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Researcher's Internal Factors – Are They Really Important in the Patenting Process? The Case of Slovenia

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Abstract: This study analyzes patenting motivators and demotivators of Slovenian researchers engaged in scientific research throughout the entire research process with a special focus on internal factors using the qualitative research approach. Based on 39 in depth interviews it was found that the research process and subsequent patenting activities are influenced by different researchers' internal factors, identified as motivating or demotivating. They can be further classified into homogenous groups in each phase of the patenting process, with different influence on the patenting process. A conceptual model for further analyses of the researcher's patenting process has been proposed.

Keywords: patenting, patenting process & productivity, researcher's motivation, R&D

JEL Classification: O34

Introduction

In recent years, an increased patenting activity of academic researchers has been noted both in terms of commercializing own knowledge through patents as well as in relation to commercializing scientific discoveries in general (Hockaday 2009). The field of researchers' patenting activity currently remains a fairly new subject of interest in scientific investigation. Given the low occurrence of related studies in Europe (Geuna and Nesta 2006; Giuri et al. 2007; Czarnitzki et al 2009), our qualitative research and conceptual framework (Figure 1) can in fact be viewed as one of the pioneer testing studies conducted in this area in Slovenia and the wider European environment.

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Paradoxically, the body of studies employed as a theoretical basis and review of experience in the area is both substantial and limited. Differences and variations in previous theoretical foundations are not surprising, since the issue of researchers' patenting activity is relatively novel and topical, and hence overlaps with several subfields. The cause for such variations can be attributed to the wide scope of the field in question, which encompasses subjects such as the patenting process (e.g. Erickson 2003), impacts on patenting innovations (Dai et al. 2005), knowledge transfer forms and its importance (e.g. Levy et al. 2007), participation and relationship between the public and private sectors (e.g. Geuna and Nesta 2006; Giuri et al. 2007, Ponomariov and Boardman 2007; Czarnitzki et al. 2009), intellectual property rights and their forms (e.g. Davis, 2004), relationships between various agents involved in the creation of new knowledge (e.g. Etzkowitz et al. 2000), institution management, knowledge flow to the industry (e.g. Etzkowitz 2003; Dietz and Bozeman 2005, Ponds 2008), etc. This supports an obvious conclusion: that considerable variation in research baselines and definitions of individual variables results in numerous problems, rendering research in this area even more demanding. At this point, we shall attempt to define the dividing line between the patenting process and the research process in order to provide a foundation for exploring the phenomenon in question. Regardless of the form of knowledge dissemination, the research process is divided into the knowledge detection phase, the knowledge dissemination phase, and the knowledge application phase (should it occur) (Ruzzier et al. 2009). If knowledge dissemination is aimed at patenting, the entire research process can be perceived as a patenting process retaining all integral phases of the research process. In the present paper, we shall therefore examine researchers' internal factors in each phase of the patenting process.

Society is becoming increasingly aware that natural science and engineering knowledge is essential for a growing amount of manufacturing capacities. Faculties, universities and other public research institutions often play an important part in the process, as enterprises turn to them with the purpose of gaining such knowledge. This has lead to changes in the structure and role of higher education and research organizations, which enable the flow of knowledge to recent industry innovations sources and thereby facilitate related development (e.g. Etzkowitz 2003; Martinelli et al. 2007). In order to acquire patent-related economic benefits, faculties and other educational establishments have started paying particular attention to knowledge and technology transfer to the industry, protection of intellectual property rights, incubators, academic spin-offs, and licensing (Meyer 2006). As a result, academic innovations with immediate commercial potential are growing in numbers, and university knowledge is now considered a new source for industry innovations (e.g. Chang et al. 2006; Hockaday 2009).

Although Slovenia was ranked in the top of developed countries in 2003 and even overtook the US with 827 scientific publications per million of population[1], it faces difficulties in the field of applied research. Being a good indicator of applied

orientation, the low number of patent applications clearly demonstrates the lack of mutual cooperation between scientists and their hesitation about engaging in applied research. Indeed, the data prove that Slovenia is considerably less successful than developed countries when it comes to the number of patents or the ratio between publications and patents (MVZT[2] 2005). According to the 2006 European Innovation Scoreboard report, the country falls in the third category group together with other average innovators (criterion: the innovation index), whereas the first two country groups are characterized as innovation leaders and innovation followers (Parvan 2007). The major research problem of the present study concerns the reasons for such classification and internal factors, that is, motivators and demotivators, that influence the number of patent applications and their commercialization. Accordingly, the aim of this paper is to identify those internal factors that either positively affect the patenting activity of researchers or hinder it in certain phases of the patenting process, and at the same time offer suggestions and guidelines for future improvements in the discussed field.

Literature Review & Hypotheses Development

Much of current research suggests that the role held by institutions and universities has changed as marketing influences foster the development of "entrepreneurial organizations" (Dai et al., 2005). This trend could be ascribed to new orientations of universities, primarily in terms of the expansion of focus from teaching to research, as well as to competitive methods of financing (Etzkowitz 2003). Universities thus face external non-academic forces that influence not only their decisions on patenting and publishing, but the whole research process, spreading from the initial phase of idea generation to the diffusion process and resulting implementation of findings. Moreover, recognizing the market potential of basic research, academic researchers are becoming increasingly active in commercializing their discoveries and patents. At the same time, the enthusiasm for commercialization of scientific discoveries, evident as early as in the initial research process phase and resulting from a more visible support of researchers' patenting activity by the state, brings forth several concerns about its advisability. There is a dilemma about whether the focus on the commercial potential of scientific discoveries through patenting truly has positive effects on scientific research. Some argue (e.g. Czarnitzki et al. 2009) that it does damage to basic scientific research and publications in scientific journals, and has negative consequences for scientific development and the future of scientific research.

When disseminating research results, scientists can choose from a wide variety of methods to present their studies: numerous publications, conference presentations, appearances, reports, commercial secrets, lectures, presentations projects, and, naturally, patents, which we are centering on in this work. Various combinations of these

options are also possible. The purpose of knowledge dissemination is related to improving scientific reputation, facilitating the freedom of actions in the future, transferring science to society, and gaining future financing as one of the most significant driving forces (Owen-Smith and Powell 2001). The decision whether to patent or publish is hence also affected by personal factors and characteristics of researchers.

Notwithstanding that researchers are the ones responsible for making the final decision on whether to conduct research and disseminate knowledge through patenting or publishing, previous studies have demonstrated (Dai et al. 2005) that the features of the university environment, wider society and policies likewise influence their decisions. In this study, the focus lies on the analysis of the patenting process with an emphasis on internal factors that motivate Slovenian researchers to commercialize their knowledge through patents. Based on the above, it is expected that:

Hypothesis H1*: *Researchers' internal factors differ according to individual phases of the patenting process and can be classified into more homogeneous groups on the basis of their common characteristics.

Therefore, it is argued that different influence factors affect researchers throughout the patenting process (phases), and motivate or demotivate them. In 2003, the European PATVAL study on researchers' motivation for patenting was conducted in six European countries, addressing the significance and intensity of the following motivations for the patenting activity of researchers: enhanced performance of the company/institution attained through innovation/patenting, personal satisfaction of researchers/other employees, career paths, prestige/reputation, and monetary rewards (material and financial motivator). Personal motivations were found to be more substantial than money or career, with enhanced company performance and employees' personal satisfaction being the prevailing motivators (Giuri et al. 2007).

Researchers' productivity can be examined in a similar way as research factors and motivators, as we are dealing with researchers whose studies are an end in themselves and who create admirable scientific bodies of work in various forms (publications, articles, patents, etc.). In 1928, Alfred Lotka highlighted the fact that the majority of published scientific papers is produced by a small group of authors. This begs the question why most researchers publish very little work, whereas others manage to produce more than 600 articles in their careers. A similarly uneven distribution can be observed in patenting. According to our own calculations presented in appendix (see appendix A), Slovenian researchers are most efficient in natural and mathematical sciences, where the average of patents is 3.33 per researcher. The second place belongs to medical sciences with an average of 3.03 patents, only then followed by engineering, where researchers hold 2.32 patents on average. A logical conclusion about researchers' productivity is that the dissemination decision is particularly influenced by the research idea selection, since applied research findings are normally dif-

fused through trademarks, patents or other commercial uses of intellectual property, while basic research results are typically published in scientific research journals or presented in conference papers. Additionally, the method of research financing can also have a considerable effect on decision-making. Publicly financed studies are expected to conclude with scientific papers or project reports (Dai et al. 2005). The influence of the type of research (i.e. basic or applied) is thus unmistakable, especially so when considering financial motives for research, since researchers are, after all, part of scientific institutions and have fairly limited financial resources.

While the role of applied research in university has grown in importance and reputation since 1970, academia continues to place emphasis on basic research. Basic researchers are generally motivated by the so-called "sacred spark" (Cole and Cole 1973) that triggers their interest, and prefer basic theoretical knowledge rather than commercial application. According to the American National Research Foundation (1996), applied research is "aimed at gaining knowledge or understanding to determine the means by which a specific, recognized need may be met". Its outcome is reflected in patents, trademarks, presentation projects or economy reports. As applied research has future market potential, it is far more attractive and enjoys better financial support than basic research; consequently, it is also associated with greater pressure and stronger personal motivations in relation to the fields that are more likely to yield income. Based on the above, it is expected that:

Hypothesis H1a: Researchers' personal motivations and administrative obstacles are the prevailing motivators and demotivators in the knowledge detection phase.

It must be pointed out that during the patenting process, more precisely, during the knowledge dissemination phase, decisions on knowledge dissemination and patenting usually do not take place at scientific and research institutions. Researchers tend to choose the dissemination method by themselves or with the help of external partners. Due to academic inertia, a great number of researchers involved in basic and applied research disseminate research findings through peer-reviewed publications, thus reaching the main outcome and final step of scientific studies (Morgan et al. 2001). However, it is very unlikely that the decision would be taken at the beginning of the research process, even when patenting is the preferred dissemination method. Expectedly, the motivations for research and patenting differ in the knowledge dissemination phase, as future material benefits resulting from a patent exceed the benefits of publication and other similar dissemination forms. Irrespective of motivators, benefits and the dissemination method, it is evident that the trend in patent applications by researchers is growing.

Financing and the amount of financial resources that is allocated to researchers have a considerable influence on the form of knowledge dissemination and scientific

studies as such. Researchers can have difficulties obtaining funding for relatively high patenting costs. Until 2002, German scientists were legally entitled to own the inventions created at the university (the so-called professor's privilege), and all research expenses were covered by tax payers' money (Czarnitzki et al. 2009). New ways of research financing have introduced changes in the legal status of researchers with regard to the transition between the industry and the academic sphere. Accordingly, the process has been perceived as crucial for researchers' motivation. In France, researchers can now devote a portion of their time to working in the industry (Llerena et al. 2003), which offers additional incentives (financial and material motivator) and simultaneously facilitates the transfer of technology to industry.

In 1992, Stephan and Levin attempted to merge several research traditions by indicating the importance of utility as a principal driving force in research productivity, where researchers are motivated by the intrinsic satisfaction of solving scientific puzzles and the extrinsic rewards of prestige and recognition among their associates. The authors formed the following groups of motivators for research productivity in relation to patenting and publishing: internal satisfaction of scientific discoveries, monetary rewards, and peer recognition, pointing out that the interaction between motivators depends upon the age of researchers.

Scientists disclose their inventions to the institution's patenting office and engage in knowledge dissemination after considering potential expenses and benefits of disclosure based on the perspective of reducing transactional expenses (Chang et al. 2006). Intangible expenses of patent applications are reflected in the time a researcher is required to devote to further patent development, which leaves less time for principal research work, whereas tangible expenses are mainly associated with maintenance and fees of patent applications. In terms of positive consequences, intangible benefits of approved patents can boost researchers' careers and further success in project applications, while the share of licensing income received by researchers represents the tangible benefit.

This means that researchers optimize funds and time with the aim of receiving more benefits, and therefore act in a rational manner. Among the benefits arising from their work with registered patents, remuneration and financial benefits are considered to be especially significant. Based on the reviewed literature, it is expected that:

Hypothesis H1b: The motivators in the knowledge dissemination phase can be divided into different dimensions (material, personal, career), with material motivations predominating.

Hypothesis H1c: The demotivators in the knowledge dissemination phase can be divided into different dimensions, with financial obstacles predominating.

Concluding the research and patenting process with the knowledge application phase, researchers face market opportunities brought forth by new scientific discoveries. It

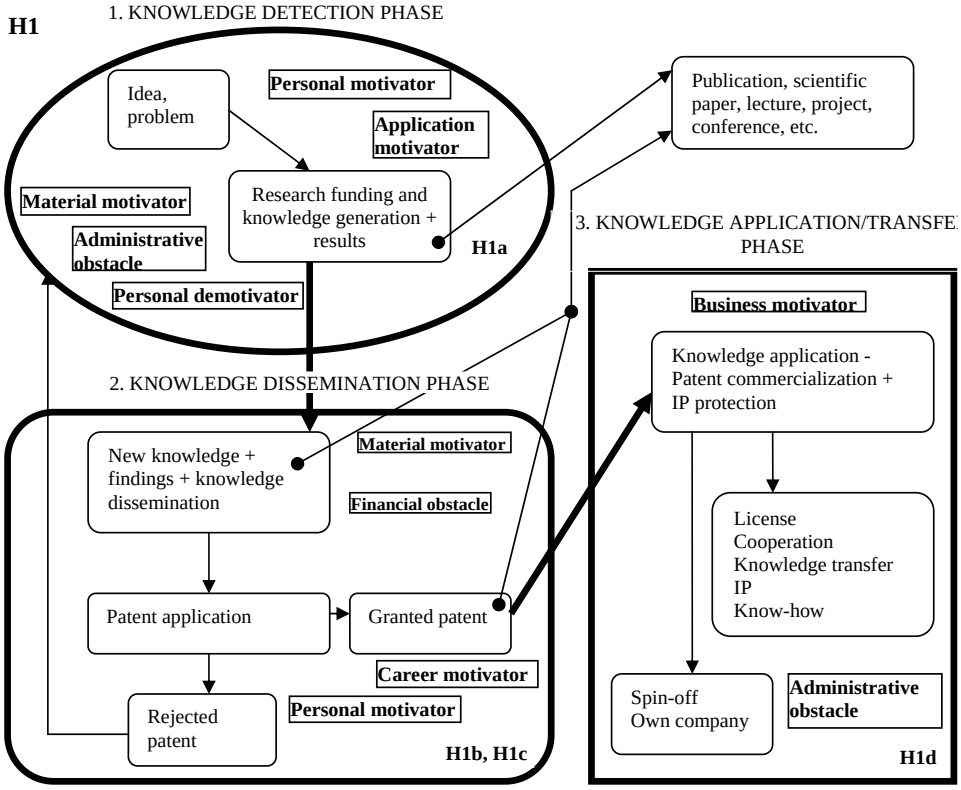
is worth noting that American scientists who are active in patenting, and hence in knowledge application, generally earn more with principal and other jobs than those not involved in patenting activities. In relation to additional income, larger monetary rewards for patenting are given to researchers employed in the education sector than to those employed in the industry, where patenting is expected as a part of the job. Another interesting finding is that in education, the average amount of working hours per week is relatively higher for those engaged in patenting activities (Morgan et al. 2001).

Contrary to that, scientific institutions in England have a different practice. The University of Oxford's technology transfer office devotes special attention to the phase of knowledge application. In the knowledge commercialization process, strong motivators clash with strong demotivators: business and financial motivations are contrasted by administrative and tax obstacles. The main issue can be ascribed to a rigid national legislation system (Hockaday 2009). Lach and Schankerman (2003) conducted another study on American university research, which found a significant and positive correlation between financial incentives for achievement and scientific research. This suggests a real influence of intellectual property rights formation on growth and productivity in the economy. Moreover, the study demonstrated a much greater response to financial rewards in private universities. It follows that the entrepreneurial orientation of researchers and their income desires will slowly prove to be stronger than the publication motivator, according to which the research process concludes with the dissemination phase. Drawing on these findings, it is assumed that:

Hypothesis H1d: Researchers' business motivations and administration-related obstacles are the prevailing motivators and demotivators in the knowledge application phase.

Fig.1 illustrates the research process and its phases with internal driving forces that are expected to have an impact on patenting.

Figure 1: The influence of various internal factors throughout the patenting process by phases:



Source: Own conceptualization, 2009.

Methodology

The methodology section presents in detail the sample population, the sampling method and data collection, the characteristics of the sample, and the analysis employed in order to test the proposed hypotheses.

The sample population comprises researchers registered at the Slovenian Research Agency (ARRS). On 29 September 2006, there were a total of 13727 researchers in Slovenia (Sicris Izum 2006) with jobs at the following research centers: private research organizations in the industry (59.7%), government research institutes (23.0%), higher education institutions (15.6%), and private non-profit research organizations (1.7%) (MVZT 2005). Among these, 771 researchers held at least one patent, whereas 12965 researchers had no granted patents.

The study adopted a qualitative approach aimed at identifying key internal factors that affect the patenting activity of researchers engaged in scientific research in Slovenia. Purposive sampling among researchers was begun by selecting the most successful researchers according to the number of granted patents and patent applications from various activity fields and institutions of employment (companies, faculties, institutes). We also identified researchers with only one or two patent applications and those without any patents or patent applications as a control group. Using a semi-structured questionnaire as a research instrument, the data were obtained by means of in-depth interviews conducted on the sample of 39 researchers from different universities (universities of Ljubljana and Maribor), faculties (19 interviewees), institutes (16 interviewees), and enterprises (4 interviewees[3]). The researchers belonged to various areas of activity; at the time of the interview, 30 had at least one granted patent, while 9 held no registered patents. With regard to gender representation, 8 participants were female and 31 male. The average age of surveyed researchers was 43 years, with the youngest aged 29 and the oldest 65 years. Interviews were carried out in the period between 10/10/2006 and 10/12/2006, lasted from 18 to 90 minutes (scientists without patents had considerably shorter interviews than scientists with patents), and followed a protocol of 45 questions. For reasons of easier data processing, we asked the researchers participating in the survey whether their interviews could be recorded; 33 out of all participants agreed to that, while the remaining six requested not to be taped.

Empirical Results

The key results of the present study will now be presented through individual phases of the research process (knowledge detection phase, knowledge dissemination phase, knowledge application phase). In order to avoid duplications, focus is placed on the more significant internal factors classified into homogenous groups. The latter are divided into motivating and demotivating factors (obstacles) that arise throughout the patenting process (see Table 1).

The first questions about the knowledge detection phase were related to motivators that provide inspiration for research, as this is a precondition for invention and subsequent patenting. The majority of research motivators were of a personal nature; consequently, we divided them into three groups in accordance with our expectations: personal (internal satisfaction), application and material (financial) motivators. The largest group was constituted of personal motivators. These are basic motivations and values that are typical of researchers and differentiate them from other people. Curiosity, happiness, topic-related interest, satisfaction, desire for the new, goal orientation, and many similar factors were indicated most frequently. Other motivators in the group included peer recognition at home and abroad, self-validation, reputation, and prestige. The second and somewhat smaller group was termed ap-

plication motivators due to a general orientation towards the industry and towards a practical application of research. Generally, these motivators complemented the group of personal motivators and were found to be highly important for the surveyed variable (patents). The last group was related to researchers' material or financial motivators, which can be categorized into proactive (desire to earn money, success...) and reactive (job, obligation, survival, pressure...). In terms of internal demotivation in the knowledge detection phase, a considerably smaller presence of obstacles was detected. This result can be explained with a relatively low level of self-criticism in Slovenian researchers, for they appear to attribute work-related problems to their environment and not themselves. Furthermore, the demotivators in the initial phase of the research process were divided into administrative and other personal obstacles. The most commonly reported administrative obstacles were too much bureaucracy and administration, the burden of dealing with matters unrelated to research, duplication, etc., whereas other personal obstacles were the lack of independence, material benefits and reputation, being torn between professional work and research, as well as complexity and unpredictability. Given these findings, it can be concluded that internal motivators in the knowledge detection phase comprise three prevailing dimensions (groups): personal, application and material (financial) motivators, with personal motivations predominating. Moreover, since the demotivators in the knowledge detection phase can be classified into two groups, personal and administrative obstacles, with the latter predominating, hypothesis H1a can be fully confirmed.

Our survey also explored the phase of knowledge dissemination and the factors that exert a positive or negative influence on motivation for obtaining a patent. In this case, the research process itself transforms into the patenting process, with the patent acting as an intermediate stage before knowledge commercialization and application. When interpreting results, attention should be paid to the nationality of patents (European or Slovenian patents), as researchers underline great differences between Slovenian and European patents, which, however, was not explicitly dealt with in the survey. Using content as a criterion, the motivators that facilitate patenting activities were divided into three homogenous groups: material, personal and career motivators (see Table 1). The group of material motivators comprised remuneration, potential profit, sales, and the benefits deriving from patents. Career motivation was reflected mainly in direct motivators that enable promotion, more precisely, in references and the new rules and measures of the Slovenian Research Agency, which give more recognition and points to patenting and thus foster career advancement. Finally, the group of personal motivators included motivation factors, such as the perspective of absolute novelties, peer reputation and prestige, moral satisfaction, self-praise, and personal interest or "making a difference". Thereby, it was established that the motivations in the knowledge dissemination phase can indeed be divided into three homogenous groups, i.e. material, personal and career motivators. Nonetheless, since material motivators do not prevail, hypothesis H1b can be confirmed only partially.

The participants shared more information in the next part of the interview that was related to demotivating factors or obstacles in the phase of knowledge dissemination. These were divided into administrative and material demotivators. In terms of the latter, most researchers mentioned the financial obstacle of gaining patents in Europe and funding in general. They also reported that patenting could be unreasonable when the industry shows no interest, that it was very difficult to find appropriate industry partners for protection on the European level, and pointed to other cost-related issues. However, it should be noted that these obstacles tend to be tackled in a different order. While some researchers start by attempting to obtain European protection (and run short of money) before looking for partners interested in using patented inventions, the other group of researchers first look for partners to finance the (European) patent and therefore emphasize how difficult it is to find them. In such cases, the ownership of patent rights could prove to be demotivating. It is probable that the reason for differences is of a financial nature; the first approach surely offers more independence, ensuring the sale of the patent or patent rights. On the other hand, researchers employing the second approach can only be paid for consultancy and research work, but enjoy no benefits from patent rights. Furthermore, participants indicated the following administrative obstacles most commonly: general lack of time and other resources, time-consuming patent writing and length of the patent granting procedure, low importance of patenting (especially in Slovenia) although the situation is slowly improving, and additional work without effective opportunities for protection. The answers also revealed differences in familiarity with the legislation and adopted rules, as many participants were not (yet) aware of changed patent evaluations in habilitation procedures. Hypothesis H1c can thus be confirmed. The funding of patent applications is expectedly the most significant demotivator in the knowledge dissemination phase.

In the last phase of the patenting process, that is, the phase of knowledge transfer to industry, the main emphasis lies on the final commercialization of the patent. In this respect, we were interested in researchers' opinions about the business motivations and their preferred form of commercialization. Our findings indicated that some researchers are prepared to commercialize their knowledge under certain conditions, principally in the form of new companies (own company, spin-off) and through the sale of patent rights (licenses and similar). With regard to obstacles that demotivate researchers and render commercialization difficult, many respondents listed general business obstacles, such as market size, lack of finance and seed capital or the risk of failure related to it. The second group of reasons was associated with the specifics of activity fields. Interestingly, one of the researchers stated that he already owns a company, having decided for the step after realizing that patent rights do not provide appropriate commercialization. Moreover, the third group comprised researchers' personality traits (lack of leadership skills) and the conflict between management and

research. The final group included a variety of reasons related to the lack of business or management knowledge and a changed approach to work with focus on applied research (the need to adjust studies and find clients, new working methods). Certain researchers showed a considerable awareness of necessary adjustments and changes in the manner of work and research orientation. This is not surprising, as the development of Slovenian science is, after all, aimed at this direction.

Based on the gathered responses, hypothesis H1d is partially confirmed. As expected, the answers pointed to researchers' internal business motivators as the only main motivators. In contrast, our expectations about prevailing administrative obstacles were not supported by the results. Instead, it was observed that demotivators form several homogenous groups, including the obstacle of management (leadership) and other demotivators of a more general business nature.

A detailed review of responses (motivators and demotivators) given by the participants is presented in Table 1 for each phase of the patenting process:

Table 1. Presentation of respondents' answers by phases of the patenting process.

Phases	**Motivators**	**Demotivators**
1. Knowledge detection process	**INTERNAL SATISFACTION** ∞ curiosity (12x) ∞ happiness (5x) ∞ interest (5x) ∞ satisfaction (4x) ∞ goal orientation (3x) ∞ desire for the new (2x) ∞ less focus on funding ∞ intellectual satisfaction without the burden of financial pressures ∞ challenge, dynamic work, inspiration, joy **APPLICATION** ∞ the industry can help trigger an idea that is good enough for publication ∞ people can benefit from your work; seeing results ∞ doing something useful; seeing results ∞ validation of your goal in practice ∞ increased cooperation with the industry ∞ curiosity; seeing your knowledge used in practice, in production **MATERIAL MOTIVATORS** ∞ enough projects provide you with enough money for new devices and exploring new things, which drives you forward ∞ financial benefits, earnings ∞ desire to succeed ∞ this is my job, responsibility towards the research team ∞ obligation ∞ improved quality at the institution, survival, pressure	**OTHER PERSONAL OBSTACLES** ∞ no material benefits ∞ no motivation ∞ no reputation ∞ lack of independence ∞ the problem of performing professional work and research at the same time; research becomes an additional activity ∞ since research is aimed at products, numerous tests are required – this is a bottleneck when viewed from the perspective of research ∞ reaching standards in research can be an issue, but you learn to accept that as a part of the process ∞ complexity, things do not always go as planned **ADMINISTRATIVE OBSTACLES** ∞ too much bureaucracy (5x) ∞ too much administration (4x) ∞ the burden of dealing with matters unrelated to research (2x) ∞ complex operation ∞ duplication ∞ lack of support in writing projects ∞ the way of fund raising is complex ∞ time – writing unimportant reports takes too much of your time ∞ writing applications; at times one feels like a beggar

Phases	Motivators	Demotivators
2. Knowledge dissemination process	**MATERIAL MOTIVATORS** • remuneration • increasing value • potential profit • prospective sale • one first considers what the patent may bring • following our intuition; knowing that the invention is a good one • patenting everything that is new **CAREER** • promotion, references, points • new incentive rules • patent publication brings additional points **PERSONAL SATISFACTION** • this was a novelty (2x) • novelty - you learn something new • ideas must be new and attractive for the market; following market trends • in the beginning, I made decisions based on my interests • peer reputation • prestige • receiving approval when you tell others that you have a patent • moral satisfaction • personal interest • bringing something good out of something bad	**MATERIAL OBSTACLES** • money for patenting in Europe or abroad (6x) ∞ money, finances (5x) • money is a great issue; it makes no sense to patent in Slovenia and it is better to write an article • financial support would be welcome • there is no capital for the European market; keeping market needs in mind • patenting is not worthwhile when there is no interest in the industry (5x) **ADMINISTRATIVE OBSTACLES** ∞ lack of time (4x) • time-consuming patent writing (2x) • length of the patent granting procedure (2x) ∞ low patent value (2x) ∞ low patent value, but the situation is improving • τηε patents registered only in Slovenia have no value • patenting just to count patents; there are no resources and no time • seeing nothing but additional work that brings a few points; failing to see the opportunity to obtain better protection and conclude the process in the best way possible
3. Application process	**BUSINESS MOTIVATORS** • commercialization of own knowledge and development • spin-off (2x), establishing a company • realization of innovations in the industry • selling patents to multinational firms • employing research capacities and knowledge through cooperation with the industry • writing articles; own publishing house • lectures for various laboratories • professional and scientific meetings • demonstration projects; presentation of new technology • promotion through lectures, brochures, web pages, workshops, publications in scholarly journals and general magazines • presentation of work in the industry	**COMMERCIALIZATION OBSTACLES** • the process is risky and too costly; not everybody succeeds • complex legislation • it is difficult to know how to start • it is difficult to start; one needs space and seed capital ∞ finances (2x) • small market • no EU networks • seed capital • it would be easier to start the process knowing there are companies out there that are willing to become your partners; this is especially difficult in the field of chemistry • education does not offer enough knowledge; everybody should work on establishing contacts with the industry (being a manager is not a good idea - insufficient technical skills) • it is practically impossible - I have enough work as it is • working in the economy is not my cup of tea • this means I would have to work on two things at the same time

Source: Own study, 2006.

Discussion

It was discovered that researchers' internal motivators are quite similar at the beginning of the research process, that is, in the knowledge detection phase, as their job characteristics have much in common. A lesser amount of participants identified finance or application-related reasons as key research motivators. Such researchers consider the purpose and application/commercialization of research (financial motivation) in the earliest stage, but are in the minority, while their studies are not an end in themselves. In terms of the main demotivators in the first phase (similar results were found in relation to patenting), overload, too much administration and a lack of support in operational matters were predominant (confirmation of Hypothesis H1a). It is clear that the solution to this problem lies in simplifying processes and introducing a gradual specialization of researchers' profiles as well as different evaluations of their activities. Currently, researchers have to handle various areas of work at the same time (professional, scientific, pedagogical work). This is especially problematic in the case of academic researchers, whose tasks include giving lectures and seminars. Furthermore, the theory considers researchers' contact with the economy as highly important for patenting activities. In that respect, our findings showed that most contact takes place informally through links and acquaintances (networks). It was found that a great number of researchers wait for the industry to come to them when they are needed, while they also point to little or no cooperation. The lack of cooperation thus appears to be a reciprocal problem. As a response, the government has introduced various formal networks (technological platforms, etc.), but views about their effectiveness are quite mixed, as evident from diverse perceptions among researchers with several patents and those without or with little patents. Most researchers do, however, see these networks as positive, in so far as they have a clear aim and are valuable for the purpose of their existence. In the case of Slovenia, researchers' contact with the economy is undoubtedly just as essential for their patenting activity as elsewhere, particularly when it comes to generating research problems and ideas, finding funding, and understanding the functioning of industry, its needs, and requirements. As proposed by researchers, the lack of contact with the industry could be bridged with the establishment of a national body/agency. The latter could present researchers' achievements, their experiences, and the challenges (problems) of the industry at formal and informal meetings organized on a national and international level. The meetings could take place in the form of industrial workshops, but would have to be field-specific. Such an agency could further promote cooperation through a website, thereby enabling faster data transfer, and perhaps even establish a database on inventions and research offers.

In terms of the knowledge dissemination process and the patenting decision, the results illustrated a shift from personal motivators to material or career motiva-

tors (partial confirmation of H1b). The key factors for a lower level of patenting, as indicated by researchers, were finance-related, i.e., lack of money for filing (especially European) patent applications, no interest in the industry, and no financial motivation. Indeed, the industry can face large financial difficulties in case of failure, and will therefore invest in European patent applications only if deemed worthwhile. With regard to administrative obstacles, researchers listed lack of time and low patent value (partial confirmation of H1c). Both issues could be resolved with a fund for financing European patents with approved potential practical application (signed preliminary contract). As a consequence, patents with practical use would be valued differently than those that are self-sufficient or aim only at gaining points for habilitations and projects. Interestingly, a high level of unfamiliarity in relation to changed patent evaluations and the rules on inventors' income share from patent rights (University of Ljubljana, 2006) was also observed.

The application and commercialization of knowledge is another purpose of science and patenting. Our survey provided answers about Hypothesis H1d: there are researchers who are willing to commercialize their knowledge. This business motivator is crucial for further successful development of the interaction between scientific research and the economy. Nevertheless, the relation does not depend on researchers' motivation, but more so on other factors of an external nature that were not the subject of our attention in this study, but often have a rather strong indirect effect on researchers' demotivation. This impact is evident primarily from administrative and tax obstacles in researchers' passive relationship to knowledge and patent commercialization, which forces them into a different, non-economic form of commercialization, i.e. through various publications, conferences, etc.

Drawing on the study's findings and due to the confirmation of most sub Hypotheses (H1a-H1d), our main hypothesis (H1) is confirmed: researchers' internal factors that affect the patenting process differ according to individual phases of the process and can be divided into more homogeneous subgroups. The factors were defined and classified as motivators and demotivators (obstacles) appearing in all stages of the patenting process. Future studies and research will clarify the strength and orientation of the influence of individual factors on final patenting activities. The present study explored and determined a considerable number of internal factors that have an effect on researchers in each phase of the process. Identifying and grouping a large number of factors has opened the way for further research, which will be relatively easier to conduct and will employ statistical measures to support or reject our hypotheses.

Limitations, Further Research and Conclusions

In interpreting the present study, several limitations should be borne in mind, as the failure to do so may result in misleading conclusions. The first limitation lies in

the sampling and the sample selection. When designing the study and the sampling procedure, two groups of researchers were formed, one with patents and one without patents (only 9 researchers held no patents at all), in order to illuminate differences between the groups observed. However, during the study, it became apparent that an arbitrarily defined limit of 0 (zero) patents or applications had no significant implications for diverse perceptions among researchers with one or two patents. We therefore propose that future research set the limit at two patents per scientist, to further distinguish Slovenian and foreign patents or, in other words, count patent families instead of patents as such (abroad). Secondly, since different phases of the patenting process (research process) and relevant perspectives are closely intertwined, some motivators and demotivators were found to play a role in more than one phase. Thirdly, some criticism towards provided responses and generalizations should be adopted, particularly with respect to obstacles (but also motivators) for patenting and research. For instance, if the obstacles of space or lack of equipment were indicated, this does not imply a universal problem in research in Slovenia, nor does it suggest the reason or factor for low patent activity. Such factors should be considered on the level of individual institutions or research group.

The present study can serve as a basis for further research on the subject of internal factors and researchers' patenting activity. The duplication of reasons that appear both as motivators and demotivators should also be considered as a limitation. The latter can be ascribed to diverse personality features, skills and competences, as a consequence of which finances, for example, can act either as a work motivator or demotivator. In conclusion, further work is needed to evaluate the importance of individual internal factors, and investigate the subject in question with the aim of determining the strength and orientation of influences of individual factors as well as their interconnectedness. The findings of such research will make a significant contribution to solving related issues, promoting researchers' patenting activity and facilitating the networking of key actors in the society as a whole, both in Slovenia and in other similar European countries.

NOTES

[1] This data does not include articles presented at conferences in Slovenia or abroad, but relates to original scientific papers that were published in foreign and local journals in 2003 (MVZT, 2005).

[2] Ministry of Higher Education, Science and Technology (Ministrstvo za visoko šolstvo, znanost in tehnologijo).

[3] In Slovenia is a common situation that some researchers are partly employed at institute or university and partly employed in the private company – usually they in their lifetime career often move to work from company to institute and vice versa, according to literature they can be named as knowledge spillovers (Ruzzier et al. 2009, Jaffe et al. 1993). In our sample 4 researchers are representing previous mentioned group.

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Appendix

Patenting activity of Slovenian researchers with at least one patent registered at the Slovenian Research Agency (ARRS) on 29/09/2006, by science:

SCIENCE	NUMBER OF RESEARCHERS	NUMBER OF PATENTS*	CURRENT APPLICATION NUMBER	RESEARCHER PRODUCTIVITY**
Natural and mathematical sciences	234	779	451	3.33
Engineering	426	987	443	2.32
Medical sciences	34	103	31	3.03
Biotechnical sciences	69	185	81	2.68
Social sciences	6	11	0	1.83
Humanities	0	0	0	0.00
Interdisciplinary research	0	0	0	0.00
Not allocated	2	3	0	1.5
TOTAL	**771**	**2068**	**1007**	**2.68**

Source: COBISS 2006 (internal extract from researcher database).