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Fostering Entrepreneurship among Academia: A Study of Vietnamese Scientist Commercialization

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Abstract

Commercialization of scientists' inventions greatly contributes to the development of a country, yet the success ratio of this process is very low. Besides, research results on commercialization in developed countries are not readily applicable to Vietnam where the market institution has not been well functioning. This research examines the commercialization of scientists' inventions in Vietnam (hereafter, scientist commercialization). The objectives are to identify factors that influence Vietnamese scientist commercialization. Drawing on networking, leadership, and motivation theories and data from a sample of scientists working at the Vietnam Academy of Science and Technology, the study shows that access to research funding, networking with businesses, leaders' experience, and pecuniary and prosocial motivation are positively related to commercialization. The results shed light on the theoretical development of commercialization in developing countries. The research also discusses practical implications for promoting scientist commercialization in Vietnam.

Keywords: Scientist commercialization; networking; leadership; motivation.

JEL code: L26, M13, O31.

1. Introduction

Promoting entrepreneurship has recently become a key priority of the Vietnamese government and a heated topic in political and social debates. Many researchers have been interested in studying antecedents and consequences of venture creation or entrepreneurship in Vietnam. Scientist commercialization – or commercialization of scientists' research results – is a promising area of research since it has a big potential for transforming the economy from production-based to knowledge-based in the future (Nguyen, Q. P., 2015; Nguyen, T. H., 2013; Tran, 2007). In this paper, we consider commercialization is a form of entrepreneurship since this is an act of translating research results into practical uses through creating new products or new processes (Aldridge and Audretsch, 2011).

The last two decades of the 20th century witnessed a soaring interest in knowledge creation and innovation, naming knowledge creation companies and/or knowledge economies (Nonaka and Takeuchi, 1995). In the first 15 years of the 21st century however, the interest has been shifted to commercialization of the inventions (Aldridge and Audretsch, 2011; Alshumaimri et al., 2012; Bercovitz and Feldman, 2008; Markman et al., 2008). This is seen as an imperative development in the value chain, from "research" to "development" and "commercialization".

Research to date confirms the importance of scientist commercialization. At the national level, promotion of scientist commercialization is critical for increasing returns on investment in research (Markman et al., 2008). Thus, in the US and Europe, the governments and the public have put great pressure on universities to accelerate commercializing their inventions (Markman et al., 2008). At the organizational level, revenue from commercialization is a great compensation for state budget cuts in public universities in these countries (Miller and Acs, 2013). Besides, commercialization creates opportunities for scientists and graduate students to link theory with practice and facilitate the applicability of university education programs (Aldridge and Audretsch, 2011). For scientists, the importance of commercialization is not that clear-cut since their traditional jobs are to discover new knowledge rather than exploit the knowledge. While scholars have agreed that commercialization would contribute to scientists' career development, the debates remain on how to encourage scientists to engage more in commercialization (Lam, 2011; Miller and Acs, 2013).

Scholars around the world have identified four sets of factors that influence scientist commercialization (Aldridge and Audretsch, 2011; Bercovitz & Feldman, 2008; Markman et al., 2008). The first set is access to financial resources (Markman et al., 2008). Scholars have agreed that access to financial resources is critical for all entrepreneurs, and scientists are not an exception. Thus, studies on scientist commercialization have focused more on resources for continued research that convert basic embryonic inventions into marketable products. The second set of factors relates to scientists' characteristics, including human (i.e., education, publications) and social capital (i.e., networks with various partners) (Audretsch and Aldridge, 2009). Scientists who have success in publication (or star scientists) and those with

strong networks are more likely to engage in commercialization. The third line of research is on scientists' motivation, including financial gain, recognition, and knowledge curiosity (Lam, 2011). Finally, organizational characteristics also influence scientist commercialization. The presence of a Technology Transfer Office (TTO) and leadership experience were found to be positively related to commercialization (Bercovitz and Feldman, 2008; Markman et al., 2008).

In Vietnam, scientist commercialization is very challenging since the market for technology transfer or commercialization has not been well developed and resources for basic application research is sparse. Several scholars have pointed out key challenges facing scientist commercialization in Vietnam, including copyright protection, market information, and contract enforcement (Nguyen, Q. P., 2015; Nguyen, T. H., 2013; Tran, 2007). What influences scientists to commercialize their research results? To our knowledge, systematic research on scientist commercialization is non-existent in Vietnam. We do not know which factors influence scientists' engagement in commercialization.

Our study addressed this gap. The key objective was to explore factors that influence scientists to engage in commercialization in Vietnam. Based on the literature, we developed a model linking several factors, including access to research grants, networking with businesses, leadership experience, and scientists' motivation with probability of commercialization. These factors mirror the most common factors of commercialization in the literature and fit well with the current institutional context of Vietnam. We tested our hypotheses on a sample of scientists working at the Vietnam Academy of Science and Technology – a leading institution of research in Vietnam. To our knowledge, this is the first systematic empirical research on scientist commercialization in Vietnam. Our study contributes to the literature by expanding this line of research to a new context where market institutions have not been well developed, resources for research are sparse, and commercialization is at a nascent stage.

2. Literature review and theoretical model

Research interest of the topic

Scholars have used a variety of terminology to describe the act of converting scientific research results into new products or new processes for commercial uses. This terminology includes: technology transfer (Perkmann et al., 2013), scientist entrepreneurship (Alshumaimri et al., 2012), and scientist commercialization (Aldridge and Audretsch, 2011; Bercovitz and Feldman, 2008). In this paper we define scientist commercialization as the act of converting research results into new products/processes and introducing these into the market (Aldridge and Audretsch, 2011). Scientist commercialization could occur in several forms. First, scientists/universities could license the inventions to clients (licensing). This is a very popular mode of commercialization in the world (Markman et al., 2008). In licensing, clients can buy the current inventions. Second, universities/scientists could commercialize inventions by establishing new ventures or joint-ventures with business partners (Aldridge and Audretsch, 2011). Universities/scientists could invest in the new ventures to convert their inventions into tradable products or services. Third, scholars have

pointed out that some scientists may shelve their inventions or informally commercialize the inventions (i.e., self-production with limited quantities) (Dechenaux et al., 2011; Gianiodis et al., 2016).

Commercialization of research results has been initially documented in Vietnam (Nguyen, Q. P., 2015; Nguyen, T. H., 2013; Tran, 2007). Studies on scientist commercialization in Vietnam mainly focus on seeking solutions to promote this activity. In most studies, major solutions proposed are about the roles of the government in setting up the legal framework and developing the science and technology market for further scientist commercialization. They however, have not addressed the challenges and opportunities, ways/paths, and factors determining scientist commercialization in the context of Vietnam. Fully understanding these issues is significant for success in scientist commercialization and further development of science and technology in Vietnam.

Characteristics of scientists' inventions

Scientists' inventions contain great science and technology progress, have big potential for newness, and yet are very difficult for commercialization. Most research on this topic has been conducted in developed countries (Aldridge and Audretsch, 2011; Alshumaimri et al., 2012; Bercovitz and Feldman, 2008; Markman et al., 2008). Recently, some research has been done in the context of developing or transition economies, such as China (Shapira and Wang, 2009; Wu, 2010), Thailand (Pittayasophon and Intarakumnerd, 2017) and Saudi Arabia (Alshumaimri et al., 2012).

Compared to firm or practitioner inventions, scientist inventions have three notable characteristics. Firstly, scientist inventions are closely linked with new science and technology development. Thus, these inventions usually have high newness and high potential for valuable solutions (Dechenaux et al., 2011). This makes scientist commercialization very attractive.

Second, scientist inventions are normally at an embryonic stage (Dechenaux et al., 2009). Thursby and Thursby (2003) conducted a survey of firms in the US about scientist inventions that they have been interested in. The results showed that only 7% of the inventions were ready for commercial use. Meanwhile, 40% of the inventions were merely proof of concepts – the very first stage of inventions.

Third, scientist commercialization is high-risk, compared to those of firms and practitioners. According to Thursby and Thursby (2003), the failure ratio of scientist commercialization was about 50%, and half of these failures were due to technical reasons. Thus, a necessary condition for scientist commercialization is to maintain the involvement of the scientists in further development of the inventions. With these characteristics, scientist commercialization is greatly desirable but highly risky.

Scholars have studied factors influencing scientists' commercialization from different angles, including access to resources, personal characteristics, scientists' human and social capital, and organizational characteristics (Audretsch and Aldridge, 2009). While access to resources is important for all entrepreneurs, research on scientist commercialization points out that financial resources to continue experiments to convert basic, embryonic research results into marketable products is greatly critical (Audretsch and Aldridge, 2009). Research

on scientist personal characteristics have found that star (successful in publications) scientists and those with high human and social capital engaged more in commercialization (Dechenaux et al., 2011). Another angle has been the influence of organizational factors, including the presence of a Technology Transfer Office (TTO) and leadership experience in commercialization (Markman et al., 2008).

In this paper, we focus on the most common factors, including access to research funding, networking with businesses, leadership support, and scientists' motivation. We discuss each factor and develop hypotheses in subsequent sections.

Access to research funding and commercialization

Access to financial capital is a critical factor for any entrepreneur to start a new venture (Le and Nguyen, 2009). Scientist entrepreneurs are not an exception (Aldridge and Audretsch, 2011).What is distinctive about scientist commercialization is that access to financial resources is highly needed prior to engagement in commercialization. Before reaching the stage of launching a new product, process or even a venture, scientists have to work on their ideas (inventions) much more than normal entrepreneurs (Dechenaux et al., 2011). After finishing basic research projects, scientists normally have to go through many more experiments to turn research results into meaningful practical uses. These experiments require funding. In the context of Vietnam, scientists often apply for various sources of funding to continue experiments in order to translate their basic research results into transferable new products or process (Nguyen, Q. P., 2015; Tran, 2007). We expect that the more research funding a scientist has access to, the greater the probability he or she would be able to commercialize their research results.

Hypothesis 1: Access to research funding is positively related to scientist commercialization.

Networking

Networking is another critical success factor in creating a new venture (Le & Nguyen, 2009; Nguyen T. V. et al., 2006). In transition economies, such as Vietnam, entrepreneurs tend to use networking to substitute for developed market institutions (Le & Nguyen, 2009; Puffer et al., 2010; Welter & Smallbone, 2011). Networking fills the institutional voids by providing market information, building trust with partners to cope with uncertainty in contract enforcement, and also by getting endorsement and protection from members of the network (Puffer et al., 2010).

In the field of scientist commercialization, networking is recognized as one of the most important success factors (Aldridge and Audretsch, 2011). Scientist commercialization depends greatly on the scientists' ability to discover and realize business opportunities from the inventions. Previous research has shown that social networks influence the ability to discover business opportunities and the types of opportunities (Shane, 2000). Dechenaux et al. (2009) found that social networks, especially networks with business people strongly influence commercialization success. Other scholars found that scientists' social capital – referring to networks with various stakeholders – influence the commercialization of their research results (Aldridge and Audretsch, 2011).

Among various stakeholders, networking with businesses was critically important. First, networking with businesses helps scientists to have market information and insights, influencing their recognition of opportunities (Shane, 2000). Second, networking with businesses serves as a bridge for scientists to find partners in the production and distribution of new products which result from their research (Liao and Phan, 2016). Third, strong networking and trust help scientists and business partners to come up with business deals that are accepted by both sides (Aldridge and Audretsch, 2011; Shane, 2000). Trust between partners would mitigate the risk that one side may cheat (Nguyen, T. V., 2005). This is even more important in the absence of developed market institutions. Therefore, we hypothesize:

Hypothesis 2: Networking with businesses is positively related to scientist commercialization.

Leadership experience in commercialization

For scientists, the importance of commercialization is not that clear-cut. Traditionally, scientists' performance is evaluated based on research results, not necessarily commercialization success (Bercovitz and Feldman, 2008). Thus, motivation for scientists to commercialize their inventions is not very clear (Miller and Acs, 2013). This motivation varies, depending greatly on organizations' policies and cultures and leadership support (Audretsch and Aldridge, 2009).

In this context, we follow Bercovitz and Feldman (2008) to propose that leadership has a strong influence on scientists' commercialization. First, leaders build a culture of accepted norms and values. The acts of leaders signal which activities are encouraged. If a leader is engaged in commercialization, it becomes clear to the scientists that this activity is legitimate or even desired. In some cases, subordinates may even benchmark their activities against their leaders. Thus, if leaders engage in commercialization, that would motivate subordinates to do the same (Bercovitz and Feldman, 2008). Second, if leaders have experience in commercialization, they should be able to facilitate and support subordinates in this activity. Commercialization is a complex task which involves much tacit business knowledge, such as negotiation, financial management, etc. Advice from experienced leaders is valuable to junior scientists (Fini et al., 2009). Therefore, we hypothesize:

Hypothesis 3: Department leaders' experience in commercialization is positively related to scientist commercialization.

Motivation

All over the world, scientists are facing a tension between academic publication and commercialization-oriented activities (Ambos et al., 2008). Universities, research institutes, and scientists are increasingly required to do both, creating an ambidexterity in organizations (Ambos et al., 2008). Under an ambivalent context, scientists' motivation becomes an important driver of commercialization. According to Lam (2011), scientists can be motivated by a complex array of pecuniary and non-pecuniary factors in their commercial pursuits. Drawing on theories of motivation in social psychology and data from five major U.K. research universities, Lam (2011) demonstrated that scientists are heterogeneous in their motivation for commercialization. First, pecu-

niary (financial) motivation is important since commercialization could bring in financial sources for further research and/or individual incomes. Second, scientists also are motivated by non-pecuniary factors, such as recognition and passion or intrinsic motivation. Commercialization could bring the research results to practical uses, making good publicity for the scientists (Lam, 2011). Furthermore, commercialization could be a challenge for scientists to work on, satisfying the needs to solve puzzles in their fields (Grant and Berry, 2011). These are pro-self motivation (i.e., motivation to satisfy one's own needs).

Recently scholars have discussed entrepreneurs' prosocial motivation, i.e., motivation to help/benefit others (Grant and Berry, 2011). According to these authors, prosocial motivation enhances the relationship between intrinsic (proself) motivation and creativity and encourages scientists to develop ideas that are useful as well as novel. Prosocial motivation encourages scientists to search for information and solutions that could help others and alter cost/benefit analysis toward helping others (Meglino and Korsgaard, 2004). These cognitive processes would produce more chances for a research result to be commercialized (Grant and Berry, 2011).

Therefore, we hypothesize:

Hypothesis 4a: Scientists proself pecuniary motivation is positively related to scientist commercialization

Hypothesis 4b: Scientist proself non-pecuniary motivation is positively related to scientist commercialization

Hypothesis 4c: Scientist prosocial motivation is positively related to scientist commercialization

3. Method

Sample

The study used the survey method to collect data to examine factors that influence scientist commercialization. The population was scientists working at the Vietnam Academy of Science and Technology (VAST), a leading institution in science and technology in the country. These scientists need to hold a Ph.D. and be principal investigators of at least one state-funded research project at the ministerial or national levels during 2010 – 2016. We obtained a list of more than 500 scientists who met these criteria. With support from VAST's administrative staff, we contacted the scientists to solicit participation and delivered the questionnaire to them in person. In total, 180 scientists agreed to participate, but only 153 questionnaires were collected at the end of the survey, giving a response rate of 30.6%. We compared the respondents with non-respondents on demographic variables (i.e., age, gender, qualification, and managerial positions) and found no difference. Response bias, if it existed, was negligible.

Measures

Commercialization: This is a binary measure of whether the scientists engaged in commercialization of their research results or not. Commercialization could be in any of the following modes: licensing to other partners, self-production by research team, or start-up a new venture. The variable was coded 1 if the answer is "Yes" to any of these modes, and 0 if the answer was "No" to all modes.

Research funding: Following Alshumaimri

et al. (2012), access to research funding was measured by the number of state-funded projects at the ministerial and national levels during 2010 – 2016 and the average amount of the fund per project.

Leaders' experience in commercialization: To measure leaders' experience, we followed Bercovitz and Feldman (2008) and asked respondents whether their department heads had any technology transfer or commercialization during 2010 – 2016. We believed that leaders who had engaged in commercialization would understand the significance, benefits, and challenges of this act. This induces support and encouragement to the scientists to commercialize their inventions.

Networking with businesses: Networking with businesses was measured by the number of publications the scientists co-authored or cooperated in with businesses. This type of cooperation shows their working relationships and does not directly relate to technology transfer deals (Alshumaimri et al., 2012).

Motivation: Three types of motivation were included:

- For pro-self motivation (i.e., financial gains, reputation and recognition, and knowledge curiosity), we used Lam's (2011) measure of scientists' motivation to commercialization (Table 1). These include pecuniary (financial gains) and proself non-pecuniary motivation (recognition, self-esteem, and knowledge curiosity).

- For pro-social motivation (i.e., helping and bringing benefits to others and/or to country's development) we based on qualitative interviews and reference to Renko (2013) and Grant and Sumanth's (2009) measure of general prosocial motivation to a three-item measure of prosocial motivation in commercialization (Table 1).

Control variables: Following previous studies in scientist commercialization (Alshumaimri et al., 2012), we controlled for scientist age, gender, field of study, and service in various professional committees.

Analysis

We ran Exploratory Factor Analysis (EFA) and Reliability tests for motivation measures. For hypothesis testing, a standard logistic regression was run to test whether the variables of interests influence the probability of the scientist commercialization.

4. Results

Descriptive statistics

The measures of motivation were subjective in the form of a Likert scale. We first ran EFA to test the item loadings. Three factors were extracted and explained 67.8% of the total variance. The three factors were named as proself pecuniary motivation, proself non-pecuniary motivation, and prosocial motivation. We then ran a scale reliability test for each type of motivation, and all measures got a Cronbach's alpha of .70 or greater (See Table 1).

The EFA and reliability tests suggested that the measures met requirements on dimensionality and reliability (DeVellis, 1991). We proceeded to descriptive statistics and hypothesis testing.

The respondent profile is presented in Table 2. Sixty four per cent of the surveyed scientists were men, with an average age of 44. These scientists had an average of 19 years working at VAST. The average number of WoS publi-

Table 1: Factor loading and Conbach's alpha for motivation measures

Which of the following factors have motivated you personally to engage in industrial links activities?	Prosocial	Proself	
		Non-pecuniary	Pecuniary
To increase funding and other research resources			0.805
Application and exploitation of research results			0.645
To increase your personal income			0.785
To create opportunities for knowledge exchange/transfer		0.676	
To satisfy your intellectual curiosity		0.872	
To build personal and professional networks		0.636	0.410
To provide work placement or job opportunities for students		0.705	
To contribute to country's development	0.834		
To benefit and help others	0.862		
To repay society's investment on your personal development	0.887		
Cronbach's alpha	0.837	0.764	0.704

cations was 7.5 articles, while that number for publications in Vietnamese journals was 13 articles. Thirty six per cent of the sample had served in national/ministerial research grant committees, and 19% and 17% of them had served in government and business advisory committees, respectively.

The correlation matrix (available upon request due to the size of the table) shows that commercialization is significantly and positively related to several factors, such as number of research grants from NGOs or other sources (.19, $p<.05$), the scientist being a member of professional advisory committees for business, and prosocial motivation. On the other hand, it is negatively related to working experience. The correlations between independent and control variables revealed no abnormal signs.

Hypothesis testing

Logistic regression was run to test whether Network with businesses, Leaders' experience, Research funding, Scientists' Motivation were related to the probability of scientist commercialization. The results are presented in Table 3.

The model is significant with $\chi^2 = 75.28$ ($p<.001$), suggesting that the variables reliably distinguish scientists who engaged in commercialization from those who did not. The model reliably classified the scientists into groups with a 91.2 % success rate overall, a big improvement from the 70% success rate without the variables.

The Wald criterion showed that access to research funding from the State positively and significantly related to commercialization. The coefficients of both number of projects ($p <.05$) and the average amount ($p <.05$) from national and ministerial funds and commercialization were significant. Research funding from provincial sources had a non-significant relationship with commercialization. Funding from NGOs and other sources had mixed results, i.e., the number of projects was positively related while the average amount was negatively related to commercialization. Hypothesis 1 was partly supported.

Table 2: Descriptive statistics

1	Age	44.81	10.07
2	Gender (Female = 0)	0.64	0.48
3	Experience (year)	19.20	10.36
4	Year of getting PhD		
5	Biology	0.29	0.45
6	Medical science	0.16	0.36
7	Chemistry	0.31	0.47
8	Publications in Vietnamese journals	13.81	15.96
9	Publications in Scopus journals (not WoS)	1.82	4.58
10	Publications in WoS journals	7.56	14.81
11	Member of professorship committees	0.05	0.22
12	Member of ministerial/national research grant committee	0.36	0.48
13	Member of Nafosted committee	0.07	0.26
14	Member of business advisory committee	0.17	0.38
15	Member of government advisory committees	0.19	0.39
16	Co-author with business in Vietnamese journals	2.26	6.63
17	Co-author with business in international journals	0.44	1.46
18	Co-author with business in conferences	1.30	5.37
19	LEADERS' EXPERIENCE	0.35	0.48
20	National/ministerial research – number of project	1.52	1.67
21	National/ministerial research – average value (MVND)	1331.80	4539.30
22	Provincial research – number of projects	0.24	0.71
23	Provincial research – average value (MVND)	111.16	859.66
24	Other research (NGOs or firms) – number of project	0.28	0.77
25	Other research (NGOs or firms) – average value (MVND)	96.90	421.02
26	Motivation – proself financial	3.25	0.54
27	Motivation – proself non-financial	2.95	0.54
28	Motivation – prosocial	3.16	0.54
29	Commercialization (Yes = 1)	0.35	0.48

Co-authorship with firms in research publications had a mixed result. Co-authorship in international journals positively and significantly related to commercialization ($p<.05$), while co-authorship in Vietnamese journals had a negative association with commercialization. This result suggests that only quality research cooperation (i.e., international publications) positively related to commercialization. Hypothesis 2 was partly supported.

Leaders' experience had a clear positive relationship with commercialization ($p <.05$). This suggests that scientists were more likely to commercialize their research results if their department heads also did. Hypothesis 3 was supported.

Table 3: Logistic regression on commercialization

	B	S.E.	Wald
Control variables			
Age	-.54	.35	2.34
Gender (Male)	3.51	1.93	3.31
Experience (year)	-.91	.39	5.48*
Year of getting PhD	.10	.25	.15
Biology	-4.03	2.31	3.05a
Medical science	-1.12	1.82	.38
Chemistry	3.30	1.85	3.17a
Publications in Vietnamese journals	.18	.14	1.61
Publications in Scopus journals (not WoS)	.88	.47	3.60a
Publications in WoS journals	-.03	.16	.03
Member of professorship committees	.57	9.91	.01
Member of ministerial/national research grant committee	7.64	3.92	3.79*
Member of Nafosted committee	1.49	2.91	.26
Member of business advisory committee	-7.19	4.94	2.12
Member of government advisory committees	-8.11	5.06	2.57
Networking with business			
Co-author with business in Vietnamese journals	-1.47	.64	5.32*
Co-author with business in international journals	2.20	1.05	4.38*
Co-author with business in conferences	-.05	.14	.12
Leaders' experience	6.48	2.64	6.02*
Research resources			
National/ministerial research – number of project	1.58	.90	3.05*
National/ministerial research – average value	.00	.00	3.17*
Provincial research – number of projects	5.30	4.82	1.21
Provincial research – average value	.01	.02	.24
Other research (NGOs or firms) – number of project	6.59	3.12	4.46*
Other research (NGOs or firms) – average value	-.01	.00	4.10*
Motivation			
Motivation – proself financial	5.30	2.79	3.61*
Motivation – proself non-financial	-4.54	2.25	4.06*
Motivation – prosocial	12.87	4.60	7.84**
Constant			
-2 Log likelihood	35.377		
Cox & Snell R Square	0.563		
Nagelkerke R Square	0.800		
Chi-square	75.28		
Model success rate (%)	91.2		
Classification without model (%)	70		

*Note: *: p<.05; **: p<.01; ***: p<.001*

Proself motivation had mixed results. Expectation of financial gains had a positive association with commercialization ($p < .05$), supporting Hypothesis 4a. Non-financial proself motivation, on the other hand, had a negative relationship with commercialization. This is

opposite to our hypothesis, and we offer possible explanation in the subsequent section. Prosocial motivation had a clear and positive relationship with commercialization, supporting Hypothesis 4c.

Some results in control variables were significant. Firstly, experience had a negative association with commercialization. This suggests that scientists with long experience in VAST were less likely to commercialize their research results than newer counterparts. Secondly, scientists serving ministerial/national research grant committees were more likely to engage in commercialization.

5. Discussion

In this paper we addressed the question of what factors influence scientists to engage in commercialization of their research results. Drawing from leadership, motivation, and network theories (Aldridge and Audretsch, 2011; Bercovitz and Feldman, 2008; Lam, 2011), we proposed that access to research funding, networking with businesses, leadership experience, and scientists' motivation are key factors for scientist commercialization. We tested the hypotheses with a sample of 153 scientists from VAST, a leading research institution in Vietnam. The results showed that access to state funding, networking with businesses, and leaders' experience were positively related to the probability that a scientist engage in commercialization. Motivation had a complex relationship with commercialization. Pecuniary and prosocial motivation were positively related to commercialization, while non-pecuniary pro-self motivation was negatively related to commercialization. This was exactly opposite to our hypothesis 4b. One possible explanation lies in the context. Recently Vietnam has promoted publication in international journals, especially in Scopus and WoS listed journals. Publication in these journals has become one of the most important criteria for a scientist's reputation and esteem. Therefore, scientists who strive for esteem and recognition may spend their time and effort to work on international publication rather than on commercialization.

Our study suggests that the motivation of scientist entrepreneurship is somewhat unique in comparison to normal entrepreneurship. We have demonstrated that prosocial motivation is important not only for social entrepreneurship, which purposefully targets helping others. Scientist entrepreneurship also requires some level of pro-social motivation or desire to benefit others. Secondly, pro-self pecuniary and prosocial motivation are not necessarily mutually exclusive. Scientists could pursue both financial gains for themselves and helping others in their commercialization. These insights need further validation.

From a practical point of view, the promotion of entrepreneurship among scientists should consider several factors. First, scientists are more likely to engage in commercialization if their department heads also do. Therefore, entrepreneurship spirit should be promoted especially at this management level. If research organizations want to foster commercialization, perhaps achievement in commercialization should be included as one criterion for managerial promotion. Second, besides financial gains, prosocial motivation is positively related to commercialization. Thus, entrepreneurship promotion campaigns should encourage scientists' desire to help others. Commercialization

should be viewed as a prestige achievement which would foster scientists' proself non-pecuniary motivation.

For scientists, commercialization is a complex and tiring endeavour. Common entrepreneurship skills and strategies, such as networking, access to finance, and business management should be learned. In the context of Vietnam, networking becomes critical. Scientists should try to connect with other stakeholders who could support in information provision, access to finance, production, and or distribution of the commercialized products. A purely academic mind-set should be changed to allow some learning about business insights.

We are aware that our sample was limited at VAST, raising a question of generalization of the results. While VAST is a leading research institution in Vietnam where many inventions have been commercialized, its organizational factors may be different from other research institutions. Future research could expand the sample into universities and other research institutes. The construct of leaders' experience may not directly and fully reflect leadership support for commercialization. Future research could introduce the construct of leadership support and include a more direct measure of this construct. Despites the limitations, our research offers important theoretical and managerial implications.

Promotion of entrepreneurship has been one of the key priorities in Vietnam. In this campaign, scientist commercialization has a great potential to contribute to the country's innovation. However, scientists' entrepreneurship faces unique challenges as their inventions are often hard to commercialize and their professional prestige has been shifted toward academic publications in international journals. Until there is an eco-system that supports commercialization we could hope for a stronger and systematic wave of commercialization among scientists.

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