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Examining the differences between the motivations of traditional and entrepreneurial scientists

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Abstract

In recent decades, the rise of the entrepreneurial university and the need for commercialization of university knowledge has gained significant attention, thus posing major challenges for higher education institutions. The adequacy of commercialization requirements causes problems not only for institutions but also for individual researchers as well. Although an increasing number of scholars are focusing on researchers' motivation in academic entrepreneurship, there is still a lack of surveys that investigate the motivational differences by specific group of academics. In this study, our aim is to investigate motivational differences among specific groups of researchers at 20 Hungarian higher education institutions. We distinguished academics into two segments: entrepreneurial scientists plan to commercialize their research results at a spin-off company, while traditional scientists show no interest in this. Our results suggest that there are differences and significant relationships with entrepreneurial intention in the case of direct control over the commercialization process, securing jobs for young researchers at one's spin-off company, and the desire to demonstrate the practical relevance of one's research to family/friends. With regard to previous experience, managerial experience gained at companies may play also an important role.

Keywords: Motivation, Intention, Researchers, Entrepreneurship, University

JEL classification: L26, I23, O33

Background

Universities contribute greatly to social development with their educational and research activities. In recent decades, the rise of the entrepreneurial university and the need for commercialization of university knowledge has gained significant attention, thus posing major challenges for higher education institutions (Etzkowitz 1998).

In our knowledge-based economy, the role of universities is increasingly important (Laredo and Mustar 2001) because they play a significant role in innovation and economic development (Mansfield and Lee 1996). Academic knowledge can also contribute to economic growth, while the more a company applies university knowledge in its business activities, the more economic growth can be achieved. But only a small proportion of university knowledge is applied by industrial actors, a fact which can be explained by the scarce knowledge flow channels between academia and industry

(Mueller 2006). In the commercialization of university knowledge, spin-off companies can act as intermediaries. In this case, the researcher can commercialize his research results at his own spin-off company, and he or she can thus retain control over the further development of the invention and the commercialization process.

Universities were traditionally the centers of knowledge production, although usually—in the case of second-generation universities—the knowledge application only meant education and the spread of scientific publications (Wissema 2009). By the end of the twentieth century, the process of knowledge application altered and the "third-generation" universities emerged, where the gates were opened for the commercialization of research results and (early stage) technologies produced at universities were introduced to the market, so the commercial application of knowledge became predominant (Wissema 2009). Etzkowitz (1983) called these institutions as "entrepreneurial universities" where the applied research and the knowledge application gained importance. The industrial relationships of universities began to expand, and special institutions—like technology transfer offices—were established to coordinate them (Buzás 2005; Bercovitz and Feldmann 2006). In the knowledge-based economy of the twenty-first century, this process has gained a new impetus; the "fourth-generation" universities have emerged where knowledge has become the foundation stone of the economy of a region. These institutions influence their environment including the community and the society of the region in a proactive way (Pawlowski 2009; Prónay–Buzás 2015). Concerning this phenomenon, it is important to note that according to Carayannis and Campbell's (2006) understanding, these generations can be seen not only as successive phases but also as different innovation models that can be perceived simultaneously. The authors call it mode 3 approach where pluralism of different knowledge and innovation modes (paradigms) coexists (Carayannis and Campbell 2010).

The adequacy of commercialization requirements causes problems not only for institutions but also for individual researchers as well. Participation in the commercialization process can threaten academic freedom (Nelson 2004) and create difficulties in fundamental research and publication activities (Arvanitis et al. 2008). However, it is necessary that the inventor should be enthusiastic for commercialization of research results to succeed through spin-off creation (Blair and Hitchens 1998). Furthermore, we usually cannot expect researchers to determine the possible application areas or the commercial potential of the invention (Nilsson et al. 2010). Recent studies highlight various factors that influence researchers' decision-making process related to commercialization, including institutional, organizational, and individual factors (Perkmann et al. 2013). Thornton (1999) distinguished two groups of influencing factors. The former group includes attitudes towards commercialization and the personal characteristics of the researchers, which affect the intrinsic motivations of the individual (supply-side), while the latter group of factors consists of institutional and organizational factors (demand-side). In our study, we will approach the individuals' motivation; thus, organizational and institutional factors are excluded in our investigation.

With regard to the personal characteristics of the inventor, there are two important areas which can highly influence the possible commercial outcomes of the invention. Firstly, we have to consider the ability of the researcher to determine possible application areas and acquire financial resources for commercialization. Secondly, we must take aspiration into account, which reflects on the willingness of the researcher to

engage in commercialization (Hoye and Pries 2009). The determination of the possible application areas greatly depends on the individual's technical expertise, previous experience gained in commercialization, and his or her industrial network outside academia. Furthermore, the incentives provided, perceived risks, and expected benefits with respect to commercialization play an important role in one's participation in university–industry activities (Phan and Siegel 2006).

The tacit knowledge of the inventor also requires the participation of the scientist in the transfer of early-stage technologies (Shane 2004). In this regard, the successful application of the invention is questionable without particular knowledge about the technology that is possessed by the inventor. If the researcher finds it difficult to participate in the technology transfer or does not want to, it is difficult to apply the invention in an industrial environment (Siegel et al. 2003; Stevens and Bagby 1999).

Although the major obstacles noted above can greatly influence the successful commercialization of university scientific results, the international literature has not focused on individual researchers sufficiently (Ankrah et al. 2013). In this study, our aim is to investigate motivational differences among specific groups of researchers. We distinguished academics into two segments: entrepreneurial scientists plan to commercialize their research results at a spin-off company, while traditional scientists show no interest in this. We assumed that these two groups of scientists differ in motivations, and we wanted to determine these motivations.

Researchers' motivations

Among the influencing factors in academic entrepreneurship, we consider individual motivations as the most important. Even at the best performing universities, disclosure of commercializable scientific results to the technology transfer office and willingness to participate in commercialization depend on the individuals' motivations and intention (Shane 2004) despite their obligation to inventive activities. However, the technology transfer units at the universities are not able to monitor all the current research and development projects; thus, there are commercializable results which remain hidden from technology transfer offices. Researchers consider the possible benefits and drawbacks of commercialization, which is greatly influenced by their motivation and attitudes (Lee 1998). Previous studies have determined many factors that influence individuals' entrepreneurial intention or their participation in university–industry activities. The results of recent studies will be demonstrated in the following groups: development-driven motivations, finance-driven motivations, reputation-driven motivations, commercialization-driven motivations, and job security-driven motivations.

There is an uncertainty related to a university invention because nobody knows the applicability of scientific results in an industrial environment. Therefore, academics continuously expect industrial feedback from companies (Arvanitis et al. 2008). Both parties, the university and industry, also show an interest in gathering information about applicability; otherwise, it is more difficult to determine the commercial potential of the invention (Prónay and Buzás 2015). Therefore, the need to collect industrial feedback about the application of the invention can play an important role in an individual's motivations.

An increase of personal income is a well-known motivational factor in the literature, which can effectively motivate individuals to participate in commercialization (Nilsson et al. 2010; Renault 2006). However, other scholars have only found an indirect effect of

monetary incentives towards entrepreneurial intention, and the expected increase in personal income can only influence attitudes towards entrepreneurship directly (Goethner et al. 2012). Those researchers who are mainly motivated by financial incentives are more willing to establish a spin-off company to bring the technology to the market (D'Este and Perkmann 2011). Opposite results have been achieved as well: Azagra-Caro et al. (2008) found that non-monetary incentives play a more important role than monetary motivations. This poses challenges for universities and policy makers because providing non-monetary incentives is more difficult. D'Este and Perkmann (2011) also suggest that universities should focus on non-monetary incentives to foster academic entrepreneurship. Besides personal income, another finance-related motivation is the need to obtain financial resources for further research (Nilsson et al. 2010). Although researchers fear that university–industry interactions may threaten intellectual freedom, which is one of the most important values in academia, university–industry interactions create new opportunities to obtain financial resources from industrial partners (Lee 1998).

The desire to increase prestige also plays an important role in academics' motivation (Dietz and Bozemann 2005), which is an integral part of academic life, because the main objective of demonstrating research results through conference participation and publications is to boost one's reputation in the academic environment. Such activities can contribute to a gain in reputation not only at the university but also in industry as well (Siegel et al. 2003). Participation in university–industry interactions can also affect confidence in the individual researcher among industrial actors (Jacob et al. 2000). However, contrary to the previous results, Goethner et al. (2012) found no relationship between expected gain in reputation and entrepreneurial intention. One explanation may be that while entrepreneurship only provides benefits to one's reputation in industry, entrepreneurial activities are not associated with additional gain in reputation in academia (Arvanitis et al. 2008).

There is an increasing need in society for universities to contribute to economic development and to utilize knowledge outside academia with industrial actors (Liefner and Schiller 2008; Siegel et al. 2003). The desire to apply inventions in practice is another motivational factor among academics (Nilsson et al. 2010) because the original aim of research is to apply new knowledge for practical use. However, in most cases, academics do not possess the appropriate expertise to explore possible application areas for the invention and industrial partners also cannot determine the potential benefits of research results, thus hindering technology transfer between academia and industry. This standoff is called the science to market gap in the literature (Hellman 2005). Academics' entrepreneurial intention can fill this gap and bring technologies to the market. At the spin-off company, the inventor can continue the development process under more flexible conditions following feedback from industrial partners than he or she would experience in the academic environment. In this regard, the desire to put the invention to practical use and provide benefits for society can be achieved (Nilsson et al. 2010).

Establishing a spin-off company and commercializing university research create employment opportunities. New jobs are available not only for senior scientists and inventors but also for young researchers and students as well. These students have not yet completed their studies or started their scientific careers; therefore, they are employed with fixed-term contracts while waiting for vacancies at the university (Lam 2007). However, in most cases, with a lack of academic positions, these young researchers cannot continue

their scientific careers in academia. Thus, they look for other employment opportunities, such as establishing a spin-off company in their field of expertise (Rizzo 2015).

As we have seen, there are various motivations that can influence academics' participation in university–industry interaction and academic entrepreneurship. In our study, entrepreneurial intention plays a central role in the investigation of motivations. Entrepreneurial intention in academia has also been investigated by other scholars (Goethner et al. 2012; Kautonen et al. 2011; Krueger and Carsrud 1993; Küttim et al. 2014; Yurtkorua et al. 2014). The significant proportion of studies that focus on entrepreneurial intention build on the theory of planned behavior (Ajzen 1991), while we investigated the relationship between entrepreneurial intention and motivations towards commercializing research results through spin-off creation.

Results and discussions

Research results

In this section, we demonstrate the research results of the survey with a focus on the motivational differences between the traditional and entrepreneurial scientists. These results can highlight which motivations can play an important role in entrepreneurial intention.

Motivations towards entrepreneurial intention

First, we analyzed the motivational factors. Figure 1 summarizes the importance of the different motivational factors. According to the researchers, the two most important motivational factors are to obtain financial resources for further research (M4) and to ensure an ecosystem that is more flexible than the university for the further development of their invention (M2). To increase personal income (M3), to collect industrial feedback (M1), to benefit society with their invention (M9), to ensure direct control over the commercialization of their invention (M8), and to secure jobs for young researchers (M10) also play an important role. Surprisingly, a strong reputation, including a scientific

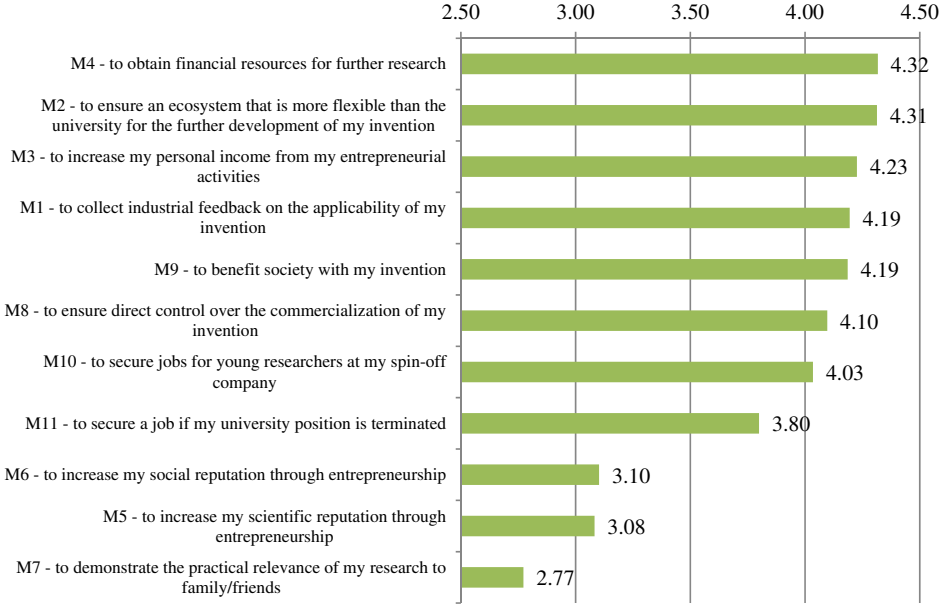

Fig. 1 Researchers' motivation (mean of responses between 1 and 5). Source: authors' compilation

(M5) and a social (M6) reputation, and to demonstrate the practical relevance of their research (M7) were ranked lower as the motivational factors than other motivations.

Comparing the opinions of traditional and entrepreneurial scientists, we found differences between the two groups (Fig. 2). In summary, entrepreneurial scientists value all the motivations more highly than traditional scientists. As we can see, there are three motivations where the gap between the two groups is higher than in other cases: to ensure direct control over the commercialization of their invention (M8), to secure jobs for young researchers at their spin-off company (M10), and to demonstrate the practical relevance of their research to family/friends (M7) (Appendix 2). There are only slight differences with regard to the other motivational factors.

In order to test statistically the motivational differences between traditional and entrepreneurial scientists, we used an independent-samples *t* test to compare opinions (Appendix 3). The results confirm the previous observation, which assumes that there are differences regarding direct control over commercialization (M8, *t* test (equal variances assumed) sig. = 0.029), jobs for young researchers (M10, *t* test (equal variances assumed) sig. = 0.027), and the need to demonstrate the practical relevance of research to family and friends. Researchers' opinions about the other motivations have not been proven different from a statistical point of view.

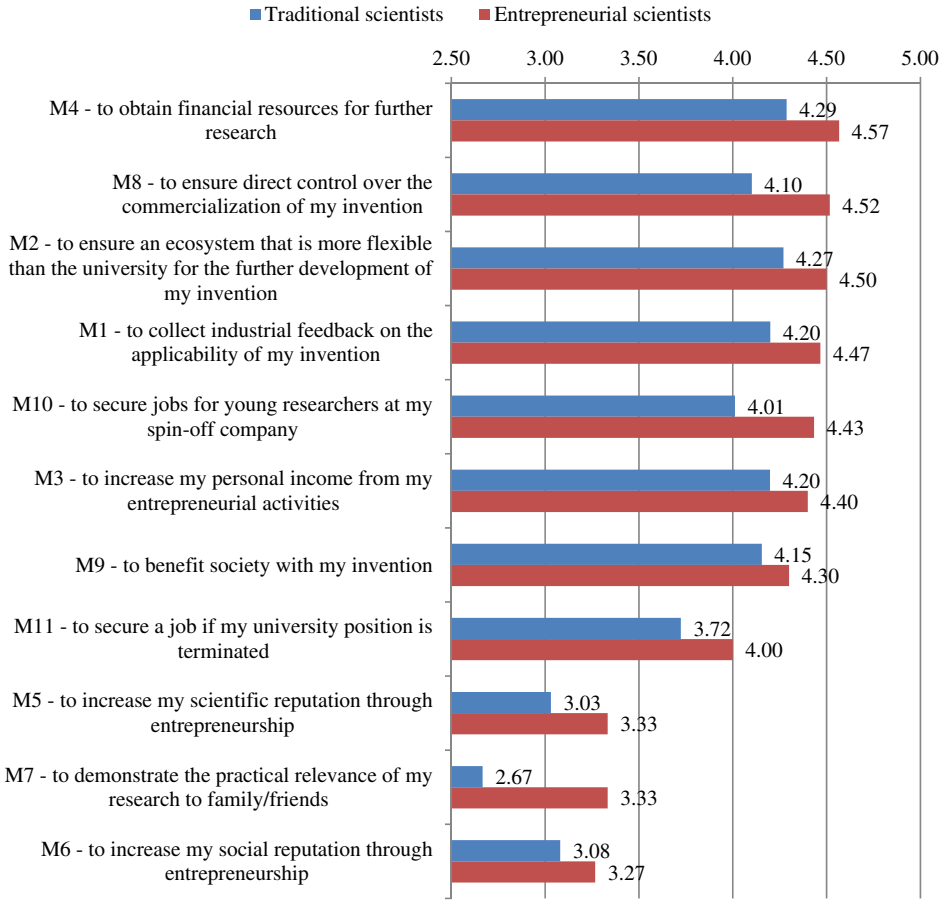

Fig. 2 Motivational differences between traditional and entrepreneurial scientists (mean of responses between 1 and 5). Source: authors' compilation

Although we found evidence of motivational differences, we also wanted to test the relationship between motivational factors and entrepreneurial intention. We used correlation to investigate the relationship between the variables (Appendix 4). According to the results, to ensure direct control over the commercialization of my invention (M8, Pearson corr. = 0.120*, sig. = 0.047, $N = 275$), to demonstrate the practical relevance of my research to family/friends (M7, Pearson corr. = 0.240**, sig. = 0.000, $N = 291$), to increase my scientific reputation through entrepreneurship (M5, Pearson corr. = 0.187**, sig. = 0.001, $N = 291$), to secure jobs for young researchers at my spin-off company (M10, Pearson corr. = 0.166**, sig. = 0.005, $N = 290$), and to obtain financial resources for further research (M4, Pearson corr. = 0.133*, sig. = 0.022, $N = 295$) were proven significant and demonstrated weak or medium strength to entrepreneurial intention. Due to a statistical debate relating to the measurement and recognition of Likert scales, we calculated the Spearman correlations as well, where two motivations lost their significance (to ensure direct control over the commercialization of my invention, M8, Pearson corr. = 0.057, sig. = 0.345, $N = 275$ and to obtain financial resources for further research, M4, Pearson corr. = 0. 109, sig. = 0. 062, $N = 295$). Thus, the results relating to these two motivations should be interpreted carefully, because tests for the relationship with the entrepreneurial intention demonstrate different results. Since, we perceive Likert scales as interval scales—otherwise mean and standard deviation cannot be computed—we accept the results of the Pearson correlation method.

Previous research and managerial experience

We wanted to investigate not only motivations but also previous experience as well. Using an independent-samples t test to comparing experience, we concluded that there are differences between traditional and entrepreneurial scientists regarding the research (EXP-COM-RES, t test (equal variances assumed) sig. = 0.004) and managerial (EXP-COM-MAN, t test (equal variances assumed) sig. = 0.039) experience gained at companies (Appendix 5). According to the results, those researchers who plan to commercialize their research results in a spin-off company have gained more research and managerial experience at companies than traditional researchers who do not show any interest in entrepreneurship.

With regard to the relationship between entrepreneurial intention and previous experience, the results suggest that research experience at universities (EXP-HEI-RES, Pearson corr. = 0.139**, sig. = 0.007, $N = 375$) and managerial experience at companies (EXP-COM-MAN, Pearson corr. = 0.158**, sig. = 0.002, $N = 380$) are associated with entrepreneurial intention (Appendix 6). Therefore, the more university research experience and the more managerial experience at companies, the higher the propensity for establishing a spin-off company for the commercialization of scientific results.

Summary of results

Table 1 summarizes the research results and statistical methods described above. According to the results, we can observe differences and significant relationships with entrepreneurial intention in the case of direct control over the commercialization process (M8), securing jobs for young researchers at one's spin-off company (M10), and the desire to demonstrate the practical relevance of one's research to family/friends (M7). With regard to previous experience, managerial experience gained at companies may play an important role. Although there were significant differences between the

Table 1 Summary of results

Variables	Differences between traditional and entrepreneurial researchers (method: independent-samples *t* test)	Relationship with entrepreneurial intention (method: correlation)
Motivations		
Development-driven motivations		
M1—to collect industrial feedback on the applicability of my invention	No difference	No relationship
M2—to ensure an ecosystem that is more flexible than the university for the further development of my invention	No difference	No relationship
Finance-driven motivations		
M3—to increase my personal income from my entrepreneurial activities	No difference	No relationship
M4—to obtain financial resources for further research	No difference	Weak positive relationship
Reputation-driven motivations		
M5—to increase my scientific reputation through entrepreneurship	No difference	Medium positive relationship
M6—to increase my social reputation through entrepreneurship	No difference	No relationship
M7—to demonstrate the practical relevance of my research to family/friends	Significant difference	Medium positive relationship
Commercialization-driven motivations		
M8—to ensure direct control over the commercialization of my invention	Significant difference	Weak positive relationship
M9—to benefit society with my invention	No difference	No relationship
Job security-driven motivations		
M10—to secure jobs for young researchers at my spin-off company	Significant difference	Medium positive relationship
M11—to secure a job if my university position is terminated	No difference	No relationship
Experience		
Research experience at a university (EXP-HEI-RES)	No difference	Medium positive relationship
Research experience at a company (EXP-COM-RES)	Significant difference	No relationship
Managerial experience at a company (EXP-COM-MAN)	Significant difference	Medium positive relationship

Source: authors' compilation

traditional and entrepreneurial scientists in the research experience gained at companies, the relationship to entrepreneurial intention did not prove important.

Concluding remarks

We have demonstrated the research results of the survey we carried out at 20 Hungarian higher education institutions. The aim was to investigate the major motivational factors related to entrepreneurial intention. Two groups of researchers were formed based on their entrepreneurial intention: while the traditional scientists did not want to establish a spin-off company for the commercialization of recent research results, the entrepreneurial scientists planned to commercialize their inventions through entrepreneurship within 1 year.

We assumed that the researchers would not differ in their entrepreneurial intentions, but in their motivations towards commercialization of scientific results. Although the respondents valued many motivations as important, the results highlight the fact that the most important motivational differences between the traditional and entrepreneurial researchers can be observed in exercising control over the commercialization process (M8), securing jobs for young researchers at their spin-off company (M10), and demonstrating the practical relevance of their research to family/friends (M7). With regard to experience, managerial experience gained at companies (EXP-COM-MAN) plays the most important entrepreneurship-related role.

We could not find significant differences in the development-driven motivations between the two groups or a notable relationship between motivations and entrepreneurial intention despite the previous results of other scholars. In this survey, neither collecting industrial feedback on the applicability of an invention (Arvanitis et al. 2008) nor ensuring an ecosystem that is more flexible than the university for the further development of the invention was viewed differently by the traditional and entrepreneurial scientists. These motivations were deemed quite important, with some slight differences.

Average salaries in the Hungarian public sector (including academia) are lower than those in Western Europe. It is surprising then that entrepreneurial researchers stated that the desire to increase personal income from the commercialization of research results is less important than other motivations. The results do not support those of previous studies which stress the particular role of personal income in entrepreneurial motivations (Renault 2006; D'Este and Perkmann 2011); however, the impact of this cannot be ruled out. Our results rather confirm opinions that suggest the use of non-monetary incentives in academia in fostering academic entrepreneurship among scientists (Azagra-Caro et al. 2008; D'Este and Perkmann 2011). Obtaining financial resources for further research was the second finance-driven motivation in our survey. The role of this type of motivation has proven remarkable, since the differences between the opinions of traditional and entrepreneurial scientists and the relationship between motivation and entrepreneurial intention were statistically supported. We can thus conclude that the need to obtain financial resources for further research was valued more highly by the entrepreneurial scientists, who also tend to commercialize their research results. This viewpoint can be explained by the recent changes in many countries regarding the funding of the higher education system which influence scientists to obtain financial resources from industry, e.g., through the commercialization of academic research (Rasmussen et al. 2006).

In the international literature, previous studies have highlighted the role of reputation as one of the most important motivational factors in commercialization (Dietz and Bozemann 2005; Siegel et al. 2003). However, in our study, reputation-related motivations were rated much lower than other motivational factors. Although the need to boost one's scientific reputation in academia does not differ between the two groups of researchers, there is a medium positive relationship between motivation and entrepreneurial intention. On the one hand, this result confirms other studies, which emphasize the fact that academics can increase their scientific reputation in the industrial environment through university–industry interactions (Jacob et al. 2000); on the other hand, entrepreneurial activities may not enhance one's reputation in academia (Arvanitis et al. 2008), which may explain why reputation-related motivations were ranked lower than other motivations. Summarizing the results of the reputation-related opinions, it is only the desire to demonstrate the practical

relevance of research activities to family members and friends that the two groups of researchers reported differently. Furthermore, this type of motivation has a significant relationship with entrepreneurial intention. Although this motivation is low, according to the respondents, those researchers who tend to commercialize their research results through a spin-off company value this kind of motivation more highly than traditional researchers.

With regard to commercialization-driven motivations, more attention must be paid to the need for direct control over the commercialization process. Firstly, it is not only the differences between traditional and entrepreneurial scientists that can be observed, but the relationship between this kind of motivation and entrepreneurial intention. While this kind of motivation is ranked by the traditional scientists as the 6th, it is the 2nd most important motivation for entrepreneurial scientists.

Spin-off companies can increase employment by creating jobs for academics or young researchers/students. Surprisingly, it was found that securing jobs for young researchers was seen as more important among the respondents than securing a job for oneself when one's academic position is terminated. The reason for this altruism may be explained by the academics who responded to the survey; they hold secure positions at the university and do not fear the loss of their jobs. With regard to the opinions of traditional and entrepreneurial researchers, it can be concluded that creating employment opportunities for young researchers through spin-off creation is more important for entrepreneurial researchers. These results confirm the findings of an Italian survey, which explored the problem of the academic bottleneck and found that spin-off companies represented a tool for hiring young researchers (Rizzo 2015).

In our research, we could identify only 28 scientists which may have impact on the results and should be interpreted carefully. The share of the entrepreneurial scientists is about 9 %, which seems to be low, but other studies (Hoye and Pries 2009; Lam 2011) also found that entrepreneurial scientists, who tend to commercialize scientific results, represents only a small share of academics. This is a limitation not only in our study, but a general problem in the investigations of entrepreneurial activity in higher education institutions.

Conclusions

Previous studies have focused on researchers' motivation in academic entrepreneurship, but there is a lack of surveys that investigate the motivational differences by specific group of academics. Our research results contribute to the need for a better understanding of motivational differences between traditional and entrepreneurial scientists. In our study, we provided evidence that managerial experience gained at companies can affect scientists' entrepreneurial intention. In this regard, universities should consider how institutions can motivate scientists to gain managerial—or at least research related—experience at companies. In most cases, higher education institutions do not tolerate researchers holding other positions at companies in addition to their current academic position; however, this stance could be a barrier to entrepreneurial intention and hinder academic entrepreneurship in general.

Methods

We carried out a survey among academics at Hungarian higher education institutions to investigate the motivational differences related to the commercialization of research results through spin-off companies. We invited researchers representing the natural

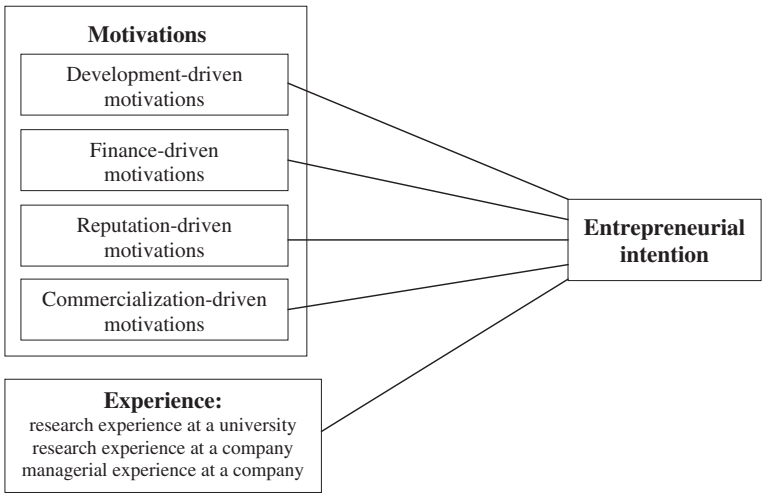

Fig. 3 Relationships between entrepreneurial intention, motivations, and experience. Source: authors' compilation

sciences, the life sciences, engineering, and agriculture from 20 higher education institutions to participate in our survey.

Variables and measurement

Our aim is to identify motivations with a significant relationship to scientists' entrepreneurial intention. In our research focus, entrepreneurial intention played a significant role. We measured the entrepreneurial intention (e.g., I plan to create a spin-off company within 1 year for the commercialization of my scientific results.) and motivational variables with a 5-point Likert scale. We asked respondents to provide information about their previous experience related to research and managerial activity. This experience was measured in years. Figure 3 demonstrates the relationships between entrepreneurial intention, motivations, and previous experience.

We assume that there are motivational differences between researchers who intend to commercialize their research results through a spin-off company within 1 year and those who do not have any interest in spin-off creation. We divided the researchers into two segments in order to test our presumption. There are two possible methods of measuring entrepreneurial intention: applying dual scale (yes/no) or measuring the degree of intention (5-point Likert scale). While the former one seems to be simpler, the latter one can be answered easily in those cases when the commercialization of scientific results through spin-off company might depend on other circumstances as well. Thus, answering dual scales (yes/no) can cause difficulties for the respondents. For this reason, we use Likert scales in our investigation, as was suggested by Ajzen[1] also applied by other authors in recent researches (Goethner et al. 2012; Kautonen et al. 2013).

Researchers who plan to commercialize their research results at a spin-off company (those who marked 4–5 on the 5-point Likert scale) are among the scientists with a positive intention towards commercialization (these are the entrepreneurial scientists), and the others (who marked 1–3 on the 5-point Likert scale) represent a neutral or negative opinion towards spin-off creation (they are the traditional scientists). In the

Table 2 Motivational variables

Motivational factors
Development-driven motivations
M1—to collect industrial feedback on the applicability of my invention
M2—to ensure an ecosystem that is more flexible than the university for the further development of my invention
Finance-driven motivations
M3—to increase my personal income from my entrepreneurial activities
M4—to obtain financial resources for further research
Reputation-driven motivations
M5—to increase my scientific reputation through entrepreneurship
M6—to increase my social reputation through entrepreneurship
M7—to demonstrate the practical relevance of my research to family/friends
Commercialization-driven motivations
M8—to ensure direct control over the commercialization of my invention
M9—to benefit society with my invention
Job security-driven motivations
M10—to secure jobs for young researchers at my spin-off company
M11—to secure a job if my university position is terminated

Source: authors' compilation

following sections, we demonstrate our results from our comparison of these two groups of researchers.

During the international literature review and the qualitative research carried out with 21 academics in 2014 (Huszár et al. 2014), we determined the most relevant motivational factors. This review and the in-depth interviews form the theoretical basis for our survey. In the questionnaire, we asked the respondents to indicate the importance of goals (motivational factors) if they decide to commercialize their research results at a spin-off company. Table 2 summarizes the motivational factors analyzed in our survey.

In the investigation of previous experience, we took into consideration not only academic experience but also experience gained at companies as well. We also distinguished the research and managerial experience gained outside academia (Table 3).

Sample

The survey was carried out with an online web-based system, which allowed for the collection of responses at low cost and in a structured way (Malhotra and Birks 2006), while maintaining the validity of the responses (Gosling et al. 2004). The questionnaire was tested at a technology transfer office with the technology transfer managers with degrees in the natural and life sciences. After the internal test, we sent the questionnaire to one university. Based on the feedback and responses from the researchers, we did not have to make any changes to the questionnaire.

Table 3 Variables of experience

Experience	Measurement
Research experience at a higher education institution (EXP-HEI-RES)	Scale
Research experience at a company (EXP-COM-RES)	Scale
Managerial experience at a company (EXP-COM-MAN)	Scale

Source: authors' compilation

Table 4 The number and share of respondents by position

Position	Traditional scientists		Entrepreneurial scientists		Total	
	N	%	*N*	%	*N*	%
Professor emeritus/emerita	6	2.1	1	3.6	7	2.2
Full professor	50	17.5	4	14.3	54	17.2
Associate professor	90	31.5	8	28.6	98	31.2
Assistant professor	48	16.8	5	17.9	53	16.9
Assistant lecturer	29	10.1	5	17.9	34	10.8
PhD candidate	9	3.1	1	3.6	10	3.2
PhD student	14	4.9	2	7.1	16	5.1
Senior research fellow	14	4.9	1	3.6	15	4.8
Research fellow	18	6.3	1	3.6	19	6.1
Research assistant	8	2.8	0	0.0	8	2.5
Total	286	100.0	28	100.0	314	100.0

Source: authors' compilation

Table 5 The number and share of respondents by scientific field

Scientific fields	Traditional scientists		Entrepreneurial scientists		Total	
	N	%	*N*	%	*N*	%
Biological sciences	39	13.3	5	17.9	44	13.7
Physical sciences	13	4.4	3	10.7	16	5.0
Dental medicine	1	0.3	0	0.0	1	0.3
Geography	4	1.4	0	0.0	4	1.2
Earth sciences	14	4.8	0	0.0	14	4.3
Pharmaceutical sciences	8	2.7	0	0.0	8	2.5
Informatics	35	11.9	4	14.3	39	12.1
Chemistry	30	10.2	2	7.1	32	9.9
Environmental sciences	10	3.4	1	3.6	11	3.4
Mathematics	4	1.4	0	0.0	4	1.2
Engineering	64	21.8	7	25.0	71	22.0
Agriculture	13	4.4	3	10.7	16	5.0
Theoretical medicine	38	12.9	1	3.6	39	12.1
Clinical medicine	21	7.1	2	7.1	23	7.1
Total	294	100.0	28	100.0	322	100.0

Source: authors' compilation

Table 6 Research and managerial experience

Experience (in years)	Traditional scientists		Entrepreneurial scientists		Total	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Research experience at a higher education institution (EXP-HEI-RES)	19.1	11.7	19.1	12.0	19.1	11.7
Research experience at a company (EXP-COM-RES)	2.8	4.2	5.1	5.3	3.0	4.3
Managerial experience at a company (EXP-COM-MAN)	2.7	4.0	4.3	5.0	2.8	4.1

Source: authors' compilation

Table 7 Attitudes towards commercialization

Attitudinal variables	Traditional scientists		Entrepreneurial scientists		Total	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
The commercialization of scientific results through spin-off company plays important role in my scientific field.	2.7	1.3	4.1	0.8	2.8	1.3
It is important for me to commercialize my scientific results through spin-off company	2.8	1.3	4.3	0.7	3.0	1.3
If I had commercializable research result, I would commercialize it through spin-off company.	3.5	1.3	4.3	0.7	3.7	1.3

Source: authors' compilation

We collected the e-mail addresses of the researchers from the departments' websites in order to send the questionnaire directly to those individuals. In collecting e-mail addresses, we considered two principal rules. Firstly, the department of the researchers had to be relevant to the scientific fields mentioned above. Secondly, the position held by the researcher had to be relevant to the research. Finally, we sent the questionnaire directly to 7967 academics between 26 February and 30 August 2015 and received 525 responses. The survey was carried out through the EVASYS online web-based survey system, and responses were analyzed with IBM SPSS 20.0 statistical software.

In the sample, almost half of the respondents (48.4 %) held full professor or associate professor positions at the university, but the assistant professors also constituted a significant share (16.9 %) (Table 4). With regard to the assistant lecturers, we can conclude that their share among the entrepreneurial scientists is almost double that of the assistant lecturers among the traditional scientists. Other positions do not show remarkable differences between the two groups of academics.

With regard to scientific fields, most of the researchers represent the biological sciences (13.7 %), informatics (12.1 %), chemistry (9.9 %), engineering (22 %), and the medical sciences (theoretical and clinical together 19.2 %) (Table 5). As we can see that, differences can be observed in the case of biological sciences, physical sciences, and agriculture, which scientific fields are overrepresented, while in the case of earth sciences and theoretical medicine researchers represent a lower share among entrepreneurial scientists than among traditional scientists.

The average research experience among the researchers is 19.1 years, which does not differ between traditional and entrepreneurial scientists. But entrepreneurial scientists have more research and managerial experience at companies than traditional scientists that is almost double (Table 6).

Since we grouped the researchers based on the entrepreneurial intention, we also wanted to test whether attitudinal differences exist between the two groups. This comparison also helps to demonstrate the important differences between the two groups of scientists. The results also suggest that entrepreneurial scientists express more positive attitudes towards commercialization (Table 7), which was supported by the independent samples test as well and proved significant differences between the attitudes (Appendix 1).

Endnotes

[1]Ajzen's website: http://people.umass.edu/aizen/pdf/tpb.measurement.pdf, downloaded: 9th of May 2016

Appendix
Appendix 1

Table 8 Descriptive statistics of motivational variables by spin-off creation intention

		Levene's test for equality of variances		*t* test for equality of means						
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95 % confidence interval of the difference	
									Lower	Upper
The commercialization of scientific results through spin-off company plays important role in my scientific field.	Equal variances assumed	16.901	.000	−5.747	285	.000	−1.42903	.24864	−1.91844	−.93962
	Equal variances not assumed			−8.297	46.085	.000	−1.42903	.17223	−1.77569	−1.08237
It is important for me to commercialize my scientific results through spin-off company	Equal variances assumed	19.550	.000	−6.208	300	.000	−1.50956	.24318	−1.98811	−1.03101
	Equal variances not assumed			−10.550	59.539	.000	−1.50956	.14309	−1.79582	−1.22329
If I had commercializable research result, I would commercialize it through spin-off company.	Equal variances assumed	12.678	.000	−3.302	294	.001	−.82423	.24962	−1.31549	−.33297
	Equal variances not assumed			−5.270	51.453	.000	−.82423	.15641	−1.13816	−.51030

Source: authors' compilation

Appendix 2

Table 9 Descriptive statistics of motivational variables by spin-off creation intention

Motivational variables	Traditional scientists				Entrepreneurial scientists				Total			
	Importance (based on means)	*N*	Mean	Std. deviation	Importance (based on means)	*N*	Mean	Std. deviation	Importance (based on means)	*N*	Mean	Std. deviation
M4—to obtain financial resources for further research	1	265	4.29	0.8923	1	30	4.57	0.6789	1	353	4.32	0.8894
M8—to ensure direct control over the commercialization of my invention	6	246	4.10	0.9948	2	29	4.52	0.6336	6	331	4.10	0.9892
M2—to ensure an ecosystem that is more flexible than the university for the further development of my invention	2	237	4.27	0.9583	3	30	4.50	0.9738	2	316	4.31	0.9428
M1—to collect industrial feedback on the applicability of my invention	3	245	4.20	1.0065	4	30	4.47	0.7303	4	329	4.19	0.9963
M10—to secure jobs for young researchers at my spin-off company	7	260	4.01	1.0076	5	30	4.43	0.7739	7	348	4.03	0.9980
M3—to increase my personal income from my entrepreneurial activities	4	267	4.20	0.8895	6	30	4.40	0.6747	3	354	4.23	0.8841
M9—to benefit society with my invention	5	265	4.15	1.0237	7	30	4.30	0.8769	5	355	4.19	1.0081
M11—to secure a job if my university position is terminated	8	253	3.72	1.2858	8	29	4.00	1.1019	8	339	3.80	1.2526
M5—to increase my scientific reputation through entrepreneurship	10	261	3.03	1.2400	9	30	3.33	1.1842	10	351	3.08	1.2543
M7—to demonstrate the practical relevance of my research to family/friends	11	261	2.67	1.2153	10	30	3.33	1.4700	11	352	2.77	1.2741
6—to increase my social reputation through entrepreneurship	9	262	3.08	1.2369	11	30	3.27	1.0807	9	352	3.10	1.2407

Source: authors' compilation

Appendix 3

Table 10 Independent-samples test

		Levene's test for equality of variances		*t* test for equality of means						
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95 % confidence interval of the difference	
									Lower	Upper
M1—to collect industrial feedback on the applicability of my invention	Equal variances assumed	1.340	.248	−1.405	273	.161	−.26667	.18973	−.64019	.10686
	Equal variances not assumed			−1.801	43.778	.079	−.26667	.14803	−.56504	.03171
M8—to ensure direct control over the commercialization of my invention	Equal variances assumed	1.889	.170	−2.196	273	.029	−.41562	.18927	−.78823	−.04300
	Equal variances not assumed			−3.109	46.191	.003	−.41562	.13367	−.68464	−.14659
M2—to ensure an ecosystem that is more flexible than the university for the further development of my invention	Equal variances assumed	.011	.918	−1.236	265	.218	−.22996	.18603	−.59625	.13633
	Equal variances not assumed			−1.221	36.478	.230	−.22996	.18837	−.61182	.15190
M7—to demonstrate the practical relevance of my research to family/friends	Equal variances assumed	2.946	.087	−2.782	289	.006	−.66667	.23967	−1.13838	−.19495
	Equal variances not assumed			−2.392	33.712	.022	−.66667	.27873	−1.23329	−.10004
M5—to increase my scientific reputation through entrepreneurship	Equal variances assumed	.004	.952	−1.272	289	.204	−.30268	.23799	−.77109	.16572
	Equal variances not assumed			−1.319	36.705	.195	−.30268	.22942	−.76766	.16230
M6—to increase my social reputation through entrepreneurship	Equal variances assumed	1.009	.316	−.792	290	.429	−.18651	.23557	−.65015	.27713
	Equal variances not assumed			−.882	38.258	.384	−.18651	.21158	−.61474	.24172
M9—to benefit society with my invention	Equal variances assumed	.391	.532	−.747	293	.456	−.14528	.19458	−.52823	.23767
	Equal variances not assumed			−.845	38.538	.404	−.14528	.17201	−.49334	.20277
M11—to secure a job if my university position is terminated	Equal variances assumed	6.632	.011	−1.112	280	.267	−.27668	.24871	−.76626	.21290
	Equal variances not assumed			−1.258	37.321	.216	−.27668	.22002	−.72234	.16898

Table 10 Independent-samples test *(Continued)*

M10—to secure jobs for young researchers at my spin-off company	Equal variances assumed	.181	.671	−2.217	288	.027	−.42179	.19024	−.79622	−.04737
	Equal variances not assumed			−2.730	41.279	.009	−.42179	.15449	−.73373	−.10986
M3—to increase my personal income from my entrepreneurial activities	Equal variances assumed	.544	.461	−1.202	295	.230	−.20150	.16767	−.53149	.12849
	Equal variances not assumed			−1.496	41.264	.142	−.20150	.13467	−.47342	.07042
M4—to obtain financial resources for further research	Equal variances assumed	.986	.322	−1.663	293	.097	−.27987	.16827	−.61104	.05129
	Equal variances not assumed			−2.065	41.278	.045	−.27987	.13553	−.55353	−.00622

Source: authors' compilation

Appendix 4

Table 11 Correlations

		Entrepreneurial intention (Pearson correlation)	Entrepreneurial intention (Spearman correlation)
M1—to collect industrial feedback on the applicability of my invention	Correlation	.100	.031
	Sig. (2-tailed)	.098	.610
	N	275	275
M8—to ensure direct control over the commercialization of my invention	Correlation	.120*	.057
	Sig. (2-tailed)	.047	.345
	N	275	275
M2—to ensure an ecosystem that is more flexible than the university for the further development of my invention	Correlation	.041	.024
	Sig. (2-tailed)	.502	.693
	N	267	267
M7—to demonstrate the practical relevance of my research to family/friends	Correlation	.240**	.230**
	Sig. (2-tailed)	.000	.000
	N	291	291
M5—to increase my scientific reputation through entrepreneurship	Correlation	.187**	.198**
	Sig. (2-tailed)	.001	.001
	N	291	291
M6—to increase my social reputation through entrepreneurship	Correlation	.108	.104
	Sig. (2-tailed)	.066	.077
	N	292	292
M9—to benefit society with my invention	Correlation	.043	.006
	Sig. (2-tailed)	.467	.915
	N	295	295
M11—to secure a job if my university position is terminated	Correlation	.058	.012
	Sig. (2-tailed)	.330	.839
	N	282	282
M10—to secure jobs for young researchers at my spin-off company	Correlation	.166**	.151**
	Sig. (2-tailed)	.005	.010
	N	290	290
M3—to increase my personal income from my entrepreneurial activities	Correlation	.089	.043
	Sig. (2-tailed)	.128	.465
	N	297	297
M4—to obtain financial resources for further research	Correlation	.133*	.109
	Sig. (2-tailed)	.022	.062
	N	295	295

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)
Source: authors' compilation

Appendix 5

Table 12 Independent-samples test

Independent-samples test										
		Levene's test for equality of variances		*t* test for equality of means						
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95 % confidence interval of the difference	
									Lower	Upper
Research experience at a higher education institution	Equal variances assumed	.000	.985	−.016	314	.988	−.03621	2.31726	−4.59554	4.52312
	Equal variances not assumed			−.015	32.172	.988	−.03621	2.37047	−4.86369	4.79127
Research experience at a company	Equal variances assumed	3.524	.061	−2.906	320	.004	−2.42156	.83326	−4.06091	−.78221
	Equal variances not assumed			−2.383	31.505	.023	−2.42156	1.01606	−4.49247	−.35065
Managerial experience at a company	Equal variances assumed	2.671	.103	−2.076	319	.039	−1.64939	.79448	−3.21246	−.08631
	Equal variances not assumed			−1.723	31.623	.095	−1.64939	.95739	−3.60044	.30166

Source: authors' compilation

Appendix 6

Table 13 Correlations

.		Research experiences at university	Research experiences at company	Managerial experiences at company	Entrepreneurial intention
Research experience at a higher education institution	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	502			
Research experience at a company	Pearson correlation	.118*	1		
	Sig. (2-tailed)	.010			
	N	473	493		
Managerial experience at a company	Pearson Correlation	.136**	.716**	1	
	Sig. (2-tailed)	.003	.000		
	N	466	484	486	
Entrepreneurial intention	Pearson Correlation	.139**	.093	.158**	1
	Sig. (2-tailed)	.007	.069	.002	
	N	375	383	380	393

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)
Source: authors' compilation

Competing interests
The authors declare that they have no competing interests.

Authors' contribution
SH participated in formalising research questions, reviewing the literature, conducting the research, carrying out the statistical analysis and making conclusions. SzP participated in formalising research questions, checking stat analysis and making conclusions. NB participated in formalising research questions, reviewing the literature and making conclusions. All authors read and approved the final manuscipt.

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