and focuses on the marketing and sales of these products or services. This view, however, disregards the option to directly commercialize knowledge without integrating it into new products, processes or services, i.e. the external exploitation of knowledge. Research into knowledge transfer, in contrast, focuses on the characteristics of the knowledge to be transferred, on contingency factors, on the form of transfer and on the ability of the recipient to absorb the knowledge, i.e. his absorptive capacity (e.g. Szulanski, 1996; Bozeman, 2000). The ability of the sender to transfer the knowledge, however, has mostly been neglected.

Exceptions to the lack of considering the source's knowledge transfer capability are the new approach to technology transfer from the perspective of the knowledge-based economy by Amesse and Cohendet (2001) and the concept of 'source transfer capacity' by Martin and Salomon (2003). These researchers state that "the quality of the technology transfer process is also fundamentally dependent on the firm's capabilities of emission of knowledge outside its frontier" (Amesse and Cohendet, 2001, p. 1473). As the authors focus on technology and knowledge transfer rather than on the external exploitation of knowledge from the perspective of a single company as unit of analysis, their concepts are very useful for examining the final stage of the knowledge commercialization process, i.e. the actual knowledge transfer. However, the prior phases regarding the internal identification of knowledge assets and the identification of potential partners, which are essential for a proactive use of the external commercialization of knowledge, are not explicitly considered.

Similarly, Lane and Lubatkin (1998) show in their article on relative absorptive capacity as a dyad-level construct that the ability of a firm to learn from another firm is determined by the relative characteristics of the two firms, especially regarding their knowledge-processing systems. These three concepts do take into account the importance of both partners for successful knowledge transfer but they do not consider the proactive, dynamic aspects of external knowledge exploitation on which the approach to be developed in this paper is based. In this approach, the external commercialization of knowledge is regarded as complementary though equally important to the internal exploitation and should be integrated into corporate strategy in order to arrive at a more efficient use of a firm's knowledge assets. We argue that taking explicitly into account the ability of the sender to identify knowledge assets and potential partners and to transfer the knowledge may further improve studies on the success factors of knowledge transfer and learning.

Thus, in the following section, the concept of desorptive capacity as an important dynamic capability of a firm against the background of an increasing external exploitation of

knowledge is developed. It is aimed at providing a theoretical foundation for knowledge desorption, which may contribute to a sound theory regarding the external commercialization of knowledge from a capability-based perspective.

3 The concept of desorptive capacity

3.1 Definition of desorptive capacity

The main tasks regarding the management of a firm's knowledge are knowledge acquisition, knowledge accumulation and knowledge exploitation which can all be realized either internally or externally (Ford, 1988; Garud and Nayyar, 1994; Grant, 1996b; Teece, 1998; Brockhoff, 1999; Probst et al., 2000; Fig. 1). As mentioned above, Cohen and Levinthal's (1990) concept of absorptive capacity is considered in literature as the ability to value, assimilate and (internally) apply new knowledge. By focusing on the absorption and internal exploitation of knowledge, this approach disregards the option to commercialize disembodied knowledge. Therefore, we develop the construct of desorptive capacity as a complement to absorptive capacity in the context of external knowledge exploitation. A company may externally exploit knowledge that it has generated itself or even knowledge that it has acquired externally. Due to the fact that existing knowledge usually may be applied by additional users at close to zero marginal cost without directly affecting the knowledge of the first user (Grant, 1996b; Ernst, 1998), a firm may externally commercialize both knowledge that is unused internally and knowledge that is used in its own operations.

--- (Fig. 1 about here) ---

Fig. 1. Desorptive capacity as a firm's ability to adequately manage the external exploitation of knowledge (Source: adapted from Brockhoff, 1999, p. 153).

The term 'desorptive capacity' is used because in science, 'desorptive' refers to the process of desorbing, i.e. "to free from a sorbed state: remove (a sorbed substance) by the reverse of adsorption or absorption" (Webster's, 1981). We transfer the concept of desorption to the knowledge context and develop the concept of desorptive capacity as a construct to explain an organization's external knowledge exploitation ability. As external knowledge exploitation is a growing phenomenon, organizations have 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. These abilities constitute what we refer to as desorptive capacity.

In order to appropriately manage the external exploitation of knowledge, companies should adopt a process perspective (Ford, 1985). Following the above definition, companies have in a first step to recognize and identify knowledge assets that are suitable for external commercialization. Thus, companies should take an integrated view comparing company knowledge and external exploitation opportunities. 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 already starts during the internal or external knowledge acquisition in order to take the external exploitation option into account in all major decisions regarding company knowledge.

In contrast to the mainly intraorganizational perspective of the internal identification of knowledge assets, the identification of external opportunities requires an interorganizational perspective. This is especially true for the identification of potential partners or knowledge customers. Empirical studies show that, due to the inefficiencies of the knowledge markets, these tasks are considered most difficult (Ford, 1985; Sullivan and Fox, 1996; Elton et al., 2002; Birkenmeier, 2003). Following the identification of potential partners, a company has to establish adequate conditions for the transactions which includes tasks, such as negotiations with potential partners. As a result of the difficulties to find appropriate partners, the final stage of actually transferring the knowledge is often not reached in practice which is probably one reason why the outward knowledge transfer is usually not perceived as a main problem. Moreover, companies may profit from their experiences with internal and inward knowledge transfers.

Regarding the ability of a company to appropriately carry out the external knowledge exploitation tasks, a distinction between the following two knowledge components is fundamental: the actual knowledge to be exploited and the knowledge about its application (Kogut and Zander, 1992; Iansiti, 1997; Jolly, 1997; van den Bosch et al., 1999; Shane, 2000; Kumar and Seth, 2001; Adner and Levinthal, 2002; Chesbrough, 2002; Koruna, 2003; Martin and Salomon, 2003). In the literature on technological knowledge, this distinction has been made by various authors but it may also be transferred to other knowledge areas. Adner and Levinthal (2002), for example, differentiate in their speciation view on technological change between technology and application domains. Similarly, Jolly (1997) states that "leveraging a new technology's distinctive advantages ... requires understanding its uses thoroughly, application by application." (Jolly, 1997, p. 99). Martin and Salomon (2003) underline that "this does not entail articulating the knowledge itself, but rather being able to describe

potential uses and conditions regarding what the knowledge can help a user accomplish” (Martin and Salomon, 2003, p. 363). Moreover, patent offices all over the world are expected to separate industrially exploitable discoveries from mere ideas.

Following Iansiti’s (1997) distinction between ‘technological potential’ and ‘technological yield’, application knowledge is required to match inventions at the fundamental level with the actual context of their final application, which may be internal or external. Both knowledge components, the knowledge to be exploited and application knowledge, may comprise tacit and explicit elements but the knowledge to be exploited is always the knowledge that a company actually wants to commercialize. The application knowledge, in contrast, refers to the knowledge about the functions that the knowledge to be exploited may fulfill, i.e. about possibilities of application and commercialization. Accordingly, the application knowledge constitutes a crucial knowledge facet by itself. While these two knowledge components separately have only little value, it is their combination that on the one hand makes the knowledge to be exploited exploitable and on the other gives the application knowledge a specific meaning and function.

This approach allows to integrate the findings of Shane (2000), who states that inconsistent with several theoretical assumptions in prior research “technological change does not generate obvious entrepreneurial opportunities, which allow anyone to discover any given entrepreneurial opportunity which results from that change” (Shane, 2000, p. 465; Brockhoff, 1997). Accordingly, a firm may identify a large number of external knowledge commercialization opportunities for a relatively small knowledge base because of its ability to discover a large number of applications of that knowledge; in contrast, a firm may also lack the ability to commercialize a large knowledge base.

In order to adequately manage both internal and external knowledge exploitation, a firm needs sufficient application knowledge. Regarding internal exploitation, a firm obviously has the relevant understanding of possible functions, applications and markets for the knowledge to be exploited (Fig. 2). Regarding external exploitation, however, it has been shown above that many companies would like to externally exploit knowledge but have difficulties with identifying external exploitation opportunities. In most cases, this is a result of lacking application knowledge, which is essential along the whole commercialization process (Ford, 1985; Sullivan and Fox, 1996; Elton et al., 2002; Birkenmeier, 2003).

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Fig. 2. Application knowledge as the critical factor for a proactive external knowledge commercialization.

Application knowledge helps a company to identify the knowledge that has a high potential of external commercialization, and it is fundamental for identifying potential partners for the knowledge transaction. Moreover, application knowledge is essential for negotiating the conditions of the transaction, such as the price of the knowledge assets, and it also helps to transfer the knowledge. Therefore, a high degree of knowledge about the relevant application reduces the transaction costs of external knowledge exploitation considerably. Usually, a company may proactively commercialize knowledge without major investments in time, capital, etc. only in areas in which it has sufficient application knowledge.

If the knowledge to be transferred is tacit which significantly complicates its transfer (Teece, 1986; Grant, 1996b), application knowledge becomes even more important because in such a situation it is still more difficult to carry out the knowledge commercialization tasks, such as identifying external exploitation opportunities. This is at least partly the case in most transactions because even if the major part of the knowledge is explicit, nearly always tacit knowledge is transferred as well (Bidault, 1989; Guilhon, 2001). Accordingly, we argue that the ability to carry out the external knowledge exploitation tasks is largely a function of a firm's level of application knowledge. Therefore, we regard application knowledge as the fundamental factor behind the concept of desorptive capacity.

For absorptive capacity, "prior related knowledge" (Cohen and Levinthal, 1990) is essential in order to be able to understand the knowledge to be absorbed. As a company in this situation wants to acquire knowledge that it needs for a specific application, one may assume that it has sufficient application knowledge but is lacking the knowledge to be exploited. This corresponds to the view of Cohen and Levinthal (1990), who use a firm's R&D spending as an operationalization of its absorptive capacity. In the external knowledge acquisition, a company looks for potential knowledge sources starting from a function that the knowledge should fulfill. Thus, a company needs the capability to absorb knowledge, combine it with the corresponding application knowledge and then commercialize it (Fig. 3). For desorptive capacity, in contrast, one can assume that a company that either has developed the knowledge internally or has absorbed it has an in-depth understanding of the knowledge that it wants to commercialize externally but lacks sufficient knowledge about its application at potential recipients. The company owns a potential solution for certain problems and faces the difficulty of identifying possible applications in different contexts and potential users. Thus, for an active approach to the external knowledge commercialization that goes beyond identifying opportunities due to effects, such as serendipity, the company needs sufficient application knowledge in order to combine it with the knowledge to be exploited and

externally commercialize it. This application knowledge may be built up through own production and sales or by directly investing in it (see section 3.3).

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Fig. 3. The focus on different knowledge components in the concepts of absorptive capacity and desorptive capacity.

Although application knowledge is regarded as the most important element of desorptive capacity, its definition indicates that desorptive capacity is conceptualized as a multi-dimensional and dynamic construct and can thus be considered a dynamic capability (Teece et al., 1997; Eisenhardt and Martin, 2000), which enables a firm to capitalize its knowledge base. Accordingly, desorptive capacity makes it easier to gain and sustain competitive advantage in changing market conditions. This view is consistent with the reconceptualization of absorptive capacity by Zahra and George (2002), who propose a dynamic capabilities approach to this construct. According to the dynamic capabilities perspective, competitive advantage is positioned 'upstream' of product markets and is based on a firm's idiosyncratic resources or assets. However, this is not enough to sustain competitive advantage because firms are increasingly forced to keep up with their highly dynamic environment which is why companies need the competence to effectively coordinate and redirect their capabilities (Teece et al., 1997). Thus, dynamic capabilities are necessary but not sufficient for competitive advantage, which "lies in using dynamic capabilities sooner, more astutely, or more fortuitously than the competition to create resource configurations that have that advantage" (Eisenhardt and Martin, 2000).

Along with the growing knowledge intensity of today's economy, this requirement of dynamic flexibility has led to the fact that many companies are not able to completely capitalize their knowledge assets internally because they are lacking relevant resources, such as complementary assets. The external commercialization of knowledge (and desorptive capacity as a prerequisite for making adequate use of it) enables a firm to have success both on the product level as well as on the knowledge level. As a result, external knowledge exploitation makes a company more flexible which is essential in high-velocity markets by generating additional income (e.g. royalties) without investing a high amount of additional capital. IBM, for example, realizes its intellectual property revenues with a 98 percent profit margin (Kline, 2003). This generation of additional income is particularly profitable in an environment with a strong regime of appropriability (Teece, 1986). Beyond generating revenues and offering further strategic advantages, an active external knowledge exploitation will provide a company with additional application knowledge, which may not only facilitate

the identification of new business opportunities but will also reduce the costs of change when the firm changes its strategy. This effect may be regarded as a feedback loop which is a result of embedding the concept of desorptive capacity in the process of external knowledge commercialization as a part of a firm's overall business strategy. This aspect illustrates the effects of external knowledge exploitation that go beyond the monetary dimension, e.g. organizational learning. This argument is also valid in environments of weak appropriability and is vital in markets of hyper competition, where a company's degree of flexibility is paramount (Volberda, 1996).

Viewing desorptive capacity as a dynamic organizational capability reflects that it develops over time. Desorptive capacity cannot be analyzed in isolation as it is interdependent with a company's other capabilities and its organizational structure which indicates path-dependence. Therefore, the following section focuses on these characteristics of desorptive capacity.

3.2 Path-dependence of desorptive capacity

It has been shown above that imperfections of the markets for knowledge resulting in high transaction costs are the main barrier to a proactive external knowledge exploitation. The less perfect these markets are, the more important it is for a company to develop desorptive capacity. If perfect knowledge markets existed, the potential for external knowledge commercialization would be great (Teece, 1986). Desorptive capacity would still be important but easier to develop because the transactions would resemble arm's length transactions (e.g. it would be easy to find a partner for a transaction).

In the imperfect knowledge markets existing in reality, however, the main problem for the knowledge supplier is the necessary application knowledge, which will differ from knowledge customer to knowledge customer and which strongly influences transaction costs. Thus, a company needs prior knowledge about the relevant knowledge markets and about the applications at potential knowledge customers to recognize the value of its knowledge and to identify possibilities of external knowledge commercialization. The more specific the knowledge to be exploited is, the higher is the importance of application knowledge and of desorptive capacity for external knowledge exploitation. Application knowledge and along with it desorptive capacity cannot be analyzed independently, i.e. separate from the firm's other activities, because it is cumulative, related to a firm's operations and develops over time. Thus, commercialization performance is greatest when the area of commercialization is

related to the areas the company is familiar with (Kogut and Zander, 1992; Lane and Lubatkin, 1998) because being active in the relevant product markets is the best way to gain the necessary application knowledge.

Generally, a company may externally commercialize knowledge inside its own industry (to competitors, suppliers or customers) and in other industries. The simultaneous use (in the same markets at the same time) of internal and external knowledge exploitation, however, is beneficial only in some situations, e.g. if there are network externalities. This is especially true if a firm's core competencies are involved in the generation and application of the relevant knowledge which is a reason why many companies are reluctant to externally commercialize such knowledge inside their own industries. Thus, the external exploitation potential is usually diminished by the internal knowledge exploitation.

As a result, the degree of diversification of a firm directly influences its external knowledge exploitation potential and its desorptive capacity. Regarding the diversification of a firm, one has to distinguish between resource or knowledge diversification, i.e. the number and scope of the different knowledge areas covered by the company, and business or product diversification, i.e. the number and scope of product areas in which the company is active (Granstrand, 2000a). The potential of external knowledge exploitation is high if a firm uses various types of generic knowledge but applies them in only one very limited product area because in this case, it may commercialize the knowledge not only inside its own industry but also beyond industry borders (Granstrand and Oskarsson, 1994). For desorptive capacity, however, the relation is the opposite. If a company uses only one very specific and limited type of knowledge in many applications, it has a high desorptive capacity in this field because it has sufficient application knowledge in the different product areas to adequately commercialize the knowledge – but it lacks the potential to commercialize knowledge externally.

According to Grant (1996b), efficient knowledge utilization calls for multi-product firms even if the external commercialization option is considered because a lot of knowledge is not product-specific and is subject to economies of scope. Regarding technological knowledge, Patel and Pavitt (1997) state that most large firms are diversified in their product fields but have an even broader range of technological competencies. "In addition to a focus on a number of 'distinctive' or 'core' technological competencies ... , management in large firms needs to sustain a broader (if less deep) set of technological competencies" (Granstrand et al., 1997, p. 18). The fact that many large companies have high competencies outside their core areas is mainly a result of the increasing knowledge convergence and knowledge fusion

(Kodama, 1992; Patel and Pavitt, 1997; Levinthal, 1998). These trends underline the high external knowledge exploitation potential that firms may realize by commercializing knowledge beyond their industry borders.

Therefore, multi-product firms that use different types of generic knowledge are expected to be most successful in the external commercialization of knowledge due to the requirements of application knowledge and commercialization potential. This is consistent with the findings of Link and Scott (2002), who show that "a more diversified potential licensor has a higher probability of participating in licensing agreements" (Link and Scott, 2002, p. 228). As these firms are multi-product, they have a high degree of application knowledge in various business areas. As their knowledge bases are usually even more diverse, they have a high external commercialization potential.

If in addition to knowledge and business diversification market diversification, and particularly internationalization as a special case (Granstrand, 1998), is taken into account as the third diversification mode, one may assume 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, new external exploitation opportunities may be identified in all markets. Regarding the effects of international diversification on the external knowledge exploitation potential, the international dimension generally expands the potential as knowledge may be externally commercialized in foreign countries which is often done in the beginning of internationalization strategies, e.g. through international licensing agreements (Root, 1994). If the company, however, is present in the foreign countries, e.g. through exporting or local subsidiaries, the external knowledge exploitation potential will usually be diminished similar to business diversification because the simultaneous use of internal and external knowledge exploitation in the same markets will be beneficial only in specific situations.

Companies with a high external knowledge commercialization potential may realize economies of scale in the external knowledge exploitation process. For example, it may be beneficial to build up application knowledge in product areas in which they are not competing themselves in order to proactively commercialize their knowledge assets (see section 3.3). Moreover, these companies may increase the efficiency of their external knowledge commercialization activities by realizing learning effects in many tasks along the commercialization process. Thus, companies with a high external knowledge exploitation potential may diminish the transaction costs in the knowledge markets by making investments aimed at developing desorptive capacity. Consistent with the concept of absorptive capacity,

well developed descriptive capacity will lower the transaction costs of commercializing knowledge (Cohen and Levinthal, 1989; Lane et al., 2001). Generally, if the possibilities of application become more diverse, a company will probably look more actively for options to externally commercialize its knowledge assets.

As the descriptive capacity of a company refers to certain knowledge and application areas and is influenced by the company's degree of diversification, it is path-dependent. Accumulating descriptive capacity in one period will permit its more efficient accumulation in the next which is reflected by the conceptualization of descriptive capacity as a dynamic capability (Kogut and Zander, 1992; Teece et al., 1997). In analogy to the absorption of knowledge (Cohen and Levinthal, 1990), a company may lock out itself from external knowledge commercialization by the following two reasons. First, if a firm does not develop descriptive capacity in the beginning, it will undervalue the external commercialization opportunities present in a given field. Second, as prior knowledge, especially application knowledge, facilitates the development of descriptive capacity, a lack of early investment will make it more costly to build up descriptive capacity in later periods. Some ideas may be too distant from the firm's knowledge base or may appear too difficult to realize to be appreciated for external commercialization. With a high descriptive capacity, however, more commercialization opportunities are identified and due to learning effects the transaction costs of the knowledge commercialization will decrease (Teece, 1981; Lane et al., 2002).

The path-dependence of descriptive capacity may also be influenced by a company's aspiration level, which may finally lead to a self-reinforcing cycle (Fig. 4). If a company has a high descriptive capacity, it will be better aware of the external commercialization opportunities, and its aspiration level may be defined in terms of the commercialization opportunities (March and Simon, 1958; Cohen and Levinthal, 1990). Companies with a high descriptive capacity will be more proactive in external knowledge commercialization, independent of current performance. The external knowledge exploitation in turn will enhance a firm's application knowledge and descriptive capacity in general. Companies with a low descriptive capacity, however, will tend to be reactive, searching for new commercialization alternatives mainly as a result of failure on the product markets.

--- (Fig. 4 about here) ---

Fig. 4. Path-dependence of descriptive capacity and self-reinforcing cycle.

Pioneering firms in the external exploitation of knowledge, such as IBM, often started the external exploitation process when they faced financial problems and later institutionalized it

(Rivette and Kline, 2000; Koruna, 2004); now that companies know the benefits that the external commercialization of knowledge offers, they should use it proactively from the beginning. However, this can be impeded by low aspiration levels which might also lead to a self-reinforcing cycle: a firm may not realize that it should be developing desorptive capacity because for an appropriate evaluation of both the external knowledge commercialization opportunities and the requirement to develop an organizational capability for their adequate management it needs a certain amount of desorptive capacity. Yet, this effect is probably not as strong as with absorptive capacity because in contrast to the external acquisition of knowledge the financial benefits of competitors carrying out external knowledge commercialization are rather apparent.

Nevertheless, it is quite difficult to imitate the success that other companies realize in the external commercialization of knowledge. This may be a result of both learning effects and economies of scale in the external knowledge commercialization process. Learning effects influence the development of application knowledge in specific knowledge areas as well as the efficiency with which general tasks along the commercialization process are carried out. Similarly, a sufficient level of external knowledge commercialization activities and relating economies of scale are necessary for investments in developing an organizational capability to pay off.

Accordingly, firms with a high external knowledge commercialization potential will only be able to lower transaction costs as described above if they take into consideration the path-dependence of desorptive capacity. This is particularly true for firms that try to commercialize knowledge proactively outside their own industries. If these companies attempt to commercialize knowledge in many different industries and often switch between a large variety of completely different applications, they will hardly be able to realize lower transaction costs as a result of learning effects. These effects may only be achieved if a company focuses on particular application areas, which it has identified as part of its external knowledge commercialization strategy, and builds up sufficient application knowledge in these areas. Thus, the path-dependence of desorptive capacity may help to explain the difficulties that many companies perceive when they start to externally commercialize knowledge (Bidault and Fischer, 1994). In consequence, transaction cost analyses regarding the 'keep-or-sell' decision in the external knowledge commercialization process should take into account desorptive capacity and the implications of its path-dependence.

Furthermore, a higher level of desorptive capacity may lead to a more proactive use of external knowledge commercialization by alleviating the fundamental reason for the 'only-

use-here' syndrome. If a company can adequately determine the full potential that an external commercialization of knowledge would have, it will be easier to objectively evaluate the fear of giving away 'corporate crown jewels' (Kline, 2003). This negative attitude towards external knowledge exploitation contrasts the very positive perspective which is often adopted in the academic literature. However, a company may also suffer from a 'sell-out' syndrome by externally commercializing knowledge to an extent that aggravates its position regarding firm-specific competencies (Boyens, 1998). The over- or under-evaluations of the external knowledge exploitation potentials resulting from these attitudes negatively affect a company's external knowledge exploitation activities (Boyens, 1998). A more detailed and differentiated analysis of external knowledge exploitation potentials based on the concept of desorptive capacity will help to overcome these extremal attitudes and their negative consequences for the company.

The conceptualization of desorptive capacity as one of a company's dynamic capabilities indicates that it is inherent to the organizational structure and may be influenced deliberately. As more and more companies start to consider external knowledge exploitation a proactive process which forms part of their general business strategies, these companies will intend to actively develop their desorptive capacities. Accordingly, the following section focuses on the aspects of desorptive capacity that are distinctly organizational and proposes various approaches how desorptive capacity may be built up and managed.

3.3 Management of desorptive capacity

The conceptualization of desorptive capacity as a dynamic capability implies that it develops over time, may be influenced through managerial action and will help companies to achieve competitive advantage by making adequate use of the external exploitation of their knowledge. Desorptive capacity is regarded as a multi-dimensional construct and should be analyzed along the external knowledge exploitation process including abilities, such as the identification of internal knowledge assets and the negotiations with potential partners. These abilities have to be developed and reconfigured by the management of a company in order to address rapidly changing environments and commercialization opportunities. Consistent with the concept of absorptive capacity, desorptive capacity is conceptualized as an organizational capability (Nelson and Winter, 1982; Kogut and Zander, 1992) which is why we focus in the following on the organizational aspects of the management of desorptive capacity. Particularly, we show the importance of organizational characteristics for increasing desorptive capacity and making adequate use of its benefits.

Trying to increase its desorptive capacity, a company may choose from a variety of possible actions. It has been stated above that application knowledge can be seen as the fundamental factor behind the concept of desorptive capacity because application knowledge is essential for successfully carrying out many of the activities along the external knowledge commercialization process. Thus, application knowledge does not only facilitate the identification of potential partners which is considered the main problem of externally exploiting knowledge in practice but it also helps to recognize the external exploitation potential of internal knowledge assets, to determine an adequate price for the knowledge assets and to finally transfer the knowledge to the recipient. Accordingly, companies may invest in the optimization of individual tasks along the commercialization process in order to build up desorptive capacity or invest in developing application knowledge as a process-spanning precondition. While the optimization of individual tasks will enhance the efficiency of the external knowledge commercialization process, sufficient application knowledge does not only enhance the efficiency of the process but is often a prerequisite for proactively commercializing disembodied knowledge.

According to the concept of absorptive capacity, the necessary prior knowledge for absorbing external knowledge may be acquired as a byproduct of a firm's R&D activities (Cohen and Levinthal, 1990). Similarly, the necessary application knowledge for external knowledge exploitation may be developed as a *byproduct of the commercialization of a firm's products or services* (Abernathy, 1978). So, these activities do not only generate revenues through the sale of the products or services but also constitute a basis for commercializing disembodied knowledge by providing in-depth application knowledge in the firm's business areas. Therefore, the degree of business and market diversification influences a firm's application knowledge and its desorptive capacity. If potential applications of the knowledge to be exploited are closely related to ongoing activity, application knowledge can be developed quite easily. If the areas of commercialization are rather distinct from the company's industry, however, application knowledge becomes more difficult to build up because it will not be sufficiently generated as a byproduct of the ongoing activities. In these cases, a company has to actively invest in developing application knowledge as a critical factor of desorptive capacity. Fig. 5 shows possibilities to enhance a firm's application knowledge and desorptive capacity, which have been derived from an analysis of the factors of influence on a firm's absorptive capacity described in selected articles in different fields of past research. While some of the factors have been tested empirically, also factors which have only been examined

theoretically have been taken into account in order to arrive at an overview as comprehensive as possible.

--- (Fig. 5 about here) ---

Fig. 5. Possibilities to enhance a firm's application knowledge and descriptive capacity and the equivalents for enhancing absorptive capacity.

One possibility of directly investing in descriptive capacity is the *institutionalization of the external knowledge commercialization* by assigning staff to identify external exploitation opportunities and to manage the external exploitation process. A company may also hire new employees or train current employees in order to increase its descriptive capacity in particular application areas. Some companies have established specialized units (Bidault and Fischer, 1994; Sullivan and Fox, 1996; Davis and Harrison, 2001; Birkenmeier, 2003), which may be regarded as an equivalent to knowledge acquisition units that were often set up in the 1990s as a result of the increasing knowledge acquisition. Other companies have transferred the idea of key account managers to the knowledge level by specifying contact persons for key knowledge clients (Birkenmeier, 2003). Through these institutionalized approaches, firms do not only enhance their application knowledge but also gain experience with the external knowledge commercialization process and may realize learning effects and economies of scale which will finally result in lower transaction costs in the external knowledge commercialization.

Nevertheless, descriptive capacity is not a competence resident in specific units but it will be distributed among the firm's employees. This is especially true under conditions of rapid and uncertain technological change, when the knowledge of all individuals is required to recognize external knowledge exploitation potentials. Thus, a firm should also rely on *informal structures* in addition to institutionalized approaches. As important information about external knowledge commercialization may be distributed across the whole company, external knowledge exploitation gatekeepers or boundary-spanners (Allen, 1977; Cohen and Levinthal, 1990), who are experts in the knowledge to be exploited but also have the necessary application knowledge to identify external commercialization opportunities, are of particular importance. A company should not only develop the competencies that are necessary for external knowledge exploitation in specialized units but should also try to profit from the T-shaped skills of selected employees (Iansiti, 1993; Madhavan and Grover, 1998), which may be intensified by activities, such as job rotation (Cohen and Levinthal, 1990; van den Bosch et al., 1999). Therefore, the external commercialization process should be

integrated into a firm's general business strategy and overall operations in order to leverage existing application knowledge in the external knowledge exploitation activities.

Many external commercialization opportunities, however, may not be identified by individual employees but only through the interaction of different knowledge sets which is why *intraorganizational communication and knowledge overlap* are essential for developing desorptive capacity (Cohen and Levinthal, 1990; Kogut and Zander, 1992; Madhavan and Grover, 1998). Thus, an organization's desorptive capacity does not only depend on its interface with the external environment but also on the knowledge transfers across and within subunits. First, knowledge may be commercialized in areas of other subunits than the one that has developed it. This intraorganizational knowledge commercialization requires the transfer of knowledge from one unit to another and can therefore from a business unit point of view be considered external knowledge exploitation (van den Bosch et al., 1999). Second and more important, other subunits than the one that developed or acquired the knowledge may have the necessary application knowledge to commercialize the knowledge outside the company. Accordingly, an adequate communication inside the company, which should be regarded as a distributed knowledge system (Tsoukas, 1996), is required to recognize the different commercialization opportunities.

For the communication to be effective, there should be a knowledge overlap between the different organizational units. "Assuming a sufficient level of knowledge overlap to ensure effective communication, interactions across individuals who each possess diverse and different knowledge structures will augment the organization's capacity for making novel linkages and associations .. beyond what any one individual can achieve." (Cohen and Levinthal, 1990, p. 133; Grant, 1996b). Some amount of redundancy in expertise and communication between, for example, corporate and divisional R&D labs and between R&D and sales or marketing functions may be desirable to increase application knowledge and to diffuse it among the different units in the company (Szulanski, 1996; van den Bosch et al., 1999). Cohen/Levinthal (1990) state that for absorptive capacity, there is a trade-off in the efficiency of communication between inward-looking and outward-looking absorptive capacity (communication inside the company vs. communication with the environment) because any particular expertise might become so specialized that it impedes the acquisition of outside knowledge and results in the 'not-invented-here' syndrome. For desorptive capacity, however, this relation seems to be rather the opposite. Of course, it is best if a subunit continuously takes a perspective that includes the environment of the company and specifically the relevant knowledge markets. However, it will be helpful and will not lead to

the 'only-use-here' syndrome if a subunit takes into consideration the requirements and applications of other subunits because the fact of considering the fields of application of other subunits helps to create an 'external knowledge exploitation culture', which will facilitate knowledge commercialization outside the company.

In analogy to an innovation culture, which supports the internal commercialization of knowledge (Ernst, 2004), an '*external knowledge exploitation culture*' and *sufficient prior experience with external knowledge exploitation* will foster a firm's external knowledge commercialization activities and may be a fundamental step in overcoming the strong limitations of applying knowledge only internally. In a company with a well developed external knowledge exploitation culture, the external exploitation option is regarded as an equivalent commercialization option. Moreover, the company will have at least some experience with the external commercialization of knowledge leading to learning effects. Such a culture will permit a more effective use of a firm's application knowledge, which usually will be distributed throughout the company as a knowledge system (Tsoukas, 1996). It will also facilitate the identification of external commercialization opportunities through a high degree of participation, which results in a broader knowledge architecture (van den Bosch et al., 1999), and through a more intense interaction between the employees. Such a broad participatory approach, which goes beyond the formal and informal organizational structures described above, will usually lead to a more proactive use of the external commercialization of knowledge. Furthermore, it will help to objectively evaluate external knowledge exploitation opportunities avoiding over- or under-evaluations and their negative consequences for the company.

An additional way of building up descriptive capacity are *interorganizational relationships and networks* in which the firm is located. From prior research on external knowledge exploitation it may be concluded that particularly close relationships with both buyers and suppliers (Bidault and Fischer, 1994; Elton et al., 2002; Koruna, 2003) will help to develop a firm's descriptive capacity. Interorganizational relations facilitate the establishment and governance of future relationships (Stuart, 1998; Gulati, 1999) because previous direct ties or shared third parties convey access to reliable and inexpensive information (Gulati, 1995; Stuart, 1998) which may both enhance a firm's application knowledge and directly help to establish new external knowledge exploitation agreements. In addition, networks will enhance the company's awareness of potential recipients beyond these networks because the company will be more used to regarding other application options including external forms of knowledge exploitation which will strengthen its external knowledge exploitation culture.

A rather different approach to increasing descriptive capacity is the intent to lower transaction costs and *increase market pull by building up a strong image as a knowledge provider* (Stuart, 1998). As it alleviates some of the problems inherent to knowledge markets, such as the identification of potential partners, this approach helps to reduce the need to build up application knowledge, which, however, is still necessary for adequate negotiations and knowledge transfer. In this context, 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). Therefore, firms will not be able to completely realize their external knowledge exploitation potentials by relying exclusively on these rather passive approaches of building up a strong reputation and additionally using intermediaries. As a reputation of being a valuable knowledge provider requires prior external knowledge commercialization activities, developing application knowledge appears to be inevitable.

Companies will usually not only use one form of developing descriptive capacity but will use different forms simultaneously depending, among other factors, on the characteristics of the knowledge to be exploited. If the competencies of a company in the specific knowledge area and the potential revenues of the external exploitation are high, the company will use rather active and resource-intensive forms of building up descriptive capacity, such as hiring experts with application knowledge in the particular field. Thus, the company will take a proactive and systematic approach to the external commercialization of these knowledge assets. If this is not the case, a company will probably try to commercialize the knowledge through channels which do not require an in-depth understanding of the potential application, such as internet platforms. These knowledge assets will not be in the focus of the external knowledge exploitation strategy which is why the company takes a rather passive approach to their commercialization.

However, it has to be emphasized that the effectiveness of increasing descriptive capacity through actions, such as hiring new personnel, is limited because the relevant knowledge has to be integrated into the organization which takes a lot of time. Similarly, the effectiveness of trying to reduce the need of application knowledge through contracting for consultants or using internet platforms will also be limited because for considerably enhancing its descriptive capacity a firm needs persons who are familiar with both the internal procedures and capabilities and the external knowledge markets at the same time. Thus, developing application knowledge in a particular field will usually require a rather time-consuming learning process.

Although the expert knowledge of individuals is crucial for desorptive capacity, its definition indicates that it refers primarily to the level of the organization or an organization's subunits. Some aspects of desorptive capacity are distinctly organizational, and the desorptive capacity of an organization will be more than the sum of the individuals' relevant knowledge because it depends on the relations and links among the individual capabilities which is consistent with Nelson and Winter's (1982) view of organizational capabilities. Sometimes, the application of the knowledge to be exploited is uniquely defined. Mostly, however, the inventor's individual knowledge, i.e. his or her background and prior knowledge, determine how the knowledge is to be applied in the first place (Jolly, 1997; Shane, 2000). If a company institutionalizes the communication inside the company as well as the communication with external partners, it will generate new potential applications by sharing, transforming and amplifying the individuals' knowledge into organizational knowledge (Nonaka and Takeuchi, 1995). The potential new applications may represent opportunities of external knowledge exploitation resulting from a company's application knowledge as part of its organizational knowledge.

The discussion regarding the need to combine knowledge to be exploited with appropriate application knowledge as well as the importance of organizational structures and the communication between different organizational subunits has shown that the ability to adequately manage the process of identifying and carrying out external knowledge exploitation activities contains elements of a combinative capability according to the concept of Kogut and Zander (1992). Thus, one can state that application knowledge itself is a necessary but not a sufficient condition of developing desorptive capacity. While application knowledge is the fundamental process-spanning component of desorptive capacity, also the development of phase-specific competencies, such as negotiation skills, will help to increase a firm's desorptive capacity. Furthermore, the organizational form of a company, its internal and external communication and what we have referred to as 'external knowledge exploitation culture' will have an effect on the creation of desorptive capacity as a prerequisite for the successful external commercialization of knowledge.

4 Operationalization of desorptive capacity

Desorptive capacity has been conceptualized as a complement to absorptive capacity in the area of external knowledge commercialization. Cohen and Levinthal (1990) consider prior related knowledge the critical factor behind absorptive capacity. Since prior related knowledge may be acquired as a byproduct of a firm's own R&D, they use a firm's R&D

spending as an operationalization of its absorptive capacity. Regarding desorptive capacity, we consider application knowledge the crucial knowledge component. Thus, the operationalization of desorptive capacity corresponding to the work of Cohen and Levinthal (1990) would be a firm's business diversification as it reflects the application knowledge that the company acquires as a byproduct of its own production and sales. However, in section 3.3 we have shown that a company may also directly invest in desorptive capacity by initiating actions to enhance its application knowledge. Based on an analysis of the possibilities to increase absorptive capacity that have been proposed in literature from various fields of research and have partly been tested empirically, we could identify corresponding methods to build up application knowledge and desorptive capacity. Therefore, we suggest to include in a first operationalization of desorptive capacity besides a firm's diversification the following aspects (Fig. 5): the institutionalization of the external knowledge exploitation, the use of informal structures, the intraorganizational communication and knowledge overlap, the external knowledge exploitation culture and a firm's prior experience with external knowledge exploitation, the firm's location in interorganizational networks and, finally, the firm's reputation and potential market pull.

Considering these different methods of developing application knowledge and making adequate use of it constitutes a detailed representation of a firm's level of application knowledge. As it has been described above (section 3.1), application knowledge is essential for all major tasks along the external knowledge commercialization process. Accordingly, the level of application knowledge will 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 as an underlying factor of influence on the relevant knowledge commercialization processes seems to be an appropriate operationalization of the desorptive capacity construct. An operationalization of desorptive capacity as a single factor component based on the level of application knowledge is consistent with various approaches in empirical research into absorptive capacity which followed the original work of Cohen and Levinthal (1990). In these studies (e.g. Szulanski, 1996; Veugelers, 1997; see also Zahra and George, 2002), different measures of absorptive capacity were employed, which, however, all focus at least partly on the existence of prior related knowledge.

Apart from the operationalization as a single factor component, the multi-dimensional definition of desorptive capacity allows an operationalization with multiple components. Similar to Cohen and Levinthal's (1990) concept, the definition of desorptive capacity follows an implicit process perspective by differentiating between the three steps of

recognizing external knowledge exploitation opportunities, identifying potential partners and negotiating adequate transaction conditions and, finally, transferring the knowledge. To reflect the process steps inherent to the definition, researchers might use individual measures of these three dimensions or might at least differentiate between two components: the preparation tasks and the actual knowledge transfer. An operationalization with multiple components would correspond to the reconceptualization of absorptive capacity by Zahra and George (2002), who propose four dimensions forming two distinct components, and to the relative absorptive capacity approach by Lane and Lubatkin (1998), who follow Cohen and Levinthal's (1990) definition by differentiating between valuing, assimilating and commercializing new knowledge.

An operationalization with multiple components permits breaking down a firm's level of desorptive capacity into the levels of competence in the individual activities, which facilitates a more detailed analysis of a firm's strengths and weaknesses in the external knowledge commercialization process. Moreover, it allows to develop an instrument corresponding to the efficiency factor in absorptive capacity proposed by Zahra and George (2002) which would 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. As a multi-component operationalization allows to consider the process steps individually, it may also be more suitable for dyad-level studies, where the main focus is usually on the actual knowledge transfer and not on the overall knowledge commercialization process of a single company (Lane and Lubatkin, 1998).

Despite potential operationalizations that focus on the individual process steps, application knowledge will remain the fundamental factor of influence on a firm's desorptive capacity. Although there are also possibilities to enhance desorptive capacity by developing phase-specific abilities, such as negotiation skills, the ways of building up application knowledge that have been described above are the main methods for improving a firm's process-spanning external knowledge exploitation capability. If these methods are not used to directly measure desorptive capacity, they still constitute essential starting points for actively managing a company's desorptive capacity. Thus, an empirical analysis of the direct effects of these factors on the success of a firm's external knowledge exploitation or on the phase-specific constructs, which may mediate the effects of these factors, may provide research results that do not only validate the theoretical concept but that are also highly relevant for direct application and implementation in practice.

For an empirical analysis of desorptive capacity and its relevance for the external knowledge exploitation activities of firms, it is essential to study its effects on the firms' success in carrying out these activities. To our knowledge, there are no large-scale empirical studies about companies' success in externally exploiting knowledge that go beyond illustrating revenue aspects, such as measuring licensing revenues (e.g. Ford, 1985; Vickery, 1988). To overcome these deficits and arrive at a more holistic approach to the success of a firm's external knowledge exploitation, the continuity of revenues through external knowledge commercialization might be an appropriate success variable, particularly if one takes into account that these revenues may significantly contribute to a firm's overall profit. The intellectual property revenues of IBM in 2000, for example, accounted for roughly 20% of its net income in that year (Kline, 2003). Furthermore, researchers might analyze the number and particularly the distribution of different external knowledge exploitation transactions, such as licensing or alliances, and might use measures that include the costs of a firm's external knowledge exploitation activities in order to arrive at variables reflecting profitability.

As all these variables refer to the monetary dimension of success, they do not capture the strategic aspects of the external commercialization of knowledge (Ford, 1988; Grindley and Teece, 1997; Koruna, 2004). In analogy to research into the internal exploitation of knowledge, the strategic dimension may be measured through the success in meeting the firm's external knowledge exploitation objectives, the overall success relative to competitors or the realization of the firm's external knowledge commercialization potentials (Cooper and Kleinschmidt, 1995; Ernst, 2002). Furthermore, the overall success of the company as a whole may be considered. If the concept of desorptive capacity is used in dyad-level studies, additional success variables, particularly regarding learning effects could be taken into account (Lane and Lubatkin, 1998).

In a model that measures the influence of desorptive capacity on a firm's external knowledge exploitation success, the methods of developing application knowledge in the single component operationalization and the phase-specific constructs in the multiple component operationalization are expected to have different effects on the various success variables and on the success of different knowledge commercialization transactions, such as licensing or alliances. In long-term alliances including bi-directional knowledge transfers, for example, the capability of actually transferring knowledge is supposed to have a greater influence on the overall alliance success. In longitudinal analyses, one may further detect that the capability of actually transferring knowledge will in turn influence the development of a

strong reputation as a knowledge provider which would indicate a mutual influence of the variables in the long term.

Apart from control variables, such as a firm's R&D intensity, contingency factors in the environment of the company have to be taken into account in empirical research into the effects of desorptive capacity on the success of a firm's external knowledge commercialization. Due to the imperfections in the markets for knowledge (Teece, 1981; Bidault and Fischer, 1994), intellectual property rights play a key role in facilitating the external commercialization of knowledge (Arora et al., 2001). Thus, the importance and effectiveness of intellectual property rights in the knowledge and application areas of a company may constitute a potential contingency factor. Similarly, there are great differences between various knowledge and application areas regarding the characteristics of the markets for knowledge in these areas, particularly the size and age of the markets (Arora et al., 2001). Therefore, market characteristics may influence the linkage between desorptive capacity and external knowledge exploitation success as well. Additional potential contingency factors may be derived from transferring the findings of new product development research to the knowledge market level. This leads to considering the competitive intensity of these markets and the technological turbulence, i.e. the rate of technology change (Jaworski and Kohli, 1993). In situations of high technological turbulence, where new knowledge becomes obsolete rather quickly, companies are expected to use the external mode of knowledge exploitation more intensely in order to compensate for the high R&D expenditures that are common in these settings.

This section has shown that the theoretical concept of desorptive capacity may be operationalized in various ways, each providing broad opportunities for empirical research. Thus, desorptive capacity seems to constitute an appropriate framework for overcoming the deficits regarding empirical work in past research into the external commercialization of knowledge. First empirical studies might operationalize desorptive capacity as a single factor component in order to directly validate the relevance of the concept's focus on application knowledge. Afterwards, a multiple component operationalization and an application of the concept to dyad-level settings may lead to additional insights regarding the individual dimensions of desorptive capacity.

5 Discussion

Against the background of an increasing external knowledge exploitation, desorptive capacity seems to be an appropriate concept to draw the attention to the need to build up an organizational capability that facilitates a proactive external commercialization of knowledge. As past research, particularly regarding absorptive capacity, focused on the acquisition and internal application of knowledge, desorptive capacity is a step towards a sound theory of the external exploitation of knowledge. Like absorptive capacity, desorptive capacity is conceptualized as an organizational capability and a multi-dimensional construct. Based on the distinction between knowledge to be exploited and application knowledge, however, the critical factor in this concept is application knowledge which is in contrast to absorptive capacity. Moreover, absorptive capacity only refers to the (internal) exploitation of absorbed knowledge while desorptive capacity includes the external commercialization of both externally acquired and internally generated knowledge.

Desorptive capacity may be valuable for the prescriptive analysis of organizational policies as well as for gaining insight into observed knowledge commercialization activities. Particularly, it explains the discrepancies between the often extremely positive approach towards the external knowledge exploitation in the theoretical literature and perceived difficulties with the external commercialization in the managerial practice. Application knowledge as the fundamental factor behind desorptive capacity as well as the path-dependence of the concept clarify why many companies have problems with establishing a proactive approach to the external commercialization of knowledge while other companies with a high exploitation potential and sufficient experience with external knowledge exploitation realize enormous benefits, in monetary and strategic terms (see section 2).

Furthermore, desorptive capacity may help to better understand knowledge transfers and strategic alliances and their respective success or failure. The literature in these areas has focused on characteristics, such as the recipient's absorptive capacity, and has mostly left out the ability of the sender to emit knowledge (see section 2). In this article, desorptive capacity has been described mainly on corporate level from the perspective of one company performing knowledge commercialization activities. As already indicated in the section on operationalizing desorptive capacity, however, the concept may be directly transferred to project-level and dyad-level settings because for an effective knowledge transfer between firms the desorptive capacity of the sender is a crucial variable. As bi-directional knowledge transfers are common in these situations, the absorptive capacity and desorptive capacity of both firms may be involved and should be considered in future research. Thus, the concept of

desorptive capacity could help to further improve the model of Lane and Lubatkin (1998) concerning relative absorptive capacity.

Although we have referred mainly to the firm as unit of analysis when developing the theoretical construct of desorptive capacity, the concept refers to all types of organizations, and it is possible to transfer the results to other institutions, such as universities or research institutes (Lane and Lubatkin, 1998). In this context, lacking desorptive capacity may be an important reason why research laboratories often have difficulties in commercializing knowledge (Agrawal and Henderson, 2002), particularly in comparison with established firms. Regarding these problems, pure knowledge selling firms are just in the same situation as research institutes which may be a reason why there are only so few of them (Granstrand, 2004). To diminish these problems of commercialization and build up application knowledge and desorptive capacity, an institute or company may collaborate over a longer time (establishing more than arm's length relations) with another company that holds complementary assets. Such behavior is common, for example, in the biotechnology industry. Generally, companies should take into account desorptive capacity in their 'keep-or-sell' decisions regarding external knowledge commercialization. By developing desorptive capacity and proactively commercializing knowledge, companies may realize learning effects and economies of scale, which influence the transaction costs of the external exploitation of knowledge. However, companies may also lock out themselves of the external knowledge commercialization by neglecting to build up desorptive capacity. With the growing external knowledge exploitation and the resulting multi-level competition on the markets for knowledge, intermediate output and products, the importance of desorptive capacity is expected to further increase in the future and may represent an essential source of competitive advantage.

6 Conclusion

As companies increasingly use the external exploitation of knowledge, they should develop the capability of adequately managing the relevant tasks along the commercialization process, which differ considerably from commercializing products or services. Therefore, in this article, we have presented the concept of desorptive capacity as a complement to absorptive capacity in the area of external knowledge exploitation. Desorptive capacity has been conceptualized as a dynamic organizational capability and a multi-dimensional construct. Differentiating between the actual knowledge to be exploited and the application knowledge

required for its commercialization, it has been shown that application knowledge is the critical knowledge component in the concept of desorptive capacity. As desorptive capacity is related to certain knowledge areas and to a company's organizational structure and operations, it is path-dependent and may be influenced by managerial action.

Conceptual at this stage, the construct is supported by some specific findings in past research, which indicate that desorptive capacity and the focus on application knowledge may help to deepen our understanding of knowledge commercialization and transfer. To move beyond the purely conceptual stage, initial considerations regarding the operationalization of desorptive capacity have been presented in this article. Based on these considerations, future research should develop methods to actually measure the construct before collecting empirical evidence and detailing the theoretical concept.

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Fig. 1: Desorptive capacity as a firm's ability to adequately manage the external exploitation of knowledge (Source: adapted from Brockhoff, 1999, p. 153)

	Knowledge acquisition	Knowledge accumulation	Knowledge exploitation
Internal			
External			Desorptive capacity

Fig. 2: Application knowledge as the critical factor for a proactive external knowledge commercialization

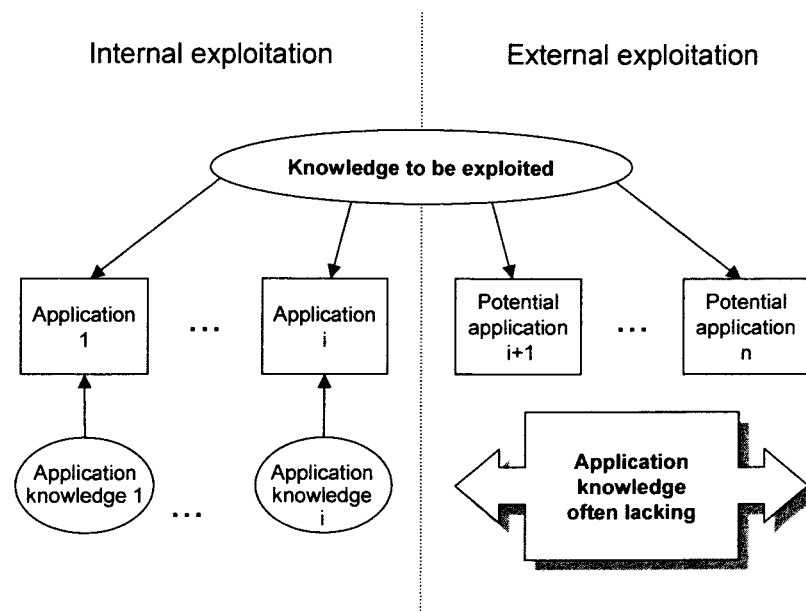


Fig. 3: The focus on different knowledge components in the concepts of absorptive capacity and desorptive capacity

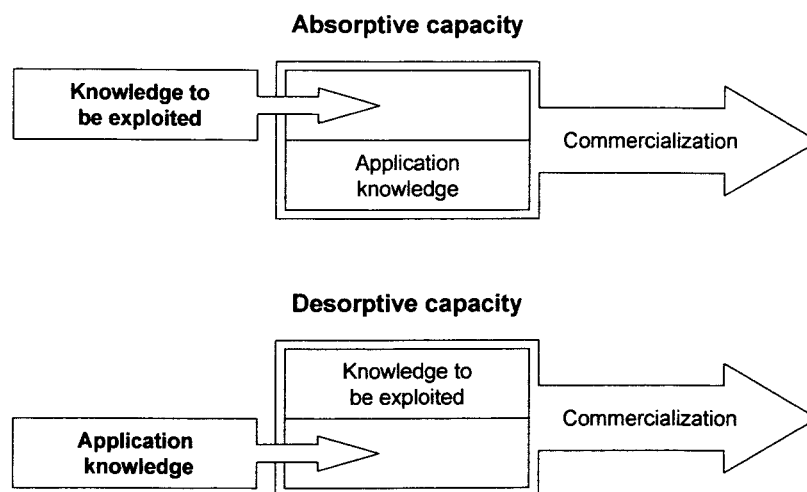


Fig. 4: Path-dependence of descriptive capacity and self-reinforcing cycle

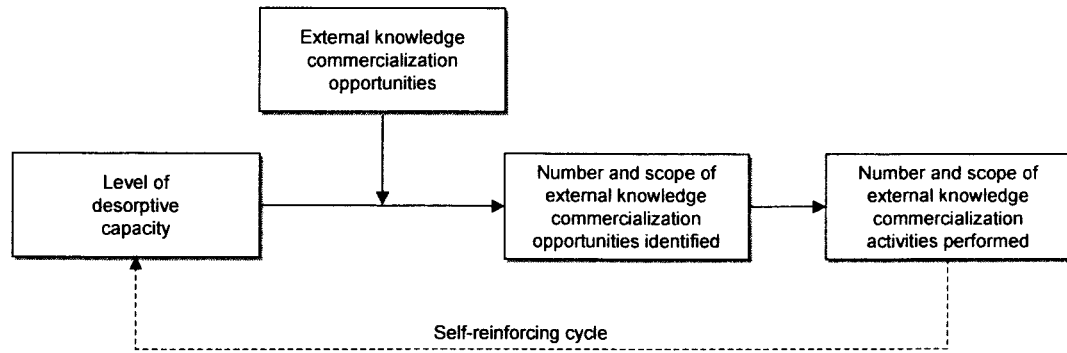


Fig. 5: Possibilities to enhance a firm's application knowledge and desorptive capacity and the equivalents for enhancing absorptive capacity

Desorptive capacity	Absorptive capacity
Own production and sales: degree of diversification	<ul style="list-style-type: none"> ▪ Own R&D and manufacturing operations: knowledge diversity (Cohen and Levinthal 1989; Cohen and Levinthal, 1990; Kim and Kogut, 1996; Lane and Lubatkin, 1998; van den Bosch et al., 1999; Deeds, 2001; Lane et al., 2001; Lane et al., 2002; Zahra and George, 2002; Scott, 2003)
Institutionalization of the external knowledge commercialization	<ul style="list-style-type: none"> ▪ Specialized actors to transfer information (Cohen and Levinthal, 1990; Zahra and George, 2002) ▪ Sending personnel for training (Lyles and Salk, 1996; van den Bosch et al., 1999; Lane et al., 2001; Minbaeva et al., 2002)
Informal structures	<ul style="list-style-type: none"> ▪ Gatekeepers or boundary-spanners (Cohen and Levinthal, 1990) ▪ Broad range of potential receptors (Cohen and Levinthal, 1990; van den Bosch et al., 1999)
Intraorganizational communication and knowledge overlap between organizational units	<ul style="list-style-type: none"> ▪ Intraorganizational communication (Cohen and Levinthal, 1990; Lyles and Salk, 1996; Szulanski, 1996; van den Bosch et al., 1999; Lane et al., 2001; Lane et al., 2002; Minbaeva et al., 2002; Zahra and George, 2002) ▪ Knowledge overlap between organizational units (Cohen and Levinthal, 1990; Szulanski, 1996; van den Bosch et al., 1999)
External knowledge exploitation culture and prior experience	<ul style="list-style-type: none"> ▪ Overcoming NIH syndrome and 'lockout' (Cohen and Levinthal, 1990; Kim and Kogut 1996; Szulanski, 1996; Minbaeva et al., 2002) ▪ Prior experience (Cohen and Levinthal 1989; Cohen and Levinthal, 1990; Kim and Kogut 1996; Szulanski, 1996; Lane and Lubatkin 1998; van den Bosch et al., 1999; Deeds, 2001; Lane et al., 2001; Lane et al., 2002; Minbaeva et al., 2002; Zahra and George, 2002; Scott, 2003)
Networks (interorganizational relationships)	<ul style="list-style-type: none"> ▪ Networks or alliances (Cohen and Levinthal, 1990; Stuart, 1998; van den Bosch et al., 1999; Deeds, 2001; George et al. 2001; Lane et al., 2002; Zahra and George, 2002; Scott, 2003)
Reputation and market pull	<ul style="list-style-type: none"> ▪ 'Knowledge push' through interest of knowledge source in recipient's learning, e.g. in international joint ventures (Lyles and Salk, 1996; Lane et al., 2001)