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## **Patent management in entrepreneurial SMEs: A literature review and an empirical study of innovation appropriation, patent propensity, and motives**

Marcus Holgersson

marhol@chalmers.se

Chalmers University of Technology / Institute for Management of Innovation and Technology  
Gothenburg, Sweden

E-mail: marhol@chalmers.se

Telephone: +46-(0)31 772 5288

Mobile: +46-(0)73 943 1121

Fax: +46-(0)31 772 1240

This paper is accepted for publication in *R&D Management*, please refer to the paper as:

Holgersson, M. (forthcoming) 'Patent management in entrepreneurial SMEs: A literature review and an empirical study of innovation appropriation, patent propensity, and motives', forthcoming in *R&D Management*.

The definitive version will be made available here:

[http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1467-9310](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1467-9310)

### **Abstract**

Managers make a number of strategic choices when trying to capture returns from innovation investments, including what appropriation strategy to use and whether or not to patent, strategic choices that depend among other things on firm size. Previous literature, being reviewed in this paper, shows that the patent propensity is lower in small and medium sized enterprises (SMEs) than in large firms and that patenting as means for appropriation is of less importance among SMEs. CEOs and/or R&D managers of 26 entrepreneurial SMEs have been interviewed to explain these differences and to provide insight on how patenting is used in SMEs. The patent competence was low among the studied SMEs, and internal patent resources were found to be important for effective and efficient use of the patent system; for application as well as monitoring and enforcement. While of limited perceived importance for protecting inventions in entrepreneurial SMEs, patents were used to attract customers and venture capital, which is of utmost importance for the survival and growth of these firms. Thus, patenting has an important role to play even in firms where the protective function of patents is secondary.

### **Keywords:**

Patents; Innovation; Intellectual property rights; Patent propensity; Appropriability; Motives to patent; Financing; SMEs

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## **Biography**

Marcus Holgersson is a researcher and PhD candidate in the Industrial Management and Economics research group at department of Technology Management and Economics, Chalmers University of Technology, Sweden. He is also affiliated with the Institute for Management of Innovation and Technology. He was educated in Industrial Engineering and Management at Chalmers University of Technology, and in Business Administration and Economics at Gothenburg University. He recently published the licentiate thesis *Intellectual Property Strategies and Innovation: Causes and Consequences for Firms and Nations* (Chalmers University of Technology, 2011), and his current research interests include innovation and intellectual property strategies and policies at both micro and macro levels in different industrial contexts with different degrees of open/closed innovation.

## 1 Introduction and concepts

Innovation is at core of contemporary business, and innovation investments are therefore central for the competitiveness of firms. All investments are by definition made with expectations of future benefits to the investor. Investments in R&D and innovation are special, since it is difficult for innovators to exclude others from also benefiting from the developed knowledge resources (Arrow, 1962; Stiglitz, 1999) and returns from innovation investments therefore tend to be captured by holders of complementary assets rather than by the innovator when imitation is easy (Teece, 1986). Managers of innovative firms, including small and medium sized enterprises (SMEs), therefore need to carefully choose strategies in order to appropriate the returns from innovation investments. One solution is to apply for a patent, which by the European Patent Office (EPO) is defined as “a legal title granting its holder the right to prevent third parties from commercially exploiting an invention without authorization”. The propensity of firms to use patents (i.e. the ‘patent propensity’) has been researched by a number of scholars following the works of Scherer (1965, 1983).

Patenting is however not the only means for appropriation – i.e. for capturing returns from R&D investments (Teece, 1986; Levin et al., 1987). For example, firms can also choose to protect their innovations by secrecy, sales or service efforts, lead time creation and/or low cost production (e.g., Levin et al., 1987). It has then been shown that although patents are frequently used by innovators, they are rated low in terms of how effectively they can protect innovations in relation to other means of appropriation (e.g., Mansfield 1986; Cohen et al., 2000).

So how come firms do apply for patents, if not for appropriation? There are in fact many other motives for innovative firms to patent than only to prevent imitation, including to improve corporate image, to motivate employees, and to avoid litigation by retaliation power (e.g., Arundel et al., 1995; Blind et al., 2006), and patents can therefore be used as tools not only for protection in innovation management, but also for incentives creation, collaboration, negotiation, licensing, tax-planning, etc. (Granstrand, 1999).

Thus, the concepts of patent propensity, appropriation strategies, and motives for patenting are closely interrelated, as illustrated in Figure 1. The purpose of this paper is to review empirical literature on these concepts and to empirically study how patenting is used by R&D management in entrepreneurial SMEs. The first research question in this paper is related to the literature review:

RQ1: What is the current state of empirical research of patent propensity, appropriation strategies, and motives for patenting?

[FIGURE 1 HERE]

As the literature review in Chapter 2 will show, previous studies indicate that there are differences between large firms and SMEs. Current literature offers limited explanations to how and why SMEs use patenting and how and why SMEs differ from large firms, however. This study aims to fill this gap, and more specifically intends to answer the following research questions:

RQ2: What is the importance and role of patenting in entrepreneurial SMEs?

RQ3: What are the motives for and against using patenting among entrepreneurial SMEs?

The empirical study focuses on *entrepreneurial* SMEs. The concept of entrepreneurship is neither entirely clear in the literature, nor commonly agreed upon (e.g., Schumpeter, 1934; Gartner, 1990; Covin and Slevin, 1991; Dean and Meyer, 1996), despite its long history arguably dating back to the 17<sup>th</sup> century and the economist Say (Granstrand, 1982). Nevertheless, entrepreneurial SMEs are here defined as SMEs that base their businesses on new or improved technologies and/or that are newly established or with new or improved means for commercialization and growth. This is comparable with the traditional definition of innovations, a concept that typically includes new technical and managerial developments on one hand and the commercialization of these developments on the other hand (e.g., Schumpeter, 1934; Freeman, 1982; Garcia and Calantole, 2002). The concept of entrepreneurial SMEs guides the sample selection (see Chapter 3), and new empirical data on entrepreneurial SMEs is presented in Chapter 4 in order to answer RQ2 and RQ3. These findings are discussed and concluded in Chapter 5.

## 2 Previous research and literature review<sup>1</sup>

### 2.1 Patent propensity

The concept of patent propensity is used with slightly different meanings in the literature. Scherer (1983) focused on the patent per R&D ratio (i.e. patent intensity analogously with R&D intensity), while Mansfield (1986) defined patent propensity as the probability to patent a patentable *invention* and Arundel and Kabla (1998) defined patent propensity as the probability to patent a patentable *innovation*. All definitions of patent propensity are however related to the underlying management decision of whether to apply for patent protection for an invention or not. Early empirical studies showed that US firms' patenting was mainly related to their R&D outlays, but with varying coefficients over industries (Scherer, 1965, 1983). The results showed that in most industries there was no significant departure from constant returns (59.7%), and that deviations from this were more commonly towards diminishing returns (25.0%) than increasing returns (15.3%) (Scherer, 1983). Constant returns have also been indicated by research showing that the R&D intensity of a firm is not affecting the propensity to patent a patentable innovation (Arundel and Kabla, 1998). Note however that there is an important difference between the patent per R&D cost ratio (as studied by Scherer) and the propensity to patent a patentable invention or innovation (as studied by subsequent scholars). Between the R&D variable and the patent variable is an intermediate variable, namely the number of patentable inventions per R&D cost (R&D yield):  $\text{Number of patents} = \text{R\&D} \times \text{R\&D yield} \times \text{Patent propensity}$ .

Differences between industries in patent output per R&D as described above can arise both due to differences in R&D yield and due to differences in patent propensity (for example due to differences in appropriation strategies). Mansfield (1986) investigated this by combining own data on US firms with the results of Scherer (1983). The results of Mansfield's analysis indicate that only 12% of industry variation in patent per R&D was

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<sup>1</sup> Both ISI Web of Knowledge and Google Scholar were used for searches on topics like patent propensity, appropriation/appropriability and motives/motivations for patenting/to patent. Additional literature was then found by snowballing. Hence, the literature review had characteristics of both a systematic review and a more narrative approach (Bryman and Bell, 2007).

explained by variation in propensity to patent. Instead, the main cause of differences in patent output per R&D was variation in R&D yield over industries. Nevertheless, Mansfield's results showed that not only the patent per R&D ratio varied widely over industries, but also the patent propensity. Later studies of European firms have confirmed such industry variations, and in addition showed that patent propensity is lower for process innovations than for product innovations (Arundel and Kabla, 1998; Brouwer and Kleinknecht, 1999). This goes in line with the common view that patent protection is in general more effective for product than process inventions, since the latter is more difficult to reverse engineer (Granstrand, 1999). In addition to variations over industries and innovation types, studies have indicated that patent propensity varies over time (Griliches, 1989, 1990; Kortum, 1993; Nicholas, 2011; Granstrand and Holgersson, 2012) and countries, with Japan being an extreme example in terms of high patent numbers in the 1980s and 90s (e.g., Rahn, 1983; Westney, 1993; Granstrand, 1999).

An issue of major interest among management and policy scholars alike is whether or not large firms benefit more from the patent system than small firms, which could be indicated by differences in patent propensities. A number of studies have found that large firms have higher patent propensities than small firms (Mansfield, 1986; Arundel and Kabla, 1998; Brouwer and Kleinknecht, 1999; Chabchoub and Niosi, 2005). However, other studies have found that small firms tend to have higher patent per R&D ratios than large ones (Bound et al., 1984; Granstrand, 1988). One part of the explanation could be that small firms have higher R&D yields but lower patent propensities than large firms. Another part of the explanation could be that innovation activities in large firms are underestimated when measured with patent statistics while innovation activities in small firms are underestimated when measured by R&D statistics (Pavitt, 1982).

Table 1 summarizes a selection of the studies on patent propensity. From previous studies it can be concluded that both the patent per R&D ratio and the patent propensity varies over industries, innovation types, time, countries, and firm sizes.

[TABLE 1 HERE]

## 2.2 Appropriation

Appropriability is defined as the ability, or rather possibility, to capture returns from R&D investments (Teece, 1986; Levin et al., 1987). Most empirical studies on appropriation focus on different means of protecting innovations from imitation, since returns tend to end up with others than innovators when imitation is easy (Teece, 1986). Levin et al. (1987) made an early empirical study of different appropriation methods. The results showed great variations over industries in the effectiveness of different means of appropriation, and that patents were more effective than secrecy for new products, while secrecy was more effective for new processes. However, sales or service efforts, lead time, and learning were rated more effective than both patents and secrecy. The limited effectiveness and use of patents for appropriation has been confirmed by a number of subsequent studies (Harabi, 1995; Kitching and Blackburn, 1998; Brouwer and Kleinknecht, 1999; Cohen et al., 2000; Leiponen and Byma, 2009), an exception being large Japanese firms rating patents as the most effective means (Granstrand, 1999). The latter is reflected in the high number of patent applications from Japanese firms at the time.

Worth noting is that the studies of appropriability above at least implicitly tend to view the different means of appropriation as distinct, when they in fact are not. Practitioners use various appropriation strategies in complementary ways. For example, both patents and secrecy can be strategically used to create market lead times (Hurmelinna-Laukkanen and Puumalainen, 2007). Hence, comparing for example the effectiveness of patents and lead times is problematic, to say the least. Arundel (2001) solved this by focusing only on patents and secrecy, since they to some extent are mutually exclusive means of appropriation. He showed that secrecy in general is rated more valuable than patents for all firm sizes and for both product and process innovations, but that the probability with which firms rate secrecy over patents decreases with increasing firm size in the case of product innovations. It should in this connection be noted that an innovation can be protected by both a product patent and a process trade secret, and that patents and trade secrets therefore are not mutually exclusive but rather important complements. Nevertheless, it can be argued that each single bit of knowledge cannot be protected by both a patent (which requires information disclosure) and a trade secret (which requires information non-disclosure).

A number of relative limitations and drawbacks with using patents have been identified in this stream of literature, partly explaining the limited effectiveness and use of them for appropriation. Three limitations have been indicated as especially important by empirical studies. First, competitors can legally "invent around" patents, thereby limiting the function of patents for protection (Harabi, 1995). Second, patent protection requires information disclosure through patent publications, leading to a special form of information leakage (Duquet and Kabla, 1998, 2000). Third, patent applications and patent protection is related to direct and indirect costs (Kitching and Blackburn, 1998; Cohen et al., 2000).

Table 2 summarizes the main findings from some of the studies on appropriability. It is remarkable how uniform the picture is on the low relative effectiveness of patents for protecting inventions (Japan and chemical industries being exceptions). Informal means such as sales and service efforts, lead time, learning, and secrecy are all found to be more effective means of appropriation.

[TABLE 2 HERE]

### **2.3 Motives for patenting**

The literature presented above gives an ambiguous picture of patenting in firms. On one hand, the literature on appropriation almost uniformly shows that patents have low effectiveness in protecting new products and processes. On the other hand, the literature on patent propensity shows that a large share of patentable inventions is despite this patented. Mansfield (1986) found that in industries where patents were rated unimportant, more than 60% of the patentable inventions were nevertheless patented. This peculiar circumstance is often referred to as the 'patent paradox'. This patent paradox leads to the question: Why do firms patent? Multiple studies have tried to give answer to that question.

Empirical research has pointed at a number of important reasons to patent, including to prevent imitation, to avoid trials, to reach strong positions in negotiations (Arundel et al., 1995; Duguet and Kabla, 1998; Granstrand, 1999), and to block other firms' R&D and patenting efforts (Cohen et al., 2000; Thumm, 2004). Studies have also indicated that

enhancing the firm's reputation is a common motive for patenting (Thumm, 2004), and more so for small firms than for large ones (Cohen et al., 2000).

Blind et al. (2006) especially pointed at the low relative importance of exchange motives for patenting as an extraordinary fact in light of increasing technology trade and open innovation. Related research on individual patent level shows that patents are most commonly used internally and for blocking competitors, while seldom licensed and cross-licensed (Giuri et al., 2007). However, in their study of the US semiconductor industry, Hall and Ziedonis (2001) found that the value of patents as "bargaining chips" in negotiations had increased after the strengthening of the US IP regime related to the pro-patent era (which was also found in Granstrand, 1999). Worth noting is moreover that standard-setting motives for patenting have been of increasing importance, especially within the telecommunications industry (Granstrand, 1999; Bekkers et al., 2002). Thus, the pro-patent era not only strengthened traditional defensive motives to patent but also generated new and more offensive motives, such as means for bargaining, standard-setting, and retaliation (Granstrand, 1999).

Regarding differences due to firm size, small firms indicate a higher importance for reputation motives (improvement of technological image and increase in company value) and a lower importance for incentive motives (motivation of staff and internal performance indicator) relative to larger firms, even though the general order of importance are not necessarily different across firm sizes (Blind et al., 2006). Small firms are also more likely to patent to license or to convince investors and banks about the value of the invention (Granstrand, 1988; Rassenfosse, 2012).

Table 3 summarizes a selection of studies on motives for patenting. It is clear that the most important motive for patenting is (the traditional motive) to prevent imitation, but there are a number of other motives that are also of large importance.

[TABLE 3 HERE]

## **2.4 Characteristics of SMEs**

Multiple differences between SMEs and large firms can be identified from previous research on the themes of this paper. A number of studies have shown that the patent propensity is lower in SMEs than in large firms (Mansfield, 1986; Arundel and Kabla, 1998; Brouwer and Kleinknecht, 1999; Iversen, 2003; Chabchoub and Niosi, 2005; Friesike et al., 2009; Keupp et al., 2009), although contrasting research indicate that SMEs actually have higher rates of patent usage than large firms if controlling for industry effects (Jensen and Webster, 2006). SMEs more often than large firms apply only for national patents, as opposed to applying for patent protection both domestically and internationally (Friesike et al., 2009). Further, SMEs more commonly than large firms prefer secrecy before patents (Arundel, 2001), and they have been argued to focus on protecting the innovative inputs (including R&D personnel) rather than innovative outputs (i.e. innovations), and then especially by using proper human resource management (HRM) (Olander et al., 2009). Research has indicated that SMEs emphasize reputation motives for patenting more than large firms (Blind et al., 2006) and that they commonly patent for monetary reasons (Rassenfosse, 2012).

A number of specific characteristics of SMEs need to be taken into account when analyzing these differences. For example, Hoffman et al. (1998) argued (based on a literature review) that the innovative activities of SMEs are more likely to involve product than process

innovation, more likely to focus on niche rather than mass markets, and more likely to involve linkages to external resources. Further, Blomqvist (2002) argued that technology-based SMEs are lean, flexible, visionary, non-hierarchical with fast decision-making, but especially (for the purpose of this paper) that the resources are mainly people-embodied and that there is a lack of organizational legitimacy. Looking more specifically at new technology-based firms (NTBFs), they are characterized by a lack of financial capital, and partnerships with larger firms commonly spur (mutual) success (Storey and Tether, 1998). Thus, there are differences between large firms and SMEs of importance to patent management, aside from differences in mere size. Therefore, the remainder of this paper will focus on RQ2 and RQ3, with the purpose to increase the understanding of the importance and role of patenting and the motives for and against using patenting among entrepreneurial SMEs.

### **3 Method for empirical data collection**

This study was designed and partly carried out within a larger investigation of patents and innovations' role for growth and welfare (SOU, 2006; Granstrand, forthcoming). As indicated by the literature review, quantitative methods have been dominant in previous empirical studies of patent propensity, appropriability and motives for patenting. Although these quantitative studies have been informative in many aspects, they are limited in others. A qualitative method is therefore used here to complement previous studies and to enrich the understanding of patent management in entrepreneurial SMEs. The data was collected in semi-structured interviews among three different samples, and non-probability sampling was used. In general, the sampling was purposive (Flick, 2009) in the sense that tail samples were chosen to generate insight in different types of entrepreneurial SMEs.

The first sample includes entrepreneurial high growth SMEs, representing SMEs with new or improved commercialization and sales growth. Top growth Swedish SMEs were sampled based on a list of the fastest (organically) growing Swedish companies (over a three year period) published by the Swedish business newspaper "Dagens Industri" (Nilses, 2004). The included firms have published at least four annual reports; have total sales greater than 10 MSEK; have at least ten employees; have during the last three years continuously increased their total sales; have during the same period at least doubled their total sales; and have a collected profit over the four years that is greater than zero. Six companies had in 2005 been on the list for all six years during which the list had been published and had sales growths from 1996 to 2003 of between 561% and 2 472%. These six were selected for the first round of telephone interviews among entrepreneurial high growth SMEs, and in addition two firms further down the list (i.e. firms that had not been on the list for all six years). The eight firms had in between 20 and 200 employees. Four of the firms were essentially service firms, while the other four were manufacturing firms active in medicine and mechanical, material, and electrical engineering. After a total of eight interviews had been performed, a decision was made not to continue with interviews among high growth SMEs, due to theoretical saturation (Glaser and Strauss, 1967).

The second sample includes entrepreneurial hi-tech SMEs, representing SMEs based on new or improved technologies. These were sampled based on a list of Swedish hi-tech firms in growth in the Swedish technology and engineering newspaper "Ny Teknik" (Alpman and Mellgren, 2005). After cleaning the list from mergers and acquisitions, inactive firms, firms without reported financials, etc., 29 firms remained. Financial data including sales and



employees was collected for all firms. Twelve of the firms were then randomly selected for telephone interviews, six from the top half of sales growth between 2001 and 2004, and six from the bottom half (two of the selected firms had negative growth). These interviewed firms were all within traditional engineering industries, including mechanical, electrical, computer, and chemical (and biotech) engineering, with roughly 5 to 70 employees.

The third sample includes firms in a geographical region, the "Gnosjö region", characterized by a documented entrepreneurial spirit, the "Gnosjö spirit", of enterprising and networking (Wigren, 2003). Six firms were selected by snowball sampling (see e.g. Bryman and Bell, 2007), focusing on firms of different sizes within the SME spectra with at least some form of patenting activities. Hence, this sample consists of SMEs related to a specific geographical area with a documented entrepreneurial spirit rather than SMEs with some specific characteristics. These firms were all within mechanical (and to some extent material) engineering industries with roughly 10 to 400 employees. The firms in the entrepreneurial region were visited and interviewed face-to-face. In addition to these interviews, a hearing was held with 14 industry representatives (primarily CEOs, R&D managers and bankers) from various firms (not included in the main sample) within the region.

The interviews were conducted with CEOs and/or R&D managers. 26 interviews were conducted in total and some of them were complemented with e-mail questions and/or follow-up discussions. Semi-structured interviews were used to allow for flexibility, open discussions and new ideas (Bryman and Bell, 2007). The interviews were mainly structured along four themes, including (1) importance and role of patenting for the firm, (2) competence and resources for patenting in the firm, (3) motives for patenting and reasons not to patent in the firm, and (4) potential support regarding patenting needed in the firm. This paper focuses on the first three of these themes. Within-case and cross-case analyses were performed of the collected data (Eisenhardt, 1989). These two types of analyses were performed on two different levels in this study due to multiple samples with multiple firms in each. Firstly, the results of each single firm were analyzed, followed secondly by a cross-firm analysis within each sample (the latter also corresponds to a within-sample analysis). Thirdly, a cross-sample analysis was conducted.

[TABLE 4 HERE]

## **4 Empirical results**

### **4.1 Entrepreneurial high growth SMEs**

The interviews in the sample with entrepreneurial high growth SMEs revealed that patenting was perceived as of little or no importance for a majority of the firms. The main reason behind this, as addressed by the interviewees, was that patents were not applicable in the firms' businesses and that technical inventions in general were of little importance. However, in one case where technical product innovations were arguably of most importance behind the growth of the firm, patents were still neglected. Despite the fact that the firm had previously experienced a former employee leaving and starting up imitating production in Germany, there were no intentions in the firm to start using patents. Comments such as "the only thing we have patented is our company name", "the market is big enough for more actors", and "we produce as much as we can anyway" revealed that the competence regarding patenting, how it

can be used and potential benefits was low. This was true in general among the high growth SMEs, with a few exceptions.

Some interviewees addressed concerns regarding too high direct as well as indirect costs of patenting, and the weak protection patents give SMEs. Considering the technical knowledge being revealed by patents and the poor possibilities of monitoring and enforcing granted patents for SMEs, patents were often perceived to do more harm than good. The absence of a single EU patent was by one interviewee also mentioned as a major disadvantage, since the vast amount of applications (and related translations) necessary to cover the European market is difficult to handle for SMEs. Another firm addressed speed to market to be of utmost importance for appropriation, especially due to short product life cycles that limited imitation risks. However, patents were nevertheless regarded to have a significant value for the company in that they were used for customer marketing purposes, for example by the use of "patented" or "patent pending" in the marketing of the product and on the product itself ("patent markings"). Note that patent markings on products can be used both to signal inventiveness to customers and to signal proprietary characteristics to competitors. Actual patents or patent applications are necessary for enabling patent markings, since false patent markings are illegal, and in the US anyone can sue for false patent marking and share the potential penalties 50/50 with the US state. (After a legal change in the US in 2009, which significantly raised potential penalties, there has been a large increase in the number of litigation filings regarding false patent markings.)

#### **4.2 Entrepreneurial hi-tech SMEs**

Compared to the high growth SMEs, the hi-tech SMEs were much more active in patenting. However, despite the fact that technical inventions were of major importance for these firms and their growth, and despite the fact that patenting was frequently used, their patenting was with a few exceptions not regarded to have large impact on the firms' competitiveness and growth.<sup>2</sup> One aspect of patenting differed and turned out to be of general importance. A majority of the firms addressed that patenting is crucial to attract venture capital (VC), and most of the firms in this sample were financed by VC. Since external financial capital is necessary to develop and grow for many hi-tech SMEs, patents play a central role in these firms. Patents were also found to be of importance in cases of mergers and acquisitions.

Patents' importance in customer marketing was again addressed by numerous interviewees. Secrecy and speed were found to be more important than patents for firm competitiveness in some cases, but not all. While the internal patenting competence in the firms was perceived to be low by the interviewees (the majority relied mainly or solely on external consultancies), top management had central roles in patenting decisions.

Some of the interviewed SMEs used patent information to avoid infringements by staying away from patented technologies and/or to find blocking patents that need to be licensed. However, none of them used patent information to find available technological solutions of

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<sup>2</sup> Note that the sampled entrepreneurial hi-tech SMEs (which were mainly in the electronics and chemistry industries) were young, between five and twelve years of age and in general only with a short time on the market, and benefits from patents might not be immediately obvious. In addition, counterfactual analysis (of what would be the situation without a patent) is difficult to perform.

others that could be used directly or invented around. Despite this, disclosure of patent information was addressed as one of the major drawbacks of patenting. This is paradoxical, since at the same time as the interviewed SMEs apparently see a value of the technological information they provide to competitors through patent publications, they do not take advantage of the reverse information flow from the competitors' patent publication. This might then be a result of a lack of resources, since this was a major problem in the entrepreneurial hi-tech SMEs, not only in the application stage but also in enforcement (and especially enforcement against large firms).

The findings from entrepreneurial hi-tech SMEs can be summarized by a comment by one of the interviewed CEOs: "A patent has three important roles in our company; 1. Facilitate financing, 2. Deter imitation, 3. Acknowledgement of unique technology". However, the same CEO summarized the general view on patents' limited ability to deter imitation and protect SMEs' inventions in that "the protection is proportional to the amount of cash in your firm".

### **4.3 Entrepreneurial region**

As described above, the "Gnosjö region" is characterized by a documented entrepreneurial spirit and culture, the "Gnosjö spirit", of enterprising and networking (Wigren, 2003). The interviews in this entrepreneurial region revealed somewhat different findings than the interviews in the other two entrepreneurial samples. Two of the firms were by sample design in the larger end of the SME spectra, and it was clear that the patent competence within these two firms was significantly higher than among the smaller ones, and both had employed patent engineers internally which was by these firms seen as a major prerequisite to use the patent system effectively and efficiently. These firms also turned out to trust the function of patents much more than the smaller firms, and patenting was of major importance for their competitiveness. As a contrast, the patent competence among the smaller firms was low in general, and patents were less trusted and of less importance for firm competitiveness.

The general preference in the sample was patents before secrecy when protecting important product innovations, and secrecy before patents when protecting process innovations. The latter was due to impossibilities of monitoring infringements in process patents since these commonly take place within the walls of other firms, and in addition that reverse engineering is more difficult to undertake for competitors in case of process innovations than in case of product innovations. The preference for patenting product innovations had to do partly with limiting risks for reverse engineering (essentially among the larger SMEs) and partly with the use of patents in customer marketing (essentially among the smaller SMEs).

A concern among the firms was that the inventive step required for an invention to be patentable is too low, and that this is a drawback for SMEs. SMEs have fewer resources than large firms, and this limits both their patenting activities and their abilities to monitor the vast amount of patents that results from larger firms' patenting, especially when requirements for patentability are low since this leads to extensive patenting among large firms. The patent thickets of larger firms and how to navigate the internal R&D among them (patent clearance) had become a major concern.

The entrepreneurial spirit and culture in the region turned out to impact the firms' patent and appropriation strategies in an interesting direction, especially among the smaller SMEs. In light of the low inventive step requirements and the related possibilities to patent minor

innovations one interviewee stated that "I would be ashamed if we patented every tiny thing we invented. We have a social responsibility". Two of the interviewees stated that their firms should not need to worry about patenting, since imitation should instead be met by outstanding inventiveness and entrepreneurial spirit: "In this region we focus on doing things, and if someone else starts doing the same things we do them even better." A related statement expressed by many interviewees was that how to produce something and the quality it results in is more important to protect (by secrecy) than the product invention (by patents), since imitators commonly cannot produce with the same level of quality. However, unauthorized imitation was still an issue for many of the firms, both imitation within the region and imitation globally (primarily in Asia). An important function of industry exhibitions/fairs/expos is then for an innovating SME to control whether any unauthorized imitation is taking place, according to the interviewees (contrasting the use of continuous patent/infringement monitoring).

## 5 Discussion and conclusion

Earlier research has been dominated by quantitative methods and commonly focused on one, or in a few cases two out of the studied themes in this paper; patent propensity, appropriation strategies, and motives for patenting. This paper contributes to the growing literature within intellectual property (IP) management by utilizing a qualitative method allowing a broader perspective including all three interrelated themes, see Figure 1. Additionally, the empirical research focuses on entrepreneurial SMEs, enabling insight into how patenting is used in the R&D management of entrepreneurial SMEs.

The empirical results, summarized in Table 5, indicate that patents were of little perceived importance when appropriating returns from R&D in the entrepreneurial SMEs. When patenting, the traditional motive to deter imitation was of limited importance (exceptions being a couple of the larger SMEs in the entrepreneurial region), contrasting previous results among SMEs as well as large firms (e.g., Arundel et al., 1995; Duguet and Kabla, 1998; Granstrand, 1999; Cohen et al., 2000; Thumm, 2004; Blind et al., 2006; Keupp et al., 2009). A major reason for the studied SMEs' low trust on the ability of patents to deter imitation was the limited resources they have for monitoring and enforcing their patents. This contrasts the results by Cohen et al. (2000), where defense costs were found to be the least important reason not to patent. SMEs commonly lack litigation resources (Kitching and Blackburn, 1998), which in many ways are prerequisites for the ability to enforce their rights. In addition, litigation risks and threats are higher for SMEs than for large firms (Lanjouw and Schankerman, 2004), and the patent system has accordingly been argued not to function properly for SMEs (Kingston, 2004). The disclosure of patent information, an important drawback of patenting according to this and other studies (Levin et al., 1987; Harabi, 1995), has then especially severe consequences for SMEs with limited resources for monitoring and enforcing their rights after being published. (Also, a published patent application might never mature into a patent – or a patent with commercially useful claims.)

[TABLE 5 HERE]

Instead of deterring imitation, two kinds of marketing motives for patenting stand out as of major importance among entrepreneurial SMEs; customer and capital marketing. These two marketing motives go well in line with some of the main struggles entrepreneurial SMEs

encounter – to attract customers and meanwhile to survive financially (e.g., Storey and Tether, 1998).

Regarding customer marketing, the use of patents for improving corporate/technological image has according to previous studies been of little importance (Granstrand, 1999; Cohen et al., 2000; Thumm, 2004; Blind et al., 2006). This is contrasted by the results here, where the potential of patents to attract customers was one of the main motives for patenting, indicated in all three samples of entrepreneurial SMEs. A reason for this might be that SMEs have weaker market positions in general than large firms (Blomqvist, 2002), and the function and innovativeness of their products thus need to be proven by other means than yet not strong trademarks, for example by patent markings.

Regarding capital marketing, earlier studies have on one hand shown limited importance of VC attraction as a motive for patenting (Thumm, 2004; Keupp et al., 2009), and on the other hand shown that SMEs can use patents as a value signal to banks and investors (Lemley, 2000; Hsu and Ziedonis, 2008; Haeussler et al., 2009; Rassenfosse, 2012). This empirical study shows that patents are used to attract VC, sometimes even being prerequisites for investments, and VC attraction was the most important motive for patenting in the entrepreneurial hi-tech SMEs, contrasting earlier studies. Thus, venture capitalists seem to rely more on patents than managers of entrepreneurial SMEs. Two potential explanations to this can be highlighted. First, venture capitalists typically make long-term investments and are then well aware of the potential benefits of patents later in the SME's life (a patent can stay valid for 20 years). Managers of SMEs, by contrast, are often unaware of the IP system (Pitkethly, 2012). Second, patents can be used as an internal governance tool, complementing for example employment contracts and mitigating the principal-agent problem by safeguarding that the knowledge and intellectual capital of the investment object, often centered among a few single individuals, is kept within the firm after the investment. This is of course of major importance to investors.

From a resource based perspective (e.g., Penrose, 1959) it seems like large firms with better access to complementary assets mainly patent to protect their technological resources (e.g., Arundel et al., 1995; Cohen et al., 2000), while this study indicates that entrepreneurial SMEs mainly patent to gain access to necessary complementary assets or resources, including financial capital. This is also indicated by SMEs more commonly using licensing out strategies than large firms (Rassenfosse, 2012), which connects technological innovations with complementary assets.<sup>3</sup> Similar to VC firms, many large firms require their small partners to patent their innovations before initializing collaboration, not the least to avoid being accused for stealing ideas from SMEs. Previous research shows that firms with R&D collaborations typically have and apply for more patents than other firms (Brouwer and Kleinknecht, 1999; Gans et al., 2002; Gans and Stern, 2003). Thus, SMEs can use patents as enablers of open innovation in order to connect their technological innovations with the complementary assets needed for commercialization (e.g., Chesbrough, 2003, 2006; Chesbrough et al., 2006; Enkel et al., 2009; Gassmann et al., 2009; Dahlander and Gann, 2010; Bogers et al., 2012).

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<sup>3</sup> At the same time large firms, for example in systems technologies, do indeed use patents for access to complementary resources as well, but then typically technological resources as demonstrated by cross-licensing activities (Granstrand, 1999; Hall and Ziedonis, 2001; Holgersson, 2011; Bogers et al., 2012).

The main constraint for entrepreneurial SMEs regarding patenting is their lack of resources, in the application stages as well as in the monitoring and enforcement stages. Internal patent competence, for example in the form of in-house patent engineers, is important for a firm's effective and efficient use of the patent system. In fact, after the interviews were performed, an acquisition of one of the larger SMEs in the entrepreneurial region resulted in a strategic change that led to the removal of the patent engineer position. A follow-up interview with R&D personnel indicated that this severely impacted the firm's abilities to utilize patenting in an effective and efficient way, and that sole reliance on external IP service providers is not sufficient to substitute for internal expertise. SMEs are in this connection not only suffering from lack of internal resources, previous research has also shown that SMEs are disadvantaged compared to large firms in establishing links to external expertise (Rothwell and Dodgson, 1991). This is partly due to complementarities between in-house and external expertise, which is closely related to the concept of absorptive capacity (Cohen and Levinthal, 1990). Focusing on one or a few key patents has then been suggested by Friesike et al. (2009) as a best practice for SMEs with limited resources. This can also be a good way to build some level of internal competence which could enable better use of external expertise and an ability to analyze whether additional internal and/or external resources are needed.

The study is not without limitations. For example, the small sample sizes, being sampled by non-probability sampling, limit possibilities for generalizations. At the same time, the qualitative approach has enabled a contrast to previous results by providing richer contexts. For example, the differences between the samples and individual firms give a valuable reminder of the large span of SMEs, indicating the importance for scholars to treat generalized results with care, and for practitioners to apply tailored patent and appropriation strategies that complement the general business strategies of their firms.

## **Acknowledgements**

The work with this paper has been conducted under the auspices of IMIT (Institute for Management of Innovation and Technology) at Chalmers University of Technology, partly within the project "Patents and Innovations for Growth and Welfare" (SOU, 2006; Granstrand, forthcoming) and partly within the project "Management, Economics and IP Law of Open Distributed Innovation Processes". Financial support from Vinnova and comments by Thomas Ewing, Ove Granstrand, Clas Wahlbin, and Nicole Ziegler are gratefully acknowledged.

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**Table 1 Selected studies on patent propensity**

Study	Dataset	Main measure	Main findings
Scherer (1983)	Survey of 443 US industrial firms	Patent per R&D	Patent numbers correlate with R&D, mainly linearly The patent per R&D ratio varies over industries
Mansfield (1986)	Survey of 100 US manufacturing firms	Propensity to patent patentable inventions	Patent propensity varies over industries (ranging from 50% in primary metals to 86% in petroleum and machinery) The patentable invention per R&D ratio varies over industries Patent propensity did not change significantly between late 1960s to early 80s Patent propensity increases with firm size
Arundel and Kabla (1998)	Survey of 604 among Europe's largest industrial firms	Propensity to patent patentable innovations	Patent propensity varies over industries (for product innovations ranging from 8.1% in textiles to 79.2% in pharmaceuticals) Patent propensity is higher for product innovations (avg. 35.9%) than process innovations (avg. 24.8%) Patent propensity increases with firm size R&D intensity does not affect patent propensity
Brouwer and Kleinknecht (1999)	CIS survey of about 1300 Dutch manufacturing firms	Appreciation of value of patent protection for innovations (high value is assumed to indicate high propensity)	A clear but imperfect relation between innovative sales and patenting Patent propensity varies over industries Small innovating firms have lower probability than large ones to apply for patents Patent propensity higher among R&D collaborators
Chabchoub and Niosi (2005)	Financial, geographic, and patent data	Determinants of propensity to patent	Firm size, geographic clusters, and mix of products and services explain most of the patent propensity
Nicholas (2011)	2777 R&D firms surveyed by NRC in the 1920s and 1930s	Propensity to file for at least one patent in R&D firms and determinants of this measure	R&D firms of the 1920s and 1930s were more likely to patent than modern R&D firms Industry, firm size, and geographic location of R&D facilities are important determinants of the propensity to file for at least one patent

**Table 2 Selected studies on appropriability**

Study	Dataset	Main measure	Main findings
Levin et al. (1987)	Survey of 650 individuals representing 130 lines of business in the US	Effectiveness of alternative means of protecting competitive advantages of new or improved products and processes	Effectiveness of different means varies over industries Patents are more effective than secrecy for new products, but secrecy is more effective for new processes Sales or service efforts, lead time and learning are most effective Competitors' ability to legally "invent around" patents is the most important limitation to the effectiveness of patents
Harabi (1995)	Survey of 358 individuals representing 127 lines of business in Switzerland	Effectiveness of alternative means of protecting competitive advantages of new or improved products and processes	Patents are the least effective means of appropriation Sales or service efforts, lead time and learning are most effective, followed by secrecy Competitors' ability to legally "invent around" patents and information disclosure are the most important limitations to the effectiveness of patents
Kitching and Blackburn (1998)	Telephone survey of 400 SMEs and subsequent face-to-face interviews with 101 of them	The use of informal and formal means of appropriation	Patents are the least used means of appropriation Costs related to formal means of appropriation is the main reason behind the low use SMEs lack resources for litigation in case of infringement
Brouwer and Kleinknecht (1999)	Survey of 1008 Dutch manufacturing firms	Effectiveness of various mechanisms for protection of innovations against imitators	Time lead on competitors is the most effective mechanisms, followed by keeping qualified people in the firm and secrecy before patents and other formal means Only 25% of the firms rated patents as very important or crucial for protecting products, and 18% for protecting processes
Granstrand (1999)	Survey of 25 Japanese and 20 Swedish major industrial R&D spenders	Effectiveness of various means for protecting product technologies against imitation	The different means are rated differently in different countries and industries (in order of effectiveness): Japan: Patents, cost reductions, lead times, marketing, secrecy, switching costs Sweden: Marketing, cost reductions, lead times, secrecy, patents, switching costs
Cohen et al. (2000)	Survey of 1478 US manufacturing firms	Percentage of innovations effectively protected by various appropriation means	Patents are the least effective means of appropriation Secrecy has increased in importance since the study by Levin et al. (1987)
Arundel (2001)	CIS survey of 2849 European R&D-performing manufacturing firms	Value of secrecy vs. patents	Secrecy is in general rated more valuable than patents for all firm sizes The probability with which firms rate secrecy over patents decreases with increasing firm size in the case of product innovations
Leiponen and Byma (2009)	Survey of 504 Finnish SMEs	Most important mechanism for protecting innovations	Informal means of protection are more commonly than patenting most important However, firms with university cooperation are likely to identify patents as most important

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**Table 3 Selected studies on motives for patenting**

Study	Dataset	Main measure	Main findings
Arundel et al. (1995)	Survey of European firms	Importance of various motives for patenting	The most important motives for patenting are to prevent imitation, to improve position in negotiations and to avoid litigation
Duguet and Kabla (1998)	Survey of 299 French manufacturing firms	Reasons to patent (yes/no)	Firms most commonly patent (in order of frequency) to prevent imitation, to avoid trials and to reach a strong position in technology negotiations with other firms
Granstrand (1999)	Survey of 25 Japanese and 20 Swedish major industrial R&D spenders	Importance of various advantages of patenting	The most important advantages are (in order of importance) to protect technologies, to improve bargaining positions (e.g. in licensing), and to motivate employees  R&D productivity measurements and improvement of image are of less importance
Cohen et al. (2000)	Survey of 1478 US manufacturing firms	Reasons to patent (yes/no)	The most common motives for patenting are (in order of frequency) to prevent imitation, to block, to prevent suits, to enhance reputation, and for use in negotiation
Thumm (2004)	Survey of 53 Swiss biotech firms	Importance of various motives for patenting	The most important motives for patenting are to prevent imitation, to block, and to improve technological image
Blind et al. (2006)	Survey of more than 500 German firms (active in patenting at the EPO)	Importance of various motives for patenting	The most important motives for patenting are to prevent imitation, to secure European and national markets, defensive blocking, and to improve technological image
Giuri et al. (2007)	Survey of 7711 EPO patents	Use of patents	Patents are most commonly used internally (50.5%) and for blocking competitors while not used internally (18.8%)  Patents are often unused (17.5%)  Patents are seldom licensed (6.2%), licensed while used internally (3.9%), or cross-licensed (3.1%)
Keupp et al. (2009)	Survey of Swiss SMEs	Main reasons to apply for a patent (for users of patents)	The most common main reason is protection from competition (91.9%), followed by piracy (58.4%), contract negotiations (44.1%), publicity (28.0%), and finally finance (13.7%)
Rassenfosse (2012)	Survey of 772 applicants at the EPO	Importance of various motives for patenting	Small firms commonly patent for monetary reasons  Small firms use their patents more actively than large firms  Small firms are more likely to license than large firms

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**Table 4 Summary of sub-studies**

<b>Sub-study</b>	<b>Dataset</b>	<b>Sampling</b>	<b>Data collection</b>
Entrepreneurial hi-growth SMEs	Eight firms	Purposive and tail sampling	Telephone interviews (semi-structured)
Entrepreneurial hi-tech SMEs	Twelve firms	Purposive and tail sampling	Telephone interviews (semi-structured), questionnaire
Entrepreneurial region	Six firms + hearing with 14 representatives	Purposive and snowball sampling	Company visits and face-to-face interviews <sup>4</sup> (semi-structured), hearing

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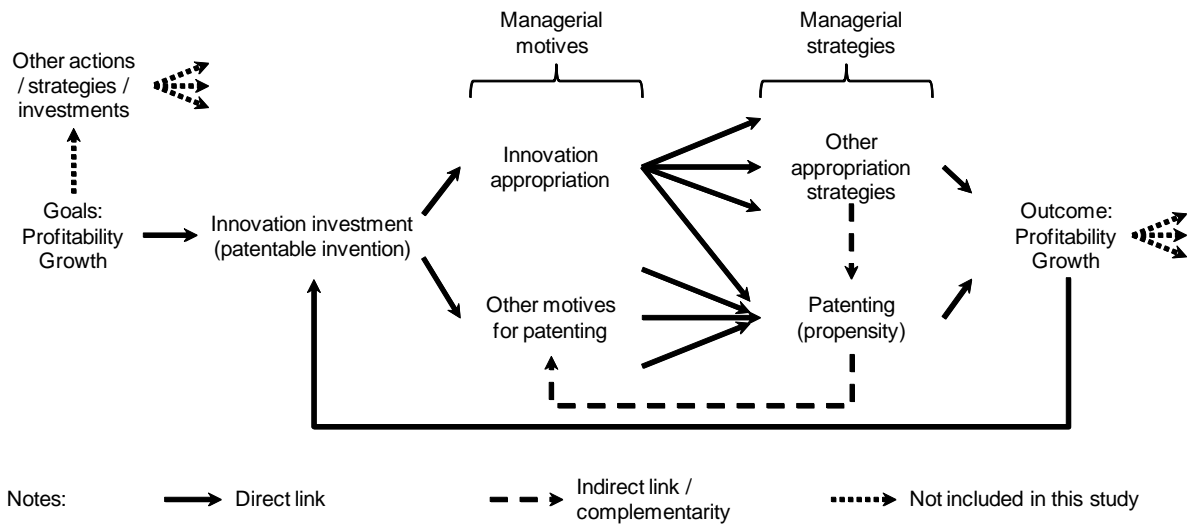
<sup>4</sup> The face-to-face interview with one of the companies had to be cancelled, and a telephone interview was therefore conducted with that firm instead.

**Table 5 Summary of empirical results**

Sub-study	Type of firms	Empirical results
Entrepreneurial hi-growth SMEs	Service as well as manufacturing firms of different ages	<p>Most firms were not active in patenting</p> <p>Patent competence was low</p> <p>Patenting was of little or no perceived importance since a majority of the firms were not based on patentable innovations</p> <p>When available, patents were used for customer marketing purposes</p> <p>When used for customer marketing, the protective function of patents is not important and one patent per product is therefore enough</p> <p>SMEs do not have enough resources for monitoring and enforcing patents</p> <p>Costs and disclosure of information are main drawbacks with patenting</p> <p>Patents are not prerequisites for high growth</p>
Entrepreneurial hi-tech SMEs	Young (below twelve years) hi-tech firms within mechanical, electrical, computer, and chemical (and biotech) engineering	<p>The firms were active in patenting and technical inventions were of major importance for firm growth</p> <p>Patent competence was low</p> <p>Patents were of little perceived importance for competitiveness and growth</p> <p>Patents were of major importance for attracting investors/financiers</p> <p>Patents were used for customer marketing purposes</p> <p>SMEs do not have enough resources for monitoring and enforcing patents</p> <p>Costs and disclosure of information are main drawbacks with patenting</p>
Entrepreneurial region	Old firms (above 30 years) within mechanical and materials engineering	<p>The firms were active in patenting</p> <p>The larger firms had more patenting resources and competence than the smaller ones</p> <p>The larger firms also put more trust than the smaller ones on patents' ability to deter imitation and patents were of more importance for their competitiveness</p> <p>When internal patent resources were removed, the efficient and effective use of the patent system became limited</p> <p>Patents were used for customer marketing purposes</p> <p>SMEs do not have enough resources for monitoring and enforcing patents</p> <p>Product quality and related manufacturing techniques and process technologies (protected by trade secrets) were more important for competitiveness than product patents</p> <p>Patents were perceived unnecessary by some of the SMEs, and imitation was instead met by outstanding inventiveness and entrepreneurial spirit</p> <p>A low inventive step requirement is a drawback for SMEs</p>



Holgerson, M. (forthcoming) 'Patent management in entrepreneurial SMEs: A literature review and an empirical study of innovation appropriation, patent propensity, and motives', forthcoming in *R&D Management*.



**Figure 1 The interrelated motives and strategies under study**