

PUBLISH OR PROFIT?
ESSAYS ON UNIVERSITY TECHNOLOGY
COMMERCIALIZATION
& ACADEMIC ENTREPRENEURSHIP

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SUMMARY

As universities increasingly engage in technology commercialization activities, concerns have been raised about the impact of such activities on faculty members' research productivity. Conflicting arguments are proposed concerning the effect of such activities on faculty research output and the empirical findings are ambiguous and unclear. In addition, most of these studies are limited to North American context, and very few have examined the subject in Newly Industrialized Economies (NIEs) in Asia. Therefore in my first essay, I investigate the treatment effect of faculty patenting and startup involvement on research productivity separately and additively by paired group comparisons, regressions, and before/after analyses. I find marked difference between the effects of patenting and those of startup involvement on research productivity. While patenting has a positive effect on publication productivity, further involvement in spinoff activities seems to have a negative effect on publication productivity. The exploratory study also shows that faculty members who have higher overall publication productivity have more patents whereas patent inventors with higher publication productivity are not necessarily more likely to be entrepreneurs.

Based on these exploratory findings, in my second essay, I further investigate the psychological factors that influence some faculty inventors to choose to start up spinoffs. Entrepreneurship scholars have identified various personality/motivational traits and proposed several cognitive models to explain the effects of individual difference on entrepreneurial decision making. However, there seems to be no testable intention models which is based on a fundamental theory and can integrate the factors scattered in the literature. Drawing upon

insights from Regulatory Focus Theory (RFT), I propose a parsimonious model of entrepreneurial intention suitable for testing in the context of university technology commercialization. In particular, I hypothesize that inventors who are more promotion focused tend to have higher entrepreneurial intention and that is partly because they tend to use more heuristics in decision making. I also hypothesize that a supportive environment breeds entrepreneurial intention and this effect is stronger for more promotion focused inventors. I test the model with primary and secondary data from two samples of university faculty members, and the results show partial support for the model.

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CHAPTER ONE

INTRODUCTION

Background

The success of Route 128 and Silicon Valley in spawning high tech startups demonstrates the crucial role played by MIT and Stanford University in regional economic transformation and development (Robert, 1991; Shane, 2003). What makes the stories of MIT and Stanford University so fascinating is that such result was not due to the traditional channel of knowledge spillover (i.e. dissemination of publically funded research results through publication and the training of skilled labor force), but rather the universities' active role in promoting technology commercialization. The Bayh-Dole Act (1980), which allowed universities to own the intellectual property (IP) generated from federally funded research, has provided universities with stronger incentives to promote the commercialization of their own research output through licensing or spinoffs. This has motivated many universities to set up technology transfer offices (TTO) and establish policy guidelines that support faculty patenting and spinoff activities. In addition to promoting various forms of research cooperation between university and industry, these institutional changes have attracted more research funding from the private sector, created job opportunities and industry clustering, and thereby increasing the flow of technology to industry (Etzkowitz, 1983; Etzkowitz, 1998; Mowery, et al., 1999).

Essay 1: Publish or Profit? The Effect of Technology Commercialization on University Faculty Members' Publication

The commercialization of university technology has been spreading from the U.S. to the rest of the world. However, while policy makers are enthusiastically replicating the successful models, a number of scholars have raised concerns about whether such activities could be detrimental to the research and other traditional functions of the university (Blumenthal et al., 1996a & b; Campbell et al., 2002; Krimsky, 2003). On the one hand, there are arguments about how commercialization activities may have a substitutive effect on the research in the university. Specifically, this camp argues that patenting hinders the public dissemination of the research findings, diverts the scientists' attention, and distorts the selection of research topics (Azoulay et al., 2006). On the other hand, supporters of commercialization suggest that it may complement the research activities in various ways (Stephan, et al., 2007). They contend that researchers who also patent may have more chances to work with industry from which they acquire new ideas for new research. Although there are empirical studies that have examined this issue (Thursby & Thursby, 2002; Agrawal & Henderson, 2002; Stuart & Ding, 2006; Azoulay et al., 2006; Lowe & Gonzalez-Brambila, 2007; Stephan et al., 2007; etc), the findings are ambiguous. Part of the reason could be that previous studies focus on the effect of only one of the commercialization activities (i.e. patenting, licensing, or spinoff) and have not differentiated the effects of different commercialization activities. Hence little is known about the separate and cumulative effect of different commercialization activities, i.e. how a scientist's research would be affected if he/she filed a patent or started up a venture, and how different the situation would be if he/she not only

filed a patent but also started up a venture subsequently. Moreover, most of the evidence has been collected from the U.S. or Canada with little attention paid to the universities in Newly Industrialized Economies which have been increasingly adopting the U.S. models of university commercialization regardless of the very different institutional and economic environment. Therefore, in Essay 1, I address these issues by examining the effect of two technology commercialization activities on research in National University of Singapore.

Based on a match-paired sample of 336 unique faculty members, I compare the publication productivity of the faculty members who have either participated in patenting or startup -- or both-- with that of those who did neither. In addition, regressions and before/after analysis are also used to examine the treatment effect of those commercialization activities. The results show that there is a difference between the effect of patenting and the effect of business venturing on faculty members' publication productivity. Patenting may "complement" research, but further engaging in business venturing may become a "substitute" for it. Furthermore, using the data collected, I also test the reversed causal effect of publication productivity on the propensity of patenting and business venturing. The results show a positive relationship between the overall publication productivity and patenting (volume) and a negative effect of publication productivity on entrepreneurial propensity.

Essay 2: Dare to take the plunge? A regulatory focus approach to academic entrepreneurial intentions

The exploratory findings of Essay 1 inspired me to examine the question of why some faculty inventors are more entrepreneurial than others. To be more specific, if a university faculty inventor realizes the market potential in his/her invention by filing an IP (technology disclosure or patent), what would influence his/her decision on further commercializing the IP? This is a question that has received only limited research attention (Shane and Khurana, 2003; Audretsch and Stephan, 1999). While the scarce existing literature offers explanation based on either sociology theory (Stuart & Ding, 2006) or Resource Based View (Landry, et al, 2006), my field work with faculty inventors and entrepreneurs suggests that the difference in personality and motivation plays an important role in the entrepreneurial decision making process and hence psychology theories may shed new light on this question.

Entrepreneurship literature offers various psychological explanations for why certain people choose to become entrepreneurs. Personality scholars have attributed entrepreneurship to various traits (Collins et al., 2004; Stewart & Roth, 2004; Brandstatter, 1997; Markman et al., 2005; Utsch et al., 1999, Rauch & Frese, 2007). A set of motivation-focused constructs have also been linked with opportunity evaluation and entrepreneurial decision making (Shane, et al., 2003; Locke & Baum, 2007). Furthermore, cognitive psychologists have incorporated distinct thinking patterns and decision processes into a general process model of entrepreneurial intention and action (Shapero, 1982; Bird, 1988; Krueger, 2003). However there are various problems associated with these studies. McMullen & Shepherd (2006) proposed an integrated model to explain entrepreneurial action,

which addressed the problem of the earlier intention models (e.g. Krueger, 2003) by incorporating the process view of entrepreneurship. However it also has a few undeniable problems, which makes it an incomplete intention model and a conceptual model that is hard to put to empirical tests.

Therefore, in Essay 2, to address the issues with Krueger (2003)'s entrepreneurial intention model and McMullen and Shepherd (2006)'s two-stage model, I propose a parsimonious intention model to explain the entrepreneurial intention among faculty inventors. I argue that 1) the different levels of intention to start a business (entrepreneurial intention) determine the different decisions made in the evaluation stage and 2) the level of intention is in turn influenced by the inventor's motivation (chronic regulatory focus), knowledge (entrepreneurial cognition), and the situation he/she is facing (entrepreneurial environment). More specifically, I argue that high promotion focused inventors are more likely to start up businesses, and this is partly because they tend to use more heuristics (Entrepreneurial Cognition) in opportunity evaluation. In addition, a supportive environment makes for more entrepreneurial inventors, especially when they are high in promotion focus. I conduct two empirical studies to test the proposed model, one on the patent inventors and the other on the inventors who have made invention disclosure but have yet been granted any patent. Both studies are conducted in National University of Singapore. The findings of the two studies showed partial support for the proposed model.

Overview of the Dissertation

The dissertation is organized as follows. Chapter Two presents the first essay, which is about the relationship between university faculty members' research productivity and their various involvements in technology commercialization. Chapter Three presents the second essay, in which I propose and test an integrated model to explain the entrepreneurial decision making of the university faculty inventors. The contribution, limitation, and implication of each study are discussed in its own chapter accordingly.

CHAPTER TWO

ESSAY 1

Publish or Profit? The Effect of Technology Commercialization on University Faculty Members' Publication

INTRODUCTION

With the great increase in university technology commercialization activities in recent years (e.g. Lowe & Gonzalez-Brambila, 2007; Lowe & Ziedonis, 2006), an emerging issue of whether the involvement of academics in various technology commercialization activities (including patenting, licensing, and founding of venture firms) might be detrimental to their academic performance has caught the attention of scholars and policy makers (Azoulay et al., 2006; Stephan et al., 2007; Geuna & Nesta, 2006; etc.). On the one hand, the economics of resource constraints suggests that scientific research and technology commercialization are two competing activities that require a trade-off of time and resource commitments, and hence implies a “substitutive” relationship between the two activities. On the other hand, some argue that the scientific and technological advances are interdependent and there are various benefits in participating in technology commercialization activities, suggesting instead a “complementary” relationship between the two.

The empirical findings in the existing literature (e.g. Agrawal & Henderson, 2002; Azoulay et al., 2006; Stephan et al., 2007; Zucker & Darby, 1998; Stuart & Ding, 2006; Lowe & Gonzalez-Brambila, 2007) about the effect of various technology commercialization activities (i.e. patenting, licensing, business

venturing) on scientific research do not offer a clear answer either. Most studies focus on one of the activities and hence ignore the cumulative effect of participation in other activities. More importantly, most of these studies have not paid enough attention to the nature of these activities or differentiate their different effects on research. Furthermore, most of the findings pertain to faculty in leading universities in North America and hence may not be applied to universities in other countries or economic regions where the institutional context and economic environment for university technology commercialization are very different.

Therefore this paper is to dissect the university technology commercialization process, examine the effect of two specific commercialization activities on academic research separately and additively, and provide empirical evidence from a leading Asian university. I propose that while patenting may complement research further involvement in business venturing may have negative impact on research output. I draw on a sample of 336 unique university researchers from National University of Singapore to test the hypotheses. The results confirm some previous findings in the literature that patenting has positive effect on publication productivity. But it is also showed that if patent inventors continued to start spinoff firms their publication productivity suffered. To the extent that these findings are confirmed or contradicted by research in other university settings, I believe that they have significant implications for university administrators and policy makers in Singapore and other Newly Industrialized Economies (NIEs).

The paper is structured as follows. In section 2, I review prior work on university technology commercialization and propose the hypotheses. In section 3, I describe the data and the methodology of the empirical tests. Section 4 presents the results. The final section concludes the findings of this study and discusses the implication and the possible future research.

LITERATURE & HYPOTHESES

The process of university technology commercialization usually starts from faculty member filing technology disclosure about his/her invention with the technology transfer office (TTO) in the university. The TTO will then evaluate the commercial potential of the invention and decide whether to file a patent and in the meantime it will also start promoting the technology to possible licensees in the market. Sometimes, instead of waiting for the licensees, inventors would start up their own companies to commercialize their own technology. During this process, patenting and business venturing are two important milestones and hence in this study I examine their effects on faculty members' research productivity separately.

The Effect of Patenting

Opposing arguments have been made in the literature on the relationship between patenting and publication of university faculty members. On the one hand, it is argued that patenting and publishing are substitutive (Azoulay et al., 2006; Stephan et al., 2007). The reasons are that researchers who patent are more secretive and protective about the research findings and hence delay or give up

the publication and that patenting is time-consuming and diverts the faculty members' attention from pure scientific pursuits. On the other hand, some argue that patenting and publication can be complementary (Azoulay et al., 2006; Stephan et al., 2007). The reasons are that there is duality between patenting and publication and patenting facilitates researchers' interaction with the industry, which then bring inspiration, funding, information, and equipment, etc.

However, the empirical findings in the prior literature seem to suggest non-negative or even positive relationship between patenting and publication. For example, Agrawal & Henderson (2002) studied a group of 236 scientists in Mechanical and Electrical Engineering department at MIT and did not find negative relationship between publication rates and patent counts. However, Azoulay et al. (2006) examined 4,270 life scientists from universities and research institutes and found that patenting has positive effect on publication rates and the most productive researchers are the most likely to patent. Based on 1995 Survey of Doctoral Recipients, Stephan et al. (2007) analyzed the patent activity of 10,962 faculty members in four fields of knowledge (i.e. computer sciences, life sciences, physical sciences, and engineering). They also found a complementary relationship between patents and publications regardless of the choice of instruments, with the relationship being strongest for engineers.

I argue that patenting and publication share the same source activity – research. Both patents and publications are logical outcome of research. In addition, as both patent application and publication require researchers to establish “newness” based on prior art, the marginal cost of writing patent

application based on the manuscript of research papers is low (Stephan, et al., 2007). Moreover, while universities usually provide legal and financial support for patenting, researchers get to focus on research itself instead of being distracted by non-research activities. Hence patenting does not necessarily have negative effect on research productivity. Furthermore, it is documented in the previous literature that patenting may facilitate the interaction between university researchers and industry, which inspires new research ideas (Mansfield, 1995). Researchers who participate in patenting therefore get to establish their reputation in the industry, which then attract research funding (Stephan, et al., 2007), proprietary equipment and information (Azoulay et al., 2006), and potential collaborations (Owen-Smith and Powell, 2001). Therefore, the overall effect of patenting on publication productivity should be positive.

H_{1a}: University faculty members who have been involved in patent inventing have higher publication productivity than those who haven't.

H_{1b}: University faculty members who have been involved in patent inventing have higher publication productivity after patenting.

The Effect of Patenting + Business Venturing

One key difference of this study with the previous ones is that I differentiate the effect of patenting and business venturing. I argue that due to the different nature of these two activities they should have different relationships with research productivity. While patenting can be another logical outcome of research, the gap between research finding and business is significant. Many studies have shown how far it is from university research finding to commercializable product/service (e.g. Lowe & Ziedonis, 2006), not to mention

the other business related activities (fund searching, marketing, and management, etc.) which university faculty members are usually not familiar with (Shane, 2003a). To make the inventions commercializable and to improve the efficiency in the business activities, cost of time and other resources would occur. This would lead to a decrease in the research outcome. Furthermore, the attention theory (Ocasio, 1997) suggests that individuals are selective in things they attend to at any given time and the focused attention on the selected things would inhibit the perception and action on the non-selected ones. Hence when a faculty member's attention is drawn to business venturing, his/her energy, effort, and mindfulness would be drawn away from research and publications. Therefore, business venturing should have negative effect on publication productivity.

The empirical findings in the literature are mixed. Most studies looked at how publication output predicts academic entrepreneurship (e.g. Zucker et al, 1998; Stuart & Ding, 2006; Landry et al, 2006) and the results indicate either positive or insignificant relationship between publication and business venturing. The only study that has looked at the effect of business venturing on publication output (Lowe & Gonzalez-Brambila, 2007) also shows that the effect is positive. However, due to the selection bias in sampling from high quality research institutions, the generalizability of their results may be limited.

Following the universities in the advanced countries, leading universities in the Asian NIEs have been in transition from traditional teaching universities to more research oriented schools since the late 1980's and the process has been accelerated since the late 1990s. But in terms of both quantity and quality of

academic publications generated annually, they are still far behind the sample universities in Lowe & Gonzalez-Brambila (2007)'s paper. The percentage of "star scientists" may not be as high either. Hence the average ability of faculty members in handling both research and business venturing could be lower.

Meanwhile, the institutional environment for academic entrepreneurship in Asian NIEs is not comparable to that in the U.S., where there are vigorous market demand for frontier technology, well-developed venture capital market, and mature market for experienced human resource to support the business ventures. According to my interviews with academic entrepreneurs in National University of Singapore who had entrepreneurial experience in both the U.S. and Singapore, starting up a high-tech business in Singapore is much more difficult and would take much more effort. During an interview, when asked about the market here, one said:

"The central gravity is not in Singapore, the manufacturing maybe, but the R&D is not here, all those people who make the decision to adopt the technology are not here... had this company been in Silicon Valley, things would've been very different."

In another interview, when asked about the venture capital (VC) market here, the professor answered:

"In Singapore, we don't have good VCs (venture capitalists). The VCs in Singapore are looking for short-term gain. They look for quick revenue...The Singaporean VCs are not big VCs either. They are more used to... small business

investment. They look for quick exit. But our case is an equity based, it takes longer time. They are not used to it, so we don't have VCs locally."

Therefore, while the nature of business venturing suggest that it should have negative effect on publication productivity, it may be possible that such negative effect is fully offset by the supportive ecosystem in the U.S., which explains most findings in the literature. However, given the under-developed ecosystem for academic entrepreneurship in Singapore and other NIEs, the negative effect of business venturing on research productivity would be augmented. Therefore, I propose:

H_{2a}: University faculty members who have been involved in patenting process and then started up their own businesses have lower publication productivity than those who have been only involved in patenting process but yet to start any business.

H_{2b}: University faculty members who have been involved in patenting process and then started up their own businesses have lower publication productivity after business venturing.

METHOD

I developed two datasets of academic staff members in National University of Singapore (NUS). The reason I chose this particular university is that NUS is the most established university in Singapore in terms of both publications and patenting. According to the Times Higher Education - Quacquarelli Symonds (THE-QS) World University Rankings, NUS is ranked relatively high among Asian universities in terms of publications per faculty. In addition, NUS has generated a substantial amount of patents which accounts for more than 90% of the U.S patents assigned to all the universities in Singapore,

making it the third largest patent holder in the country (Wong et al., 2007).

Findings from NUS are thus likely to be representative of other leading research intensive comprehensive universities in Asia, thereby filling a gap in the literature which has been concentrated on universities in North America.

The first dataset covers all the staff members of the university who have been involved in the invention of one or more patents granted by the USPTO and assigned to the focal university by the year 2005. The second covers all the staff members who have been involved in founding at least one university spin-off firm by the year 2005. I define spin-off firm as any new company which is founded by at least one current university staff (by the year of 2005) and has licensed at least one technology from the university technology transfer office.

I then constructed a matching sample for each of the inventors or founders in the two datasets by randomly selecting a person from the university's administrative file on current academic staff who is in the same faculty and has the same academic rank, but has no history of patenting or spin-off founding. The combined datasets, including the matching samples, cover a total of 336 unique individuals. I obtained the information on the academic rank of each of these individuals at the time of their first patenting or venture-founding event from their online curriculum vitas. I also compiled the publication records of all individuals covered in the datasets from the Thomson-ISI journal publications database, as well as relevant details of their USPTO (US patent and trademark office) patenting records from NUS database of U.S. patents.

As shown in Figure 1-1a, 53% of the pooled sample consisted of Engineering faculty, followed by Other faculty¹ (16.4%), Science faculty (15.2%), and Medicine faculty (13.4%). In terms of academic rank (Figure 1-1b), the biggest portion of the pooled sample is Associate Professor (47.7%), followed by Other faculty member group² (22.6%), Professor group (16.1%), and Assistant Professor group (7.7%).

Insert Figure 1-1a and Figure 1-1b here

Table 1-1a and Table 1-1b summarized the journal publication, patenting, and spinoff founding count in different faculties and ranks respectively. As expected based on the tenure system of university, professors have the most journal papers and citations, followed by associate professors, and then assistant professors. Professors also have more patents than their junior counterparts, but assistant professors are found to have more patents than associate professors. Science faculty has the highest average publication rate and citation rate, followed by Engineering faculty, Medicine faculty, and Other faculties. This is not unexpected in that Science faculty performs more basic research than other faculties and basic research tends to go public through journal papers and be more often cited.

Insert Table 1-1a and Table 1-1b here

¹ Other faculty group includes: Computing (10%), Design and Environment (3%), and the research institutes affiliated to NUS.

² Other faculty group includes: adjunct faculty (4%), research staff (9.5%), and teaching and administrative staff (8%).

Statistical analyses were conducted on different sub-samples in this study. To test H_{1a} , I performed an independent sample t-test and two-way ANOVA analysis to compare the publication performance of a sub-group of the sample and that of the matching sample. To test H_{1b} , I did a paired sample t-test to compare the publication productivity of patent inventors before and after the patent application. In addition, I also ran a linear regression to test the relationship between patenting and publication on the overall sample ($N=336$). To test H_{2a} , I ran a linear regression with the patent inventor sub-sample and I also did an independent sample t-test to compare the publication productivity of the inventor founders and their matching group. To test H_{2b} I did a paired sample t-test to compare the publication productivity of patent inventors before and after the spinoff event. Finally, to find out the reversed causal effect, I did two sets of regressions to find out whether research productivity has effect on patenting and business venturing.

RESULTS

Effect of Patenting

I conducted an independent sample t-test on the mean of the journal publication per year between the inventor group ($N=122$) and its matching group to see if they are significantly different. The result shows that the inventor group and the matching group have significant different means of journal publication per year ($t=2.44$, $p=0.02$), and the inventor group ($M=4.92$; $SD=4.55$) has more publications per year than the non-inventor group ($M=3.55$; $SD=3.52$). This

means H_{1a} is supported, that is faculty members who have patent(s) are also more likely to have more journal publications per year, which echoes the previous empirical findings in literature (Azoulay et al., 2006; Stephan et al., 2007).

To test if this effect would be moderated by the faculty affiliation and the academic rank of these staff, I conducted a two-way between-group analysis of variance to explore the impact of patenting behavior and faculty affiliation on the number of journal publications per year. Subjects were divided into four groups according to the faculty they belong to (group 1:Engineering; group 2: Science; group 3: Medicine; group 4: Others). The results are shown in Table 1-2a. There is statistically significant main effect for faculty [$F=2.91$, $p=.04$], but the main effect for patenting behavior is not significant [$F=2.13$, $p=.15$], and the interaction effect [$F=.38$, $p=.77$] does not reach statistical significance either. The descriptive statistics (Table 1-2a-1) show that the mean publication productivity for patent inventors in Engineering, Science, and Medicine faculty are higher than those of the matching group. The opposite result only exists in the Other faculty category. As the majority of the university technology commercialization happens in Engineering, Science, and Medicine faculty, which also make up of 89.7% of the sub-sample in this section, the ANOVA result about the effect of patenting on publication productivity is consistent with that of the t-test.

Insert Table 1-2a and 1-2a-1 here

I also ran a two-way between-group analysis of variance to explore the impact of patenting behavior and academic rank on the number of journal

publications. Subjects were divided into four groups according to the academic rank (group 1: Professor; group 2: Associate Professor; group 3: Assistant Professor; group 4: Others). The results are shown in Table 1-2b. There are statistically significant main effects for patenting behavior [$F=6.79$, $p=.01$] and for faculty affiliation [$F=2.71$; $p=.05$]; but the interaction effect does not reach significance [$F=1.32$, $p=.27$]. This means that even when the effect of academic rank on publications is considered, the difference between inventor and non-inventor still exists significantly.

Insert Table 1-2b here

In addition, I ran a regression of the publication productivity on both the dummy of patenting and the patenting volume controlling both the faculty affiliation and academic rank of the sample. The result is presented in Table 1-3a. Similar to the previous results, the patent dummy is significantly positive ($\beta=.29$, $p<.05$), and patent volume is also significantly positive ($\beta=.31$, $p<.05$). These results offer further support to H_{1a} .

Insert Table 1-3a here

To test H_{1b} , I compared the publication productivity of the patent inventors (excluding spinoff founders) before and after their 1st patent application. The result shows that the publication productivity increased after the patent application ($t=7.08$, $p<.01$), which supports H_{1b} .

Insert Table 1-3b here

To sum up, the evidence shows that university faculty patent inventors have higher publication productivity than their peers who have no patent

inventions. These results hold even when I control for academic rank and faculty affiliation of the faculty members. In addition, patent inventors experienced an increase in their publication productivity since their 1st patent application too.

Effect of Double Identity: Patent Inventor & Spinoff Founder

To test H_{2a}, I took the dataset of the patent inventors (N=122) and used OLS regression to find out whether the additional technology commercialization activity (i.e. business venturing) on top of patenting would be negatively related to publication. To control for scientific disciplinary and the career status of the patent inventors, I used their faculty affiliation and academic rank in the regressions. The dependent variable is journal publications per year. The correlation and the descriptive statistics of the variables in the regression are summarized in Table 1-4.

Insert Table 1-4 here

The regression result is presented in Table 1-5a. Consistent with the results in Table 1-3a, the number of patents owned by the inventors is positively related to their research productivity ($\beta=.28$, $p<.05$). A dummy variable for participation in the founding of a business is added into the regression. As shown in Model 3, the coefficients for “founding” are significantly negative ($\beta=-.71$, $p<.01$), which suggests that the faculty patent inventors who started up businesses have lower publication productivity than those who have yet to do so (H_{2a} supported). The regression result also shows significance for some academic Rank and Faculty affiliation dummies. Hence I conduct a series of t-tests

comparing publication levels across different faculties and academic ranks (based on result in Model 4). The result is reported in the note below Table 1-5a.

Consistent with the university performance appraisal system, faculty with higher ranks have higher publication productivity; whereas no significant difference is found across different faculties.

As a robustness check, I also selected a group of patent inventors who have the same academic ranking and faculty affiliation as the patent inventor founders but no record of spinoff founding as a matching group (N=27) to the group of inventor founders (N=27) and conducted a paired sample t-test on both groups' publication productivity. The result (Table 1-5b) shows that the matching group has significantly higher publication productivity (M=5.60) than the inventor founder group (M=3.30) ($t=3.06$, $p=.00$). These results offer further support to H_{2a} .

Insert Table 1-5a, b, c here

Finally, to test the change of publication productivity after firm founding (H_{2b}), I conducted a paired sample t-tests. I compared the publication productivity of the patent inventors who founded spinoffs before and after the founding dates of their firms (see Table 1-5c). An increase in publication productivity after the spinoff is found ($t=.24$, $p<.05$). Hence H_{2b} is not supported. The result seems to suggest that spinoff founding has a positive effect on the patent inventor founders' publication productivity. But combined with regression results in Table 1-5a which shows that the inventors who are also spinoff founders have lower

publication productivity in general than their peer inventors who have not started any business, this t-test result may also suggest that these spinoff founders might be able to experience a greater increase in their publication productivity had they not started the businesses.

This explanation is supported by two other paired sample t-tests (Table 1-5c). Since most of the spinoff firms were founded around 2000, I used year 2000 as a proxy cutting point to calculate the “before/after” publication productivity for the inventor group (N=122) and the whole sample population (N=336) and the results of the t-tests clearly show that all three groups experienced an increase. These results also reflect the effect of the policy changes in NUS because it is around 2000 that the university started to accelerate its process in building up its research profile. Nonetheless, due to the small size of the sample (N=27) which I used to conduct the t-test, the implications of this result need to be treated with caution.

Exploratory Study – Reversed Causal Effect

Although the focus of this study is how academic research is influenced by the various commercialization activities, the data collected allows me to examine the reversed causal effect of publication productivity on the commercialization activities. First, I ran a binary logistic regression on the sample population to study the effect of publication productivity on patenting propensity. The dependent variable is a dummy variable which equals to one if the subject has invented at least one patent and zero if not. The results are presented in Table 1-6a

Model 1. Consistent with the results in Table 1-3a and Table 1-5a, publication productivity is positively related to patent propensity ($\beta=.09$, $p<.05$). In addition, I also run an OLS regression on the patent inventor sample ($N=122$) to see the effect of publication productivity on patent volume. To ensure the causality test validity, the IV in Model 3 – publication productivity is the publication productivity before the 1st patent application or firm founding. The coefficient of publication in the OLS regression is not significant. However, as most of the patent inventors have invented more than one patent over the sample period, to use publication productivity before the 1st patent application or firm founding as the IV may be a bit too conservative. Hence I also used the overall publication productivity in the regression (Model 4) and the result shows a positive relationship ($\beta=.13$, $p<.05$), which suggests that publication and patenting could really be mutually strengthening.

Insert Table 1-6a, b here

Then I ran a binary logistic regression on the patent inventor sample ($N=122$) to study the effect of research productivity and patenting on entrepreneurial propensity. The dependent variable is a dummy variable which equals to one if the subject is an entrepreneur and zero if not. Again, to ensure the validity of the causality tests, the independent variables – patent volume and publication productivity – are truncated by the year of 2000. Year 2000 is used as the cutting point because most spinoff firms were founded around that time. The results (Table 1-6b) show that patenting is positively related to firm founding ($\beta=.49$, $p<.1$) and that publication is negatively related to firm founding in both

regression models ($\beta=-.48$, $p<.05$, and $\beta=-.61$, $p<.01$). This result is contrary to the findings in literature (e.g. Stuart & Ding, 2006), which indicates that in non-US and non-high-research-profile university context we may not expect that the professors who have good publication record are also more likely to start up venture businesses. It also implies that the faculty inventors whose publication records are not competitive may have more intention to explore other possible career opportunities.

As the dummy variables for academic rank are significant in the results, I conducted a series of t-tests to find out the differences across academic ranks. The results show that professors are more likely to start ventures than associate professor ($t=2.40$), but there is no significant difference between professors and assistant professors ($t=-.00$) or associate professors and assistant professors ($t=.00$) (results based on model 2).

DISCUSSION

In this study, I examined the relationship between academic publication productivity and two forms of technology commercialization activities (patenting and business venturing) of university researchers. I proposed that patenting “complements” research but further involvement in business venturing “substitutes” it. Based on a sample of 336 faculty members from National University of Singapore, I tested both hypotheses from three different angles (i.e. paired group comparison, regression analysis, and before/after effect examination)

and the results are supportive. Here I address the key implications of the research findings.

First, this study establishes a clear differentiation between the effects of two different technology commercialization activities on research output. Considering the different nature of patenting and business venturing, I propose that they have different relationship with academic research and such hypotheses are supported by the subsequent empirical tests. These findings support the process view of university technology commercialization and provide a more integrated analysis about the mixed effect of this process on academic research.

Second, this paper takes into account the economic and social context in Singapore and the development stage of NUS and provides counter-argument to the “herding” behavior in policy making among many leading universities in the NIEs in Asia. By showing the opportunity cost for faculty patent inventors to get involved in business venturing which has never been documented in the literature, especially how this cost is significant in the under-developed ecosystem for academic entrepreneurship, this paper suggests that spinoff founding based on patent invention may not be encouraged among the faculty members. As this finding is contrary to the findings in the literature (e.g. Stuart & Ding, 2006; Lowe & Gonzalaz-Brambila, 2007), it also reveals the limitation of the previous studies in terms of generalizability.

Last but not least, unlike any of the prior studies, the reversed causal effect of publication productivity on commercialization activities is also examined based

on the data collected. I find that higher publication productivity leads to higher patenting propensity. The regression with the overall publication productivity shows that higher publication rates also leads to higher patent profile. On the contrary, faculty members with higher publication productivity may be less likely to become entrepreneurs. To some extent these results support the “complementary” argument about patenting and publication, they also reveal the difference between the researchers in the highly research-intensive universities in North America and the ones in developing universities in Asia.

Limitations and Future Research

The findings of this study should be considered in light of several limitations. The study is limited by a sample of 122 patent inventors (including 27 spinoff founders). Although the sample has already covered the entire population of patent inventors and spinoff founders in NUS during the sampling period, the fact that both populations are small makes random sampling meaningless. Hence the explanatory power of some regression analyses (e.g. Table 1-3a) is affected. Besides, as the sample is from one single university in Singapore, the generalizability of its findings in other research institutes and countries (economies) is also limited. Future study should enlarge the sample size by including the faculty inventors whose inventions exist as technology disclosures with the university technology transfer office and expanding to more research institutions in Singapore or across multiple economies in the region.

Another limitation is due to the university policy concerning the confidentiality of the technology commercialization. As a result, only two major events in the university technology commercialization process -- patenting and firm founding – are examined, leaving out an important intermediate activity – licensing. Hence to fully explore the effect of technology commercialization on research in university, future study should try to include the analysis about licensing.

Furthermore, going beyond the empirical findings in the exploratory study, it is interesting to find out more about what makes some faculty members patent and what makes some faculty inventors choose to become entrepreneurs. For the latter question, besides the answers I can find in the existing literature, I conduct several interviews with faculty inventors and entrepreneurs. I find that in addition to the factors considered in this study (i.e. research productivity and quality, scientific disciplinary, and academic rank), individual psychological difference should make a powerful predictor of entrepreneurial propensity. Is there any difference in the personality, motivation, or cognition between faculty entrepreneurs and others? If so, how do these individual differences affect the decision making process of the faculty inventors? These are the issues that I will address in the second essay of this dissertation.

Practical Implications

I believe that the findings of this paper should be provocative for university policy makers and administrators in Newly Industrialized Economies

(NIE) in Asia. It suggests that the beneficial effects of involvement in patenting activities outweigh the resource diverting effect of such engagement on research productivity and hence should not be of major concern. Indeed, given that inventive outputs from universities may generate significant economic impacts when commercialized, this result suggests that faculty patenting should be encouraged more and facilitated better by not only university administrators, but also regional economic development policy makers.

However, at the same time, another finding of this study should raise the level of caution for the entrepreneurship promoting policies in the universities in the region. Contrary to the implications of the previous studies in North America, this study suggests that faculty members' involvement in entrepreneurial activities based on patent inventions may not be plausible, especially when the university is still trying to establish its research profile and the supportive ecosystem for academic entrepreneurship is incomplete.

Although the results are based on data in NUS and Singapore, some argue that the findings should be applicable to universities in other NIEs, as they share similar problems in university technology commercialization. Like NUS, the leading universities in these economies are also following the U.S. model in building up the research publication profile. Like Singapore, the market condition -- venture capital, human resource, and market for technology are significantly lagging behind those in the U.S. However, many differences in the environment are worth noticing too. For example, unlike Singapore, some NIEs may have large demand for frontier technologies in their local markets (e.g. China and India),

which makes business venturing easier for faculty inventors. On the other hand, unlike NUS, many universities in those countries (economies) may not have fully established their technology transfer office to facilitate patenting and business venturing. This would add to the burden of the faculty inventors and then may lead to a decrease in their publication productivity. Therefore, comparative studies among universities in different NIEs need to be conducted before the results of this study can be generalized.

CHAPTER THREE

ESSAY 2

Dare to take the plunge? A regulatory focus approach to academic entrepreneurial intentions

INTRODUCTION

In the exploratory study of the previous paper, I found that faculty patent inventors' publication productivity was negatively related to the likelihood of their becoming entrepreneurs. In addition, academic rank also has a positive effect on entrepreneurial decisions. These results provoked my further interest in identifying the factors that influence the entrepreneurial decision making process for academics. If a university faculty member realizes the market potential in his/her invention by filing an IP (intellectual property³), what would influence his/her decision on further commercializing the IP? This is a question that has received only limited research attention (Shane and Khurana, 2003; Audretsch and Stephan, 1999).

Drawing on theories of social influence, socialization, and status dynamics, Stuart and Ding (2006) studied how proximity to colleagues in commercial science influences an individual's entrepreneurial propensity. They found that scientists whose colleagues or coauthors have entrepreneurial experience are more

³ In the case of university technology commercialization, the IP can either be patent or technology disclosure.

likely to become entrepreneurs themselves, and that the acceptance level of commercial science in the scientific community has a positive impact on scientists' entrepreneurial propensity. From resource based view, Landry et al (2006) studied 1554 university researchers in Canada and found a set of complementary resources to be helpful to the launching of university spin-offs – when researchers have more of those resources they are more likely to start up ventures.

While these studies offer different insights from sociology and economics about the research question, my field work with faculty inventors and entrepreneurs and the entrepreneurship literature (Rauch & Frese, 2007; Zhao et al., 2010) suggests that personality and motivation play a role in researchers' entrepreneurial decision making process which is also important. In addition, these studies have not specified the internal mechanism of how the social norms and the availability of complementary assets influence people's entrepreneurial decision. Hence in this paper I draw on motivational and cognitive theories in psychology to examine the dynamics of entrepreneurial decision making process in the context of university technology commercialization. I propose a parsimonious intention model based on Regulatory Focus Theory (RFT) to explain the entrepreneurial intention of university faculty inventors, and empirically test the model on two faculty samples in National University of Singapore.

The paper is organized as follows: firstly the relevant entrepreneurship literature is reviewed; secondly, RFT and its implications in entrepreneurship

research are introduced, followed by the proposed model and hypotheses; thirdly, the methodology used for the empirical test and the results are presented; fifth and finally, discussion of the implication of this study concludes the study.

LITERATURE REVIEW

Entrepreneurship is defined as the process by which “opportunities to create future goods and services are discovered, evaluated, and exploited” (Shane & Venkataraman, 2000). One of the core questions in the entrepreneurship literature is why only some people become entrepreneurs (Baron, 2002) and there is a strong tradition of research focused on the role of individual differences and psychological factors in entrepreneurship field.

Personality researchers have identified various traits that might directly influence the goals and action strategies that lead to business creation (see review in Rauch & Frese, 2007). These traits include need for achievement (nAch), locus of control, self-efficacy, innovativeness/creativity, and independence/ autonomy, etc. In a similar line of research, scholars have also pointed to the link between motivation and entrepreneurial decision making (Shane et al., 2003). Among the motivation factors identified, drive and egoistic passion are distinctive from those identified in the studies about traits (Shane, et al., 2003; Locke & Baum, 2007). However there are various problems associated with these studies. The predictive power of personality traits has always been challenged by many scholars and the mechanisms by which personality variables have their effects on entrepreneurship—the specific influences at different stages of entrepreneurial

process—have not been fully specified (Peterson, 1981; Gartner, 1988; Aldrich, 1999). As for the studies about motivation factors, the empirical evidence is rare.

Cognitive psychologists have incorporated distinct thinking patterns and decision processes into a general process model of entrepreneurial action. For instance, Bird (1988) introduced an intention model in which social context and individual variables interact with rational and intuitive thinking to structure entrepreneurial intention and action. Building upon the theory of planned behavior (Ajzen, 1991), Krueger et al (2000a, b) proposed that the intention and the act of starting up a new firm are driven primarily by an entrepreneur's perception of the desirability and feasibility of an opportunity, and that these two appraisals are influenced by various exogenous factors, including social norm, self-efficacy, collective efficacy, and personal desirability. While this framework provides useful insights, it does not specify the possible interaction between personal and situational factors. Moreover, it neglects the progressive stages in entrepreneurial decision making process and this problem becomes unavoidable when the model is applied to the context of university faculty entrepreneurship. For example, faculty inventors may not have the intention to start businesses when they identify opportunities in their research. In other words, the intention model should have more relevance in the later stage of entrepreneurial decision making.

Scholars who focus on cognitive processes argued that entrepreneurial decisions are shaped by risk perceptions, and that risk perceptions and opportunity evaluations are affected by various heuristics such as overconfidence, belief in the

law of small number, and illusion of control (Keh et al., 2002; Simon et al., 2000). Along this line of research, based on the theory of uncertainty, McMullen & Shepherd (2006) proposed an integrated model to explain entrepreneurial action. They argued that people differ in their appraisals of uncertainty due to their differences in knowledge (perception of the uncertainty) and motivation (the willingness to bear uncertainty). Then they differentiate the effect of knowledge and motivation in two stages of the entrepreneurial decision making process – *attention stage* where opportunities are acknowledged and *evaluation stage* where acknowledged opportunities are evaluated. While this model addressed the problem of the earlier intention models (e.g. Krueger, 2000a, b) by differentiating the two stages of entrepreneurial decision making, it is not necessarily a better model. Compared with the intention models, the theoretical foundation of this two-stage model is not as solid. It does not offer good reasons for excluding the situational factors which should be as important as the subjective appraisal of uncertainty in the entrepreneurial decision making process. Moreover, the model does not specify any of the constructs or mechanisms of how these constructs relate to each other, which makes it difficult to formulate testable hypotheses. As a result, it remains a conceptual model with no empirical evidence.

To address the problems associated with the existing models and to address the unique context of university faculty entrepreneurship, I propose a parsimonious intention model to explain the variance in entrepreneurial decision making. This model follows the two-stage differentiation in McMullen and Shepherd's model (2006) but only focus on the later stage (evaluation stage).

Both personal factors and situational factors are incorporated in the model. Furthermore, all the constructs involved are specified, including the mechanisms of how they interact with each other. Therefore, the model generates testable hypotheses for empirical study. In the next section I introduce Regulatory Focus Theory (RFT) as the theoretical foundation of my framework, and explain why it is useful for explaining faculty inventors' entrepreneurial decision making.

REGULATORY FOCUS THEORY (RFT)

Regulatory focus theory is predicated on the assumption that the hedonic principle operates differently when serving fundamentally different basic *needs*, such as the needs of *nurturance* (e.g., nourishment) and *security* (e.g., protection) (Higgins, 1997). RFT further proposes that nurturance-related regulation and security-related regulation are distinct because they are aligned with different types of *goals* and distinct *modes of goal pursuit*. While the nurturance-related regulation anchors *aspiration and accomplishment* goals (promotion focus), the security-related regulation anchors *responsibilities and safety* goals (prevention focus) (Higgins, 1997). Promotion-focused people are inclined to *approach* their ideal self, while prevention focused people are inclined to *avoid* mistakes or mismatches (Higgins, et al., 1994). These differences in strategic inclination (means) further imply that promotion-focused people are *eager* to ensure hits and against errors of omission, generate more alternatives when situation allows, and persist longer and perform better in difficult situations; while prevention focus people are *vigilant* to insure safety and non-losses, work to insure correct rejections and insure against errors of commission, tend to generate more

repetitive answers, and quit faster in difficult situations (Crowe & Higgins, 1997). Finally, when people's strategic means of goal attainment is aligned with their chronic regulatory focus, some value independent of the outcome is generated, which is referred to as *regulatory fit* (Higgins, 2000). In the presence of regulatory fit, people feel right in their goal pursuit activity, they become more strongly engaged in whatever they are doing, and they develop more intense reactions to the goal enabling (or disabling) object (Lee & Higgins, 2009). In other words, people's *motivational strength* in terms of intensity and persistence is contingent on their regulatory focus (Forster et al., 1998) and the effect of motivation on *goal commitment* is moderated by regulatory focus (Shah & Higgins, 1997).

Increasingly, established entrepreneurship scholars are acknowledging that regulatory focus theory may shed new light in entrepreneurship research (Baron, 2002; Krueger, 2003; Mitchell, et al., 2007; Brockner, et al., 2004). This recent interest among entrepreneurship scholars in RFT theory stems, in part, from the fact that this framework taps into the approach and avoidance behavioral systems that are fundamental and innate (Elliot & Covington, 2001). The approach and avoidance systems have been studied in various psychological domains, such as motivation, personality, affect, and cognitive evaluation and their roots can even be found in neurophysiology or biopsychology (Grey, 1987; Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). Hence the reorientation of entrepreneurship research—shifting from exploration of select personality traits (motivation) to the very basic motivational orientations—highlights an

acknowledgement of the importance of identifying the fundamental building blocks in motivation systems. Understandably, in order to build a cumulative science of entrepreneurship, solid foundations such as these are essential.

This increased interest among entrepreneurship scholars in applications of regulatory focus theory may also be attributed to its demonstrated relevance in predicting and explaining behaviors in diverse disciplines, including sports (e.g. Plessner, et al., 2009), health (e.g. Eiser et al., 2004), consumer behavior (e.g. Wang & Lee, 2006), and friendship (Elliot, et al., 2006), etc. If regulatory focus theory works well in those contexts, why would the context of entrepreneurship be any different?

In his pioneering work to address the implications of regulatory focus theory for entrepreneurship scholarship, Baron (2002) argued that, relative to prevention-focused people, those who are promotion-focused are likely to search more broadly and more vigorously for opportunities, generate more hypotheses concerning potential opportunities, and tend to set lower standards for concluding that opportunities exist. McMullen and Shepherd (2002) put similar ideas to empirical test with a sample of 142 MBA students, and found that benefits of action are more strongly associated with entrepreneurial intentions for people in promotion situations than for people in prevention situations, and that costs of inaction are more strongly associated with entrepreneurial intentions for people in prevention situations than for people in promotion situations.

While theoretically these ideas are compelling, it is not easy to compare the different entrepreneurial intentions between promotion focused people and prevention focused people, because the two constructs are not opposite ends of a single continuum. Regulatory focus theorists contend that people vary in the extent to which they are promotion- and prevention-focused as a function of their genetic make-up and developmental experiences. In laboratory settings (e.g. McMullen & Shepherd, 2002), where promotion and prevention-focus are experimentally induced, these two orientations are generally placed in opposition—promotion and prevention-focused individuals are compared and contrasted. In everyday life, however, we understand that people are, in varying degrees, both promotion- and prevention-focused. Hence, low promotion focus need not imply high prevention focus. Thus, while McMullen and Shepherd (2002)'s findings are consistent with the arguments in Baron (2002) and Brockner et al (2004), further research is needed to establish their generalizability to real-life situations where regulatory focus is not experimentally primed -- the sort of settings where real potential entrepreneurs make decisions.

The application of RFT in my research builds upon the work of Brockner et al (2004), Baron (2002), and McMullen and Shepherd (2002). In contrast to the experimental approach adopted by McMullen and Shepherd (2002), I measure promotion- and prevention-focus strength within the context of two field studies. I propose that people who are more promotion-focused are more likely to draw positive conclusions about opportunities and consequently act on them (i.e. start new businesses). I also propose that the relationship between promotion focus and

entrepreneurial intention is mediated by “entrepreneurial cognition”. Finally, I propose that promotion focus moderates the relationship between “perceived environmental support” for entrepreneurship and entrepreneurial intention.

HYPOTHESES & PROPOSED MODEL

Entrepreneurship is the process by which opportunities are discovered, evaluated, and exploited (Shane & Venkataraman, 2000). To start a business, a person first needs to have a profitable idea. However a person does not become an entrepreneur just because he/she has discovered a profitable idea. The fact is after a serious process of evaluation and decision making there is a high chance that this idea may be aborted. Why do only some people with discoveries choose to start businesses? What are the factors influencing the opportunity evaluation and entrepreneurial decision making?

Based on McMullen and Shepherd (2006)’s two stage model and Krueger’s (2000) Entrepreneurial Intention model, I argue that it is the level of an inventor’s intention to start a business (*Entrepreneurial Intention (EI)*) that determines his or her decision made in the evaluation stage, and this intention is influenced by his or her motivation (regulatory focus), knowledge (*Entrepreneurial Cognition (EC)*), and the environmental support he/she perceives (*Entrepreneurial Environment (EE)*).

Insert Figure 2-1 here

Promotion Focus and Entrepreneurial Motivation

In Krueger (2000b)'s entrepreneurial intention model, "personal desirability" is one of the drivers of "perceived desirability", which then has direct effect on entrepreneurial intention. Personal desirability refers to a personal attitude which depends on perception of the intrinsic and extrinsic reward from performing the target behavior. In McMullen and Shepherd (2006) model, they also mentioned that the "motivation" in opportunity evaluation stage which leads to entrepreneurial action is the assessment of desirability – "whether its attainment will fulfill the motive for which it is being sought". Hence motivation or desirability assessment of entrepreneurial action is an important drive for entrepreneurial intention.

RFT suggests that promotion-focused people strive to satisfy their nurturance needs. They pursue the ideal self and their desired end state is aspiration and accomplishment (Higgins, 1997). As promotion focus increases, people have greater need for achievement and set higher goals in life. For university faculty inventors, starting a business based on their own inventions represents an ideal, as most inventors would like to see their inventions transforming into real product or service, which can create real value in the society. Moreover, participating in spinoff firm founding provides an opportunity to achieve success in industry besides academia. Hence the more promotion-focused a faculty inventor is, the more desirable it becomes to pursue a goal like this, and the higher his/her entrepreneurial intention would be.

RFT also suggests that people's motivation during goal pursuit will be stronger when there is *regulatory fit* – that is the value generated when the goal pursuit means aligns with the regulatory orientation (Forster et al, 1998; Shah & Higgins, 1997, Higgins, 2000; Lee & Higgins, 2009). As the way faculty inventors pursue the goal of technology commercialization can definitely sustain their promotion-focused orientation, the anticipated regulatory fit would also increase the inventors' entrepreneurial intentions. In other words, the more promotion-focused a faculty inventor is, the more active he/she is when involved in technology commercialization activities. As a result, the value of regulatory fit is generated, which then leads to greater motivation to start up his/her own business.

H₁: The more promotion-focused the inventor is, the higher his/her intention to start up a business would be.

Promotion Focus and Entrepreneurial Cognition

In McMullen and Shepherd (2006)'s model, they mentioned "knowledge" as another consideration which leads to entrepreneurial action in opportunity evaluation stage. The term "knowledge" refers to the assessment of feasibility – "whether it can be achieved in the manner envisioned". In Krueger (2000b)'s intention model, he pointed out that "perceived self-efficacy" is one of the antecedents of "perceived feasibility", which then has direct influence on entrepreneurial intention. He further explained that perceived self-efficacy refers to an individual's perception of his/her own ability to execute certain target

behavior. Therefore, it is important for an inventor to predict the difficulty in spinoff founding and evaluate his/her own ability in spinoff founding before the entrepreneurial decision is made.

Entrepreneurial cognition refers to the “knowledge structures people use to make assessments, judgments or decisions involving opportunity evaluation, venture creation and growth” (Mitchell et al., 2002). The mind-sets of entrepreneurs are distinguished by their extensive use of heuristics or cognitive shortcuts (Busenitz & Barney, 1997; Baron, 1998; Busenitz & Arthur, 2007; Hisrich, et al., 2007). Heuristics are “decision rules, cognitive mechanisms, and subjective opinions people use to assist in making decisions” and the “simplifying strategies that individuals use to make decisions in uncertain and complex conditions”. (Busenitz & Barney, 1997). These decision heuristics may lead to inaccurate prediction of the future (e.g. representativeness) and skewed evaluation of one’s own abilities (e.g. overconfidence, illusion of control).

RFT suggests that the strategic inclination of promotion-focused people during goal pursuit is to ensure that all possible opportunities are seized and none are missed (Crowe & Higgins, 1997). It also suggests that promotion-focused people are inclined to take risks in pursuing their goals (Friedman & Forster, 2001; Forster et al, 2001a,b). As there is usually very scarce information for opportunity evaluation in the pre-startup phase of entrepreneurship, and the timing is crucial in opportunity exploitation (especially in high-tech industries), it is very difficult to use conventional rationality to minimize decision making risks. I argue that when facing such highly uncertain and complex situation, faculty inventors who

are high in promotion focus are more likely to risk the accuracy of opportunity evaluation and use the decision heuristics as the basis of perceived feasibility.

Past research has already established a positive relationship between entrepreneurial cognition (e.g. overconfidence, illusion of control, representativeness, etc.) and entrepreneurial decision / opportunity evaluation (Simon et al, 2000; Keh et al, 2002). In other words, the more one uses decision heuristics in opportunity evaluation, the more likely he/she would choose to start new business. Therefore, it follows that entrepreneurial cognition (heuristics) at least partially mediates the relationship between inventors' promotion focus and entrepreneurial intention.

H₂: The effect of promotion focus on faculty inventors' entrepreneurial intention is mediated by entrepreneurial cognition (heuristics).

Situational Factors and Entrepreneurial Intention

People's behavioral intentions are shaped by both personal and situational factors (Bird, 1988; Krueger, 2003). Past research has shown that intentions models predict behavior better than either individual or situational variables (Krueger, 2000b). Hence unlike McMullen and Shepherd (2006)'s two-stage model which only focus on subjective appraisal of uncertainty, the current model takes situational factor back into consideration. Krueger (2000 and 2003) asserted that situational factor typically has indirect influence on entrepreneurial intention through influencing key attitudes – perceived desirability and perceived feasibility. He pointed out that “perceived social norms” is another component of perceived

desirability. Social norms usually reflect the influence of organizational culture. In other words, the impact of organizational culture on individual faculty inventor's entrepreneurial intention operates by its impact on perception of desirability (and feasibility) (Krueger, 2000b).

He also pointed out that "perceived collective efficacy" is another component of perceived feasibility. This means even though an inventor is perfectly capable of spinoff founding (high in perceived self-efficacy), he/she may need other fellow faculty members' support in this activity (Krueger, 2000b). Hence a perceived supportive community for entrepreneurship would lead to higher perceived desirability and feasibility and hence higher entrepreneurial intention. Furthermore, Krueger (2000b) mentioned that "perceived availability of resources" may be one "precipitating factors" that has direct influence on entrepreneurial intention. Hence if there are easily accessible resources in the environment, faculty inventors would have higher entrepreneurial intention.

In this model, I summarize these situational factors (i.e. organizational culture, supportive community, and accessible resources) into one construct. I argue that faculty inventors' appraisals of the extent to which the environment (department, faculty/school, university, and society) supports entrepreneurship have a positive impact on their entrepreneurial intention.

H_{3a}: Perceived environmental support is positively associated with entrepreneurial intention of faculty inventors.

According to RFT, the motivational effect of incentives is contingent on people's chronic regulatory focus (Shah, et al., 1998;). That is, the effect of incentives on motivational strength is greater when the incentives are matched with the actor's chronic regulatory focus. Promotion-focused people, in particular, are sensitive to the presence of rewards and opportunities for gains. Hence when the perceived environment is encouraging and supportive of entrepreneurship -- when the rewards/gains through entrepreneurship are apparent, people who are more promotion-focused will be more motivated to pursue such goals.

H_{3b}: Perceived environmental support moderates the effect of promotion focus of the faculty inventors on the entrepreneurial intention.

Considering the Role of Prevention-Focus in Entrepreneurial Intention

The framework I am proposing directly addresses the relationship of promotion-focus with entrepreneurial intention, and leaves the role of prevention-focus un-addressed. As Brockner et al (2003) have argued, promotion-focus is important because it provides motivational impetus for entrepreneurship. These scholars have argued further, however, that prevention-focus is likely to factor into eventual *entrepreneurial success* because of its implications for opportunity evaluation and 'due diligence'.

It is interesting to note that the individual differences that have been examined in past entrepreneurship research are primarily promotion-focused in nature. For instance, according to RFT, promotion-focused people focus attention on ideals, and their goals are anchored in a desire for accomplishment

(Higgins, 1997). Hence promotion-focused people have a strong need for achievement (nAch) and set high goals in life. In addition, when promotion-focused, people are more innovative (Liberian et al., 1999; Friedman & Forster, 2001), they generate more solutions to problems and they persist longer when responding to difficulties (Crowe & Higgins, 1997). If individuals with high self-efficacy tend to spend more effort for longer time, persist through difficulties, and set higher goal and strive for it (Bandura, 1997), people who are high in promotion focus should have high self-efficacy as well. Finally, RFT suggests that people with promotion focus are eager to insure “hits” and avoid “misses” in signal detection and this strategic eagerness inclines them toward quantity/speed rather than quality/accuracy (Crowe & Higgins, 1997; Forster et al., 2001a,b). This implies that people with high promotion focus also have higher risk propensity in decision making. In sum, the construct of promotion focus captures important aspects of the personality traits that have been studied in entrepreneurship literature, and hence it makes a parsimonious approach in capturing personality differences in entrepreneurship research.

Now it is surprising to find almost no individual differences that are prevention-focused in the entrepreneurship literature. RFT suggests that prevention focus people pursue the “ought” self and their desired end state is safety and responsibility (Higgins, 1997). In the context of entrepreneurial decision making, concerns for safety and responsibility can both suppress and sharpen an entrepreneurial idea, and sometimes the two forces can influence the decision making even at the same time. For example, think about a professor

who wants to earn some extra income to support his big family or create a backup career plan in case he doesn't manage to get tenure. On the one hand, the concern for his family and career makes him want to start up his own business outside of the university; on the other hand, his orientation towards fulfilling the obligations as a teacher and a researcher serve to stifle entrepreneurial initiative.

Therefore, although I do not include prevention-focus in my current intention model, it is definitely an area that merits attention in future research. As a practical consideration in this research, it seems important to include prevention-focus as a predictor in all empirical analyses because it represents a plausible rival construct—is it promotion-focus that provides impetus for entrepreneurship, or might prevention-focus stifle it? Furthermore, it is important to establish that the effects of promotion-focus are robust across different levels of prevention-focus—that is, would the effects of promotion-focus be as strong when prevention-focus is high as when prevention-focus is low?

In short, while I do not make direct predictions concerning the effects of prevention-focus on entrepreneurial intentions, I include prevention-focus as a predictor in all analyses. Furthermore, as a robustness check, I examine the possibility that prevention-focus level is a boundary condition on promotion-focus effects by putting the interaction of promotion- and prevention focus in the analyses.

Research Setting and Methodology Overview

As the focus of this study is on the opportunity evaluation stage of entrepreneurial decision making, it is important to ensure that the subjects in this study had already identified or recognized one or more entrepreneurial opportunities. In past studies, researchers have conducted experiments with primed subjects (primarily students) assigned to decision making tasks (Keh et al., 2002; Simon et al., 2000; McMullen & Shepherd, 2002). Given the artificiality of such settings, the generalizability of study findings across settings and subjects has been limited. For the present study, I found that university technology commercialization may be a good setting to test the proposed framework as it is relatively easy to identify those who have identified/recognized entrepreneurial opportunities – faculty members who have filed at least one patent application or technology disclosure. Therefore the faculty inventors at the National University of Singapore (NUS) were chosen as the sample of this study. The sample should be representative of university faculty inventors in Singapore because NUS is the largest university in the country, accounts for more than 90% of the U.S. patents filed by all Singaporean universities, and is the third largest patent holder in the country (Wong et al., 2007). Faculty members from all departments and faculties/schools within the university who had inventions filed with the technology transfer office (TTO) of NUS were included as potential study participants.

To understand the situation faced by the inventors and their concerns, I conducted ten personal interviews with patent inventors, some of whom were also

entrepreneurs. These interviews usually lasted for 1 hour and the questions asked were all open-ended. Based on these interview findings, a structural questionnaire was designed.

Subsequently, two questionnaire-based studies were conducted. In the first study, all the patent inventors were contacted and then interviewed by the researcher. The questionnaire was mostly filled in by the researcher, except for the questions about personality and cognition. In the second study, all faculty members who have made invention disclosures but had not patented their work were invited by email to participate in an online survey. Follow-up work was done by telephone calls and up to three email reminders.

STUDY 1

Method

Sample

The sample frame for this study consisted of all the faculty inventors of NUS whose invention(s) has been patented at the U.S Patent and Trademark Office (USPTO). A list of patent inventors was extracted from the USPTO and NUS patent databases. The list contained all staff members of NUS who had been involved in the invention of one or more patents granted by the USPTO and assigned to the focal university by the end of 2007. Staff members holding adjunct appointments, those holding a title with another organization, and those who had left NUS prior to time this study was conducted were removed. In total,

an effective sample of 122 patent inventors was identified and 82 interviews were conducted, yielding a response rate of 67.2% for the study.

Preliminary Interview

Prior to data collection, I conducted preliminary interviews with 10 faculty inventors. The purpose of the interviews was to understand the incentive system of the university that catalyzes or hinders entrepreneurial activities and to understand how faculty members view the incentive system. The interviews usually lasted for 1 hour and the questions asked were open-ended (e.g. “What are the expectations/incentive systems in your work area that are important to you”). The complete set of questions is attached in Appendix A. Based on the observations from the interviews, I developed the questions to measure “Entrepreneurial Environment” in the department/faculty/school, in the university, and in Singapore as a whole. The interview process also helped me to design some questions about the inventors’ plan to start businesses, including how they collect information about faculty entrepreneurship (Entrepreneurial Information Seeking) and how they take steps to prepare themselves to start businesses (Entrepreneurial Preparation).

Questionnaire Pretest

To select a good measure for *Overconfidence* from two prominent existing measures in the literature (Lichtenstein & Fischhoff, 1977; Russo & Schoemaker, 1989) and to test a combined measure of “Regulatory Focus” with items from both Higgins et al (2001) and Lockwood et al (2002), I developed a pretest

instrument, which included questions about overconfidence, illusion of control, representativeness, and regulatory focus (Appendix B1). The subjects of the pretest were 45 MBA students in a “Negotiation & Conflict Management” class. I told the class that the study was about decision-making and then asked the students to answer the questions and give some feedback on the questionnaire. In total, 34 of 45 MBA students took the survey in class. Pretest feedback showed that the *Overconfidence* questions adapted from Busenitz & Barney (1997) (Lichtenstein & Fischhoff, 1977) were more effective, and hence was chosen as the measure used in the formal questionnaire. Also, a short integrated measure of *Regulatory Focus* was also developed based on the feedback from the MBA students.

Data collection

First an email was sent to all the patent inventor subjects, informing them of the study, the nature of the participation desired, and emphasizing the confidentiality and the amount of time required for participation (Appendix B2). A follow-up call to each subject was then made, either by me or by my assistant, within 7 working days after the email, re-stating the request for participation and attempting to make an interview appointment. If the appointment could be successfully made, I had a 30-minute interview at the subject’s office, during which Questionnaire 1 (Appendix B3) was completed partly by me and partly by the subject (Section I & VI).

Measures

Where possible, measure items were drawn from existing published indices. For some measures (e.g., Regulatory Focus), a shortened set of items was included. New measures were developed where there were no established ones. Reliability test and factor analysis were used to examine the measures with multiple items in the study. *Entrepreneurial Intention (EI)*. Entrepreneurial intention has been measured in various ways in the literature. For example, Shapero (1982) and Krueger et al (2000) asked the subjects about the probability of starting their own business in the next 5 years. Other studies used a dichotomous measure of this variable by asking questions like “do you think you’ll ever start a business (yes or no)” (Krueger, 1993; Lee & Wong, 2004). However, the single item measure has been the limitation of those studies (Krueger, 2000). Other scholars used multiple items to measure entrepreneurial intention. For instance, Crant (1996) used a 7-point Likert scale format to measure this construct with three items. The questions he asked included, “I will probably own my own business one day” and “It is likely that I will personally own a small business in the relatively near future”. His result showed fairly high reliability ($\alpha=.93$) for this continuous measure. Zhao and Seibert (2005) used a four-item measure on 5-point Likert scale to measure students’ entrepreneurial intention. The four items depicted four prototypical entrepreneurial activities, namely, starting a business, acquiring a small business, starting and building a high-growth business, and acquiring and building a company into a high-growth business. This measure also showed high reliability ($\alpha=.88$).

Therefore it seems that the continuous measure of *Entrepreneurial Intention* with multiple items have better reliability and validity than the single item or dichotomous measure. Hence, for this study, I adapted and combined the measures in Keh et al (2002) and in Krueger (1993) as the measure for *Entrepreneurial Intention* in the questionnaire. Subjects were asked to rate 4 statements on a 5-point Likert Scale based on how much they agree with them ($\alpha=.68$).

Insert Table 2-2a here

Entrepreneurial Information Seeking (EIS) & Entrepreneurial Preparation (EP). As Krueger (1993) pointed out, since entrepreneurship is a complex process, the intention to participate in it and the planning of it usually co-evolve. Based on the results of the qualitative study, I developed several items to measure the planning actions taken by the inventors during the entrepreneurial decision making process. These questions helped me to capture the more objective behavioral indices of each inventor's entrepreneurial intention. According to the interview results, the inventors normally would collect some information about university technology commercialization and entrepreneurship, and they would prepare themselves in various ways in anticipation of entering the market. In total, there are 4 items for Entrepreneurial Information Seeking and 7 items for Entrepreneurial Preparation, and I asked the inventors whether they had done those things within the past 1-2 years. They were asked to choose yes/no answers to each question. However due to the format of the data and the limited

sample size in this study, the reliability for these two measures were uneven ($\alpha=.38$ and $.85$).

Insert Table 2-2b, c here

Regulatory Focus. Regulatory focus was measured with items from the two most frequently used Regulatory Focus measures (Higgins et al., 2000; Lockwood et al., 2002). In light of the pretest findings suggesting that the survey instrument might be too long, a subset of items from the two measures was selected—4 items from the RFQ (Higgins et al, 2000) focused on early developmental experiences, and 6 items from the RF measure in Lockwood et al (2002) focused on current attitudes and behaviors. Consistent with recently published findings (Summerville & Roese, 2008), we found that promotion-focused items from the two measures did not load on the same factor. Based on this result, I excluded RFQ items from the analysis, retaining only the subset of items from Lockwood, Jordan and Kunda’s 2002 measure. The combined measure yields reliability (Cronbach’s α) of $.64$ for promotion- and $.59$ for prevention-focus.

Insert Table 2-2d here

Entrepreneurial Cognition. Based on the definition of entrepreneurial cognition (Mitchell, et al., 2002) and the previous literature (Busenitz & Barney, 1997; Simon et al, 2000; Keh et al., 2002), I identified three heuristics for inclusion in this study—*Overconfidence, Illusion of Control, and Representativeness*. Overconfidence and Representativeness measures were

adapted from Busenitz and Barney (1997), and the measure of Illusion of Control was adapted from Keh et al (2002). The first two measures are calculated as indices, while the measure for Illusion of Control is a multi-item Likert scale ($\alpha = .64$).

Insert Table 2-2e here

Entrepreneurial Environment (EE). There is no established measure for *perceived environmental support* in the previous literature. Hence based on the preliminary interview results, I developed 23 questions about perceived environmental support for entrepreneurship at different levels – department/school, university, and country. Given sample size constraints, and the fact that no hypotheses were made about the unique effects of support from different sources, I computed an overall index of support from the entrepreneurial environment. Results of confirmatory factor analysis suggested that it would be necessary to exclude two negatively worded items. The items are listed in Table 2-2f below ($\alpha = .78$). I name this construct as Entrepreneurial Environment.

Insert Table 2-2f here

Control variables. Following Shane (2003a), I considered several control variables in the analyses, besides prevention focus. I used the year in which inventors received their Ph.D degrees (*Year of Ph.D*) to control for differences in levels of scholarly development and accomplishment. The faculty/school (*Faculty*) of each inventor was used as a proxy for scientific discipline. Finally, the

entrepreneurial experience of the inventors was controlled with a dummy variable (*Founder*).

Analysis

I adopted a two-step approach to data analysis (Anderson & Gerbing, 1988) using SPSS and AMOS programs. First, confirmatory factor analysis was used to evaluate the convergent and discriminant properties of study measures. As the number of items (up to 43) is too large for the sample size (82), I took steps to reduce the size-to-estimator ratio (Landis, et al., 2000). I created three “composites” for the construct which has more than 4 items (i.e. EE) following the procedures in Mathieu and Farr (1991). For those with fewer items (i.e. PROM, PREV, EI, and Illusion of Control), I used all the individual items as observed indicators of the latent constructs.

Second, to test the hypotheses, ordinary least squares (OLS) regression was used. As for the mediation effect, procedures in Baron and Kenny (1986) and Preacher and Hayes (2004) were used and Sobel test results were reported. In the regression analyses, control variables were entered in the model first, followed by other independent variables and the interaction term.

Results

Table 2-4 presents the descriptive statistics and the pairwise correlations of all the study variables. The relationships among the three dependent variables are positive and significant ($r=.25, .25, .39$), showing support for Krueger (1993)’s argument that intention and planning co-evolve for a complicated action

like entrepreneurship, which also makes it reasonable to use Entrepreneurial Information Seeking and Entrepreneurial Preparation as robustness check for the DV - Entrepreneurial Intention. Overall, the model yielded a chi-square of 138.73 on 109 degrees of freedom ($p=.03$) and other goodness-of-fit statistics (CFI=.89, RMSEA=.06), indicating that the factor structure moderately fitted the data. However the result of CFA might be affected by the sample size ($N=82$). The regression results are presented in Table 2-5a. As the analysis of the variance (ANOVA) test results showed, the DVs (EI, EIS, and EP) did not vary across different faculties/schools, *Faculty* was not included as a control variable.

Insert Table 2-4 here

I hypothesized that inventors' promotion focus would be positively related to their entrepreneurial intention (H_1), and that this relationship is mediated by use of heuristics (H_{2b}). In model 1 of Table 2-5a, the relationship between PROM and EI is significantly positive ($\beta=.22$, $p<.01$), and this relationship becomes insignificant in the presence of Illusion of Control (model 2, 3, and 4). Further investigation based on Baron and Kenny's requirements for mediation show that Illusion of Control is significantly associated with PROM ($\beta=.49$, $p<.01$; H_{2a} supported) and with EI ($\beta=.17$, $p<=.01$). Sobel test statistics (Preacher & Hayes, 2004) was 2.08 ($p<.05$), which suggests that Illusion of Control is a significant mediator (H_{2b} partially supported). Hence both H_1 and H_2 are supported.

Insert Table 2-5a here

I also predicted that a supportive environment should have a positive relationship with the inventors' entrepreneurial intention (H_{3a}) and that promotion focus moderates this relationship (H_{3b}). However, neither EE nor the EE by PROM interaction term was significant in the regression results. Furthermore, the regressions for robustness check (Table 2-5a Model 5-12) do not produce much significant support, which are not unexpected as the format of the data (1 or 0) yielded poor reliability. Lastly, the interaction between PROM and PREV is not significant in any of the regressions, indicating that the effect of PROM is not affected by the variance in PREV on any of the DVs.

Discussion

The findings of Study 1 showed that patent inventors who are highly promotion focused have stronger entrepreneurial intentions, and this relationship is partially mediated by illusion of control. This study was not without limitations. For example, the response format for entrepreneurial intention made it difficult for CFA and reliability test and the promotion/prevention focus measures are low in reliability. However, given the limited sample size, the results are satisfactory. Study 2 was conducted to provide a more robust test of the proposed model with a larger sample, and with improved measures.

STUDY 2

Method

Sample

A group of 150 faculty inventors who have technology disclosures with the university technology transfer office participated in this study. In the process of university technology commercialization, filing a technology disclosure is the first step. Afterwards, the inventors may directly license these disclosures or apply for more solid IP protection – patents. But filing the technology disclosure indicates that the inventor sees the commercial value of his/her invention. Study participants were chosen from all the faculty members across faculties and schools in the university associated with at least one invention disclosed to the Technology Transfer Office (TTO) of NUS by the end of 2007. The list of inventors was obtained from the TTO of NUS. After removing all patent inventors who participated in the previous study, 378 technology disclosure inventors remained, among which 150 responded to the online survey. Thus, the effective response rate for this study was 39.7%

Data collection

While Study 1 data was collected through personal interviews, Study 2 data was collected with an online survey (Appendix C1). I first sent an email to all the subjects in the technology disclosure inventor list, informing them of the study, the nature of the participation desired, and emphasizing the confidentiality and the amount of time required for participation (Appendix C2). A follow-up call was

then made by a research assistant to each subject within up to 7 working days after the email, re-stating the content of the email sent and appealing for the participation. Respondents were traced by their email addresses which they were asked to enter at the beginning of the survey. Up to three follow-up email reminders (Appendix C3, 4, 5) were also sent (over the course of three weeks) to those who had not yet participated in the study.

Changes in measures

Several changes in measures were introduced in order to ensure that measures were reliable. Firstly, the complete regulatory focus measure from Lockwood, Jordan and Kunda (2002) was included rather than a subset of items (Table 2-3). The change was proved effective as the Cronbach's alpha of Promotion focus improved to .87 and that of Prevention focus .80. Secondly, the response format of the questions for Entrepreneurial Information Seeking and Entrepreneurial Preparation was changed to correspond with the format for Entrepreneurial Intention (5-point Likert scale). In this way, the reliability of these two measures became .80 and .96 respectively. Thirdly, the instrument was shortened by excluding the two scenario questions for Representativeness. Fourthly and finally, additional control variables were included in this study. For example, the number of license agreements that the inventors had signed with the industry was included to control for the entrepreneurial experience of the inventors.

Insert Table 2-3 here

Analyses

As in Study 1, the two-step approach of data analysis was adopted using SPSS and AMOS programs. First, confirmatory factor analysis was used to evaluate the measurement model adequacy. Using the same method to decompose EE in Study 1, I created three “composites” for PROM, PREV, and EP separately, as all of them have more than 4 items. Second, to test the hypotheses, ordinary least squares (OLS) regression was used. As for the mediation effect, procedures in Baron and Kenny (1986) and Preacher and Hayes (2004) were used and Sobel test results were reported. In the regression analyses, control variables were entered in the model first, followed by other independent variables and interaction term.

Results

The means, standard deviations, and correlations for the measures are shown in Table 2-6. The overall CFA for the measurement model showed significant loadings for all measures. The model fit statistics (CFI=.93, RMSEA=.08) showed that the hypothesized factor structure fit the data well. After the change in the question format, EI, EIS, and EP became more highly correlated. As in Study 1, I conducted a one-way ANOVA on the DVs to see if they varied across different faculties/schools but the result showed no significant differences. Hence the dummy variables created for Faculty/School were not included in the subsequent analyses.

Insert Table 2-6 here

The regression analysis results are reported in Table 2-7a. As in Study 1, PROM and EI (entrepreneurial intention) are positively related ($\beta=.25$, $p<.01$), which means H_1 is supported. PREV is negatively related with EI, but the effect size is only marginal, and it becomes insignificant when other variables included in the regressions. Besides, Illusion of Control is significant in the regression results, indicating a partial mediating effect. Following Baron and Kenny's procedure, I regressed both heuristics variables (Illusion of Control and Overconfidence) on PROM and PREV and the results (Table 2-7b) show that promotion focus is a positive predictor of Illusion of Control (H_{2a}). Then I regressed EI on both Illusion of Control and PROM and PREV and the results show that Illusion of Control is significant in the regression model ($\beta=.17$, $p<.01$). Finally, Sobel test statistics (2.02, $p<.05$) show that that the mediating effect of Illusion of Control on the relationship between EI and PROM is significant. Hence H_1 , H_{2a} , and H_{2b} are all supported.

Insert Table 2-7a here

The third hypothesis was that a supportive environment would have a positive relationship with the inventors' entrepreneurial intention (H_{3a}) and that promotion focus moderates this relationship (H_{3b}). However, in model 3 (Table 2-7a), EE (entrepreneurial environment) is not related to EI (entrepreneurial intention), which shows that the direct effect may not be significant. To avoid the multicollinearity in testing the interaction, both EE and PROM were centered

(Cohen, et al., 2003). But the interaction of the centered variables (model 4) does not show any significance either. As in Study 1, the interaction between PROM and PREV is not significant in any of the regressions either, suggesting that prevention-focus level is not a boundary condition on promotion-focus effects.

The number of licenses that the inventors have had is a significant predictor of entrepreneurial intention. This result is consistent with the previous finding that the more entrepreneurial experience one has, the more likely one is to start another business (e.g. Shane, 2003). The year in which they got their Ph.D degrees is positively related to EI (Table 2-7a, Model 1-4). This shows that the junior faculty members are more interested in entrepreneurship than the senior ones. To confirm this finding, I replaced the variable Year of Ph.D in Model 1 with three academic rank dummies (Prof, Associate Prof, and Assistant Prof) and found that Assistant Prof is a significantly positive predictor of EI ($\beta=.46, p<.05$). This finding is different from that in Landry et al (2006), which showed no significant influence of the ranks and a significantly positive influence of the experience (measured by the number of years between the year of Ph.D and 2002 when their study was conducted) on the willingness to create a spinoff. The difference in the findings could be due to the effect of the more supportive environment of NUS for entrepreneurship among the younger generation.

The regression results for the other two DVs are presented in Table 2-7a (Model 5-12). For EIS (Model 5-8), the regression results seem to hold as PROM is significantly positive in model 5 ($\beta=.24, p<.01$), Illusion of Control is significantly anchored in PROM (Table 2-7b) and also significant in predicting

EIS (model 6-8), and the Sobel test statistics is 2.01 ($p < .05$) indicating the significant mediation of Illusion of Control. EE and the interaction of EE and PROM are still insignificant. For EP (model 8-12), the regression results are a bit different -- PROM is no longer significant and hence although Illusion of Control is significant it does not play the mediator role. The reason, I argue, could lie in the different nature of Entrepreneurial Preparation, as it includes actions which could have happened after the venture was founded in some cases. Nevertheless, the general findings in the robustness check show that both PROM and Illusion of Control are significant predictors of entrepreneurial behavior while EE and its interaction with PROM are not. However, due to the different nature of Entrepreneurial Planning (unlike EI, EIS and EP captured real actions rather than intention), the proposed framework for Entrepreneurial Intention may not be so applicable.

Discussion

Overall, Study 2 showed partial support for the hypothesized framework. The results indicate that technology disclosure inventors who are high in promotion focus tend to have high entrepreneurial intentions, and this relationship is at least partially mediated by Illusion of Control. In contrast with promotion focus, prevention focus is not a significant variable in main-effect and mediation models predicting entrepreneurial intention. Nor is it a significant moderator in the relationship between promotion focus and entrepreneurial intention. As in Study 1, the perceived environmental support (EE) is not a significant main-effect or moderating variable. This may be due to the fact that all the sample subjects are

from one single university. Hence although there are differences in the support levels across faculties (or schools), they are too subtle to be captured. It may also be due to the fact that the survey was conducted in the name of NUS Entrepreneurship Center and hence the sample inventors did not report their real appraisal for the environmental support. Nonetheless, it is also possible that the design of the construct is not specific enough to reveal the “perceived social norms”, “perceived collective efficacy”, and “perceived availability of resources”, etc., which can channel the influence of situation on entrepreneurial intention. Therefore, although there is no significant finding about the effect of this situational factor in this study, it does not necessarily mean that it has no impact on entrepreneurial intention.

GENERAL DISCUSSION

This study investigated why some university faculty inventors but not others intend to start up business based on their own inventions. Drawing from regulatory focus theory and entrepreneurship literature, I propose and test a parsimonious intention model to explain the variance in faculty inventors’ entrepreneurial decision making. As predicted by this model, I find that more promotion-focused inventors have stronger intention to start up venture businesses, and this relationship is explained, at least in part, by these inventors’ greater use of cognitive heuristics or “entrepreneurial cognition.” I now discuss the implications of the research findings.

First of all, this paper offers a fresh perspective on the foundations for entrepreneurial intention based on psychology theories. The findings substantiate my claim that entrepreneurial intention is anchored in promotion-focus and showcase the potential of regulatory focus theory in providing anchor for theory building in the area of entrepreneurial decision making. In practical terms, regulatory focus theory provides a lens for making sense of past research findings on various aspects of personality that have been associated with entrepreneurial intentions, including need for achievement, self efficacy, autonomy, risk-taking, etc. Clearly the regulatory focus approach has advantages insofar as it is parsimonious yet inclusive. Moreover, this study also provides theoretical and empirical evidences for the antecedent of entrepreneurial cognition. As most of the existing literature focuses on the consequences of decision heuristics in entrepreneurship, this study demonstrates that potential entrepreneurs' illusion of control is anchored in promotion focus.

Regulatory focus theory makes it clear that promotion- and prevention-focus are distinct dimensions rather than polar opposites, and my findings highlight the centrality of promotion-focus in particular. While I had not theorized about prevention-focus effects, I was careful to include prevention focus and control for its potential effects in all analyses. My findings show that it is promotion focus and not prevention focus that is explaining the variance in entrepreneurial intention, and these results are robust across levels of prevention focus.

Secondly, the proposed framework addressed several limitations of the previous studies. Unlike the intention models (e.g. Krueger, 2003), it distinguishes two different stages in entrepreneurial decision making -- opportunity recognition and opportunity evaluation -- and is clearly focused on the latter. As a result, this model is more suitable for explaining entrepreneurial intentions of faculty inventors in the university. In addition, it also specifies the interaction between situational and personal factors, which has been overlooked in Krueger's model. Compared to the two-stage model of McMullen and Shepherd (2006), this model takes into account the situational factor that can influence potential entrepreneur's decision and specifies the constructs of "motivation" and "knowledge" and the mechanism of how they relate to each other. This helps to make the model more complete and generate testable hypotheses.

Thirdly, different from the previous literature in which the environmental factor was considered on either university or firm level (Locket & Wright, 2005; Franklin, et al., 2001), I develop a construct that measures the available entrepreneurial support in the environment from individual inventor's perspective. Besides, to address the critique about the single-item measure for entrepreneurial intention (Krueger, 2000), I introduce a multi-item measure which incorporated the assessment of desirability and feasibility of the entrepreneurial opportunity and the willingness/motivation to commercialize it. Moreover, as Krueger (1993) argued that entrepreneurial planning is likely to co-evolve with the intention before the real action, I propose two objective measures -- entrepreneurial

information seeking and entrepreneurial preparation (EIS and EP) -- to capture such planning. The validity of entrepreneurial preparation and its consistent regression results with those of entrepreneurial intention show further support to the construct of entrepreneurial intention.

Fourth and finally, this research provides useful field data on entrepreneurial intentions. In contrast with much of the past research that has been focused on gleaning insights into entrepreneurial intentions and behavior from experimental research with undergraduate subjects, this research provides unique perspective on entrepreneurial intentions within the context of university technology commercialization.

Limitation(s) & Future Research

Several limitations of this research should be kept in mind so that they can be better addressed in future research. First, data were collected through single-source, self-report surveys. Considering the potential inflation of the relationships among variables, care was taken to minimize possible common method bias. For example, the personality questions were put in the last section of the questionnaire so as to reduce their impact on the answers of other questions. Objective measures of entrepreneurial intention were also used to support the subjective one. Still, longitudinal research design with multiple sourced surveys conducted at different stages would certainly improve the rigor of the study.

Second, the current study is cross-sectional. Rigorous study of the relationship between entrepreneurial attitudes, entrepreneurial intentions, and

entrepreneurial behaviors will require consideration of cause-effect relationships over time (Krueger, 2000). Longitudinal models and research designs should be considered in future studies so as to establish the temporal sequence of events, cognitions, and activities in entrepreneurial decision making.

Third, although the sample of the study is from one of the most representative universities in Singapore and South-east Asia, the fact that it is from a single institution and a small country may affect the generalizability of its findings. In addition, this exclusive focus on one university may be one reason why there is limited variability in the appraisals of environmental support (EE). Future research would certainly benefit from an enlarged sample which can cover multiple universities from different countries and economic regions.

Fourth, since the focus of the current study is on *entrepreneurial intention* rather than *entrepreneurial success*, the complex effects of prevention focus in entrepreneurship could not be explored fully. Nonetheless, I did include prevention focus in both empirical studies as a control variable and even examined its possible interaction with promotion focus. But almost no significant effect was found in the regressions. Brockner et al (2004) argued that it is important for entrepreneurs to take caution in “idea screening” and that successful entrepreneurial decision making also depends on prevention focus. Hence prevention focus and its impact on entrepreneurial success certainly merit more attention in future research.

Fifth, although this study specifies one possible mechanism of how promotion focus can influence entrepreneurial intention, there may be other mediators that can channel such an influence. For example, Baron (2008) proposed a framework on how affect can have impact on the cognitive processes of entrepreneurship, including judgments and decisions. Brockner and Higgins (2001) also pointed out the possible effect of regulatory focus on people's emotionality. Specifically, they asserted that "promotion-focused people's emotions vary along a cheerful-dejected dimension, whereas prevention-focused people's emotions vary along a quiescent-agitated dimension". Hence it would be interesting to investigate how people's regulatory focus influences their emotionality, which then influences their entrepreneurial opportunity evaluation and decision making.

Finally, although two additional objective measures of entrepreneurial intention (i.e. entrepreneurial information seeking and entrepreneurial planning) are used to support the intention construct, questions remain concerning the strength of the relationship between self-reported entrepreneurial intentions and entrepreneurial behavior. In a longitudinal study among IT professionals in Singapore, Lee et al. (2009) selected over 100 respondents 6 years after an initial entrepreneurial intention survey was conducted and asked them whether they had started up their own business. Positive correlation between entrepreneurial intention and the real business start-up was found in their results, which provides support to the validity of the entrepreneurial intention construct used in the

current study. Nonetheless, a follow-up study with the sample inventors in the current study would surely help to further validate the proposed intention model.

Practical Implications

The findings of this research bring into focus the importance of understanding the personality traits of faculty members for the university administration. If the goal is to increase technology commercialization activities among faculty members, it may be constructive to recruit faculty members with the right personality/motivation (e.g. highly promotion-focused) to begin with.

In addition, considering the role played by decision heuristics in the pre-startup phase, universities may make effort to frame entrepreneurial opportunities to the faculty inventors in favorable ways so as to help them make decisions. For example, universities can hold seminars and public forums, and they can invite the current successful faculty entrepreneurs to talk about their experiences. This may help the potential faculty entrepreneurs to have more favorable predictions about their own abilities and the future business, which subsequently would lead to higher intention in spinoff founding. Another suggestion is to recruit students to participate more in university technology commercialization, so that the major responsibility of running the business (e.g. marketing, finance, accounting, management, etc.) would be taken off from the professors. This should also help faculty members' predictions about their own abilities and their future conditions in getting involved in spin-off founding, which then leads to higher entrepreneurial intention.

Last but not least, the findings of this study show that the policies in NUS and in Singapore have become more positive for academic entrepreneurship and to a certain extent the supportive environment helps to boost inventors' intention to start businesses. Hence more measures should be taken to improve the environment for academic entrepreneurs. For example, from my fieldwork with faculty members in NUS, I find that there is huge space for the university to improve on its services in technology transfer consultation and IP management. Various suggestions have also been given by these faculty members during the interview, which implies that a better feedback system is necessary for the administrators to understand the needs of the potential faculty entrepreneurs and gather ideas about how to meet those needs.

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TABLES

Table 1-1a

Descriptive analysis (pooled sample) – by faculty

	Engineering (178)	Science (51)	Medicine (45)	Others (55)	Missing (7)
Journal paper (mean)	63.57	98.37	47.18	31.53	NA
Citation (mean)	297.82	753.63	348.42	191.55	NA
Patent (mean)	1.37	1.26	1.82	1.50	NA
Inventor	73	20	16	13	NA
Entrepreneur	35	7	10	19	NA

Table 1-1b

Descriptive analysis (pooled sample) – by academic rank

	Prof (54)	Associate Prof (160)	Assistant Prof (26)	Others (76)	Missing (20)
Journal paper (mean)	95.94	63.41	34.42	47.17	NA
Citation (mean)	646.07	341.80	155.15	279.30	NA
Patent (mean)	1.65	1.22	1.43	1.62	NA
Inventor	23	59	7	25	NA
Entrepreneur	12	34	7	13	NA

Table 1-2 ANOVA test for Inventor vs. Matching Group

Table 1-2a Tests of Between-Subjects Effects (Faculty)
(Dependent Variable: publication per year)

Source	F	Sig.	Partial Eta Squared
Corrected Model	2.35	.03	.08
Intercept	124.50	.00	.38
Patent	2.13	.15	.01
Faculty	2.91	.04	.04
Patent * Faculty	.38	.77	.01

R Squared = .075 (Adjusted R Squared = .043)

Table 1-2a-1 Descriptive statistics of Patent inventor vs Matching group subset
(Dependent Variable: publication per year)

		Mean	Std. Deviation	N
others	Non-inventor	2.71	2.77	10
	Inventor	2.69	2.97	13
	Total	2.70	2.82	23
engineering	Non-inventor	3.59	3.65	62
	Inventor	5.38	4.93	66
	Total	4.51	4.44	128
science	Non-inventor	4.61	3.86	17
	Inventor	6.08	4.71	17
	Total	5.35	4.30	34
medicine	Non-inventor	2.61	2.81	13
	Inventor	3.44	2.58	14
	Total	3.04	2.68	27
Total	Non-inventor	3.55	3.52	102
	Inventor	4.92	4.55	110
	Total	4.26	4.14	212

Table 1-2b Tests of Between-Subjects Effects (Rank)
(Dependent Variable: publication per year)

Source	F	Sig.	Partial Eta Squared
Corrected Model	2.66	.01	.09
Intercept	133.26	.00	.40
Patent	6.79	.01	.03
Rank	2.71	.05	.04
Patent * Rank	1.32	.27	.02

R Squared = .077 (Adjusted R Squared = .044)

Table 1-3a OLS Regression predicting publication productivity

Independent Variables	Model 1	Model 2	Model 3
1. Patent dummy		.29*	
2. Patent			.31*
3. Engineering	.50**	.45**	.47**
4. Science	.71**	.67**	.69**
5. Medicine	.38*	.35†	.37†
6. Professor	.36†	.34†	.32†
7. Associate Prof	-.08	-.09	-.10
8. Assistant Prof	.25	.27	.25
Constant	.44**	.37*	.34†
R Square	.07	.09	.01
R Square changed	.07	.02	.08
Model F	3.97**	4.33**	4.04**

Note:

1) † p<.1; * p<.05; ** p<.01

2) All the continuous variables were taken natural log to ensure the normal distribution.

Table 1-3b Paired Sample t-test for Inventors

	Before patenting	After patenting	T statistics
	(mean)	(mean)	
Publication per year	2.88	7.37	7.08**

Note: † p<.1; * p<.05; ** p<.01

Before (after) patenting refers to before (after) the year of 1st patent application.

Table 1-4. Descriptive statistics and Pearson correlation for Regressions

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1. Publication	81.71	86.71	-									
2. Engineering	.60	.49	.07**	-								
3. Science	.16	.37	.17	-.54	-							
4. Medicine	.13	.34	-.10	-.47	-.17	-						
5. Professor	.20	.40	.37	-.05	.14	.08	-					
6. Associate Prof	.52	.50	-.18	.17**	-.02	-.17	-.52**	-				
7. Assistant Prof	.06	.24	.00	-.02**	-.11	-.10	-.13	-.26**	-			
8. Patent (volume)	1.93	1.74	.25**	.12	-.01	-.04	.09	.08	-.08	-		
9. Founding	.22	.42	-.14	.07	-.08	-.03	.13	.08	.03	.24**	-	
10. Journal Citation	575.18	896.74	.88**	-.08	.26**	-.07	.35**	-.19	-.08	.22*	-.15	-

Note: N=122. All the continuous variables have been divided by the number of years from the first publication to 2005.

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 1-5a OLS Regression- predicting publication productivity (patent inventors only)

Independent Variables	Model 1	Model 2	Model 3
1. Patent		.28*	.38**
2. Founding			-.71**
3. Engineering	.88**	.80**	.75**
4. Science	.94**	.88*	.76*
5. Medicine	.52	.47	.41
6. Professor	.55*	.48†	.68*
7. Associate Prof	-.07	-.12	.03
8. Assistant Prof	.44	.43	.59
Constant	.30	.28	.33
R Square	.15	.18	.26
R Square changed	.15	.03	.08
Model F	3.47**	3.66**	5.11**

Note:

1) † p<.1; * p<.05; ** p<.01

2) All the continuous variables were taken natural log to ensure the normal distribution.

3) T tests (based on Model 3 results) for the rank dummy variables show that professor has more publications than associate professor (t=-3.02) and associate professor has more publications than assistant professor (t=1.29), but the difference is only significant at 0.1 level. T tests for the faculty dummy variables show that there is not much difference among the three faculties in terms of journal publication (t=.03, 1.18, and -1.39), only engineering faculty may publish more than medical faculty at significant level of 0.1 (t=-.1.39).

4) The critical value for one-tailed t-test c=1.66 (at significance level .05) and 1.29 (at significance level.

Table 1-5b Independent Sample t-test

	Inventor founder	Match group	T statistics
Publication per year	3.30	5.60	3.06**

Note: † p<.1; * p<.05; ** p<.01

Table 1-5c Paired Sample t-test for Inventor Founders

Publication per year	Before spinoff	After spinoff	T statistics
Inventor founder	2.16	6.10	2.40*
Inventor	3.15	6.74	9.13**
All	3.95	7.72	5.78**

Note: † p<.1; * p<.05; ** p<.01

Table 1-6a Binary logistic and OLS regression – predicting patenting

Independent Variables	Model 1	Model 2	Model 3	Model 4
1. Publication	.09*		.07	.13*
2. Engineering	.61	.28	.22	.16
3. Science	.18	.19	.11	.07
4. Medicine	.15	.18	.15	.12
5. Professor	.20	.27	.23	.20
6. Associate Prof	.04	.18	.18	.19
7. Assistant Prof	-.35	.03	.05	-.02
Constant	-1.28**	.05	.06	.01
R Square	.03	.05	.06	.08
R Square changed	.05	.05	.01	.03
Model F	7.32	1.01	1.00	1.49
	65.50%			

Note:

1) † p<.1; * p<.05; ** p<.01

2) In Model 1(binary logistic regression):

a. C&S R square: Cox and Snell R square

b. N.R square: Nagelkerke R square

c. H&L Chi-square: Hosmer and Lemeshow test

d. the percentage correctly predicted by the model

3) In Model 2-3 (OLS regression): all the continuous variables were taken natural log to ensure the normal distribution.

Table 1-6b Binary logistic regression - predicting firm founding

Independent Variables	Model 1	Model 2
1. Publication	-.48*	-.61**
2. Patent		.49†
3. Engineering	-.04	.03
4. Science	-.58	-.55
5. Medicine	.39	.18
6. Professor	4.02**	4.32**
7. Associate Prof	2.08†	1.83
8. Assistant Prof	-18.51	-18.44
Constant	-1.99	-2.82†
C&S R squared ^a	.19	.23
N.R squared ^b	.31	.36
H&L Chi-squared ^c	5.63	1.71
Percentage (%) ^d	82.50%	83.80%

Note:

a. C&S R square: Cox and Snell R square

b. N.R square: Nagelkerke R square

c. H&L Chi-square: Hosmer and Lemeshow test

d. the percentage correctly predicted by the model

1) † p<.1; * p<.05; ** p<.01

2) T tests for the rank dummy variables (based on Model 2 results) show that professor is more likely to have ventures than associate professor (t=2.40) but there is no significant difference between professor and assistant professor (t=-.00) or between associate professor and assistant professor (t=.00).

3) The critical value for one-tailed t-test c=1.66 (at significance level .05) and 1.29 (at significance level .1)

Table 2-1. Descriptive statistics of the demographic attributes of the participants in both studies

		Study 1	Study 2
Age	25-34	4.88%	19.67%
	35-44	20.73%	31.15%
	45-54	40.24%	27.87%
	55-60	24.39%	4.92%
	Above 60	9.76%	5.74%
	Mean	51.03	38.9
Gender	Male	91.50%	77.00%
	Female	8.50%	12.30%
Race	Chinese	81.71%	73.77%
	Indian	9.76%	9.84%
	Caucasian	4.88%	5.74%
	Other	3.66%	10.66%
Married		93.90%	77.87%
Faculty/School	Engineering	54.88%	36.07%
	Science	17.07%	19.67%
	Medicine	14.63%	21.31%
	Computer	8.54%	4.92%
	Others	4.88%	7.38%
Academic rank	Professor	32.93%	13.11%
	Associate Prof.	50.00%	29.51%
	Assistant Prof.	3.66%	14.75%
	Others	13.41%	31.97%

Note: the count of missing data is not included.

Table 2-2a. Entrepreneurial Intention Measurement

Questionnaire Items
1. I am willing to further develop my technology with representatives from industry if they approach me.
2. Commercializing my technology is worth pursuing.
3. It is feasible to commercialize my own technology given the situation.
4. I would like to start up my own business to commercialize my technology in the next two years.

Table 2-2b. Entrepreneurial Information Seeking Measurement

Questionnaire Items
1. I have taken courses/attended seminars about technology commercialization.
2. I have read books/publications on technology commercialization.
3. I have discussed with professionals and industry contacts about how to commercialize inventions.
4. I have consulted with other colleagues who have already commercialized innovations.

Table 2-2c. Entrepreneurial Preparation Measurement

Questionnaire Items
1. I have identified potential business partners (e.g. colleagues, students) to co-found a startup firm.
2. I have explored sources of startup capital.
3. I have explored places to locate business operations.
4. I have prepared a business plan.
5. I have explored the customer base to support business operations.
6. I have tried to serve some initial users (free or otherwise).
7. I have promoted my technology to potential business partners and/or customers in conferences or other social events.

Table 2-2d. Regulatory Focus Measurement (Study 1)

Questionnaire Items
1. Growing up, not being careful enough got me into trouble at times.
2. Growing up, I would often “cross the line” by doing things that my parents would not tolerate.
3. Growing up, I often did well at different things I tried.
4. I have found very few hobbies or activities in my life that capture my interest or motivate me to put effort into them.
5. In general, I am focused on achieving positive outcomes in my life.
6. I often imagine myself experiencing bad things that I fear might happen to me.
7. I often imagine myself experiencing good things that I hope will happen to me.
8. I often worry that I will fail to accomplish my goals.
9. I often think about how I will achieve success.
10. I am anxious that I will fall short of my responsibilities and obligations.

Table 2-2e. Illusion of Control Measurement

Questionnaire Items
1. I can accurately forecast the total demand for my product (or service, or invention).
2. I can accurately forecast when larger competitors will enter the market
3. I can make my business a success, even though others may fail.

Table 2-2f. Entrepreneurial Environment Measurement

Questionnaire Items	
Sec. I	<ol style="list-style-type: none"> 1. Within my department/school/faculty, starting a business is something good to do. 2. Within my department/school/faculty, resources/expertise are available to support faculty members who start businesses. 3. Within my department/school/faculty, those who start businesses should expect to receive criticism and scrutiny from others. 4. Within the last 5 years, support within my department/school/faculty has increased for academic entrepreneurship.
Sec. II	<ol style="list-style-type: none"> 1. The university administration makes it clear to faculty members that starting a business is something good to do. 2. The university administration makes it clear to faculty members that starting a business is not encouraged. 3. Within the last 5 years, support from the university administration has increased for academic entrepreneurship. 4. ILO (Industry Liaison Office, previously called INTRO) makes it easy for faculty members to license their technologies (inventions). 5. ILO has been making effort to showcase the technologies developed by faculty members. 6. There are resources/expertise in ILO to support faculty members who want to license their technologies (inventions). 7. ILO tends to give exclusive license or other favorable terms to faculty inventors who want to start up spinoff firms. 8. I am aware of the university technology commercialization process. 9. Within the last 5 years, support from the ILO has increased for academic entrepreneurship. 10. I am aware of what NEC (NUS Entrepreneurship Center) can do to help if I want to start up a spinoff firm. 11. I have heard about or attended workshops, forums, or seminars organized by NEC before. 12. There are resources/expertise in NEC to support faculty members who want to start up spinoff firms. 13. Within the last 5 years, support from NEC has increased for academic entrepreneurship.
Sec. III	<ol style="list-style-type: none"> 1. There is financial support from the government for faculty members who want to start up spinoff firms. 2. Within the last 5 years, support from the government has increased for academic entrepreneurship. 3. There are active venture capital firms searching for startup investment opportunities. 4. There are local customers who are willing to try out products/services of university spinoff firms. 5. University spinoffs from NUS have promising prospect in the regional markets. 6. Within the last 5 years, the entrepreneurial environment in Singapore has become more active.

Table 2-3. Regulatory Focus Measurement Factor Analysis (Study 2)

Questionnaire Items
1. I often worry that I will fail to accomplish my goals.
2. I see myself as someone who is primarily striving to become the self I "ought" to be – to fulfill my duties, responsibilities, and obligations.
3. I am anxious that I will fall short of my responsibilities and obligations.
4. I often think about the person I am afraid I might become in the future.
5. I often imagine myself experiencing good things that I hope will happen to me.
6. My major goal in life right now is to avoid becoming a failure in my career.
7. I frequently imagine how I will achieve my hopes and aspirations.
8. I typically focus on the success I hope to achieve in the future.
9. In general, I am focused on achieving positive outcomes in my life.
10. I often think about how I will achieve success.
11. I often imagine myself experiencing bad things that I fear might happen to me.
12. I frequently think about how I can prevent failures in my life.
13. I often think about the person I would ideally like to be in the future.
14. In general, I am focused on preventing negative events in my life.
15. I see myself as someone who is primarily striving to reach my "ideal self" - to fulfill my hopes, wishes, and aspirations.
16. My major goal in life right now is to achieve my career ambitions.

Table 2-4. Correlation & Descriptive Statistics: Study 1 (N=82)

	1	2	3	4	5	6	7	8	9	10	11
1. Intention (EI)	-										
2. Information seeking (EIS)	.25	-									
3. Preparation (EP)	.35	.39	-								
4. PROM	.31	.19	.17	-							
5. PREV	-.18	-.13	-.11	-.15	-						
6. Overconfidence	.08	-.08	-.03	.12	-.09	-					
7. Illusion of control	.35	.18	.16	.36	.00	.09	-				
8. Representativeness	.03	-.10	.08	.10	.05	.15	.01	-			
9. Entp. Environment (EE)	.12	.06	-.01	.13	-.03	-.02	.02	.05	-		
10. Founder	.20	.09	.64	.17	-.17	-.08	.12	.13	-.08	-	
11. Year of Ph.d	-.01	-.10	-.19	-.08	.21	.11	.03	.21	.14	-.10	-
Mean	3.84	.57	.55	5.22	2.93	.48	3.93	1.09	3.16	.45	1987
S.D	.69	.27	.36	.86	1.11	.19	1.13	.93	.44	.50	8.50

Note: Correlations greater than .23 are significant at .05 level; correlations greater than .27 are significant at .01 level.

Table 2-5 Regression results: Study 1 (N=82)

Table 2-5a. Predicting Entrepreneurial Intention, Entrepreneurial Information Seeking , and Entrepreneurial Preparation

Dependent Variables Model	Entrepreneurial Intention					Entrepreneurial Information seeking					Entrepreneurial Preparation				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. PROM	.22*	.14	.12	.12	.13	.05	.04	.04	.04	.04	.03	.01	.01	.01	.01
2. PREV	-.08	-.09	-.08	-.08	-.08	-.02	-.02	-.02	-.03	-.02	.01	.01	.01	.00	.01
3. Overconfidence		.13	.16	.16	.17		-.13	-.13	-.12	-.13		.05	.05	.06	.06
4. Illusion of Control		.17*	.17*	.17*	.17*		.03	.03	.03	.03		.03	.03	.03	.03
5. Representativeness		-.01	-.01	-.01	-.01		-.03	-.03	-.03	-.03		.01	.01	.01	.01
6. Entp. Environment (EE)			.17	.17	.17			.03	.03	.03			.05	.04	.05
7. PROM*EE				.03					-.07					-.09	
8. PROM*PREV					.01					-.01					.00
9. Founder	.19	.17	.18	.18	.18	.03	.02	.03	.03	.02	.45**	.44**	.45**	.45**	.45**
10. Year of Ph.D	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-.01	-.01	-.01	-.01	-.01
Constant	-5.02	-2.54	-3.36	-3.35	-6.3	4.7	3.18	3.56	3.54	3.71	11.09	12.21	12.8	12.78	12.72
R ²	.13	.20	.21	.21	.21	.05	.09	.09	.10	.09	.42	.43	.43	.45	.44
R ² Change	.13	.07	.01	.00	.00	.05	.03	.00	.01	.00	.42	.01	.00	.01	.00
Mode F	2.96*	2.65*	2.43*	2.14*	2.14*	1.06	.99	.88	.88	.77	14.20**	8.04**	7.02**	6.43**	6.16**

Note: In Model 4, 8, and 12, all the variables involved in interaction terms are centered.

** p<=.01 (2-tailed).

* p<=.05 (2-tailed).

† p<=.1 (2-tailed).

Table 2-5b. Predicting Mediators

DV		Overconfidence	Illusion of Control	Representativeness
Model		1	2	3
1.	PROM	.02	.49**	.12
2.	PREV	-.01	.06	.06
Constant		.39*	1.22	.30
R ²		.02	.13	.01
Model F		.80	5.95**	.57

** p<=.01 (2-tailed).

* p<=.05 (2-tailed).

† p<=.1 (2-tailed).

Table 2-5c. Sobel test results

Dependent Variables	Illusion of Control
Model	Entp. Intention
Sobel Test Statistics	2.08
P (2-tailed)	.04

Table 2-6. Correlation & Descriptive Statistics: Study 2 (N=122)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Intention (EI)	-												
2. Information seeking (EIS)	.45	-											
3. Preparation (EP)	.51	.75	-										
4. PROM	.37	.16	.22	-									
5. PREV	.13	.06	.15	.46	-								
6. Over-confidence	-.01	-.11	-.21	-.12	-.12	-							
7. Illusion of control	.50	.46	.49	.22	.08	-.08	-						
8. Entp. Environment (EE)	.41	.29	.23	.26	.27	.01	.31	-					
9. Tech. Disclosure	.20	.20	.29	.23	.05	-.11	.14	-.02	-				
10. Patent	.14	.16	.24	.07	-.08	-.12	.21	-.09	.39	-			
11. License	.19	.22	.26	.20	.05	-.01	.15	-.13	.32	.26	-		
12. Founder	.02	.40	.39	-.03	.00	-.07	.07	-.07	.24	.10	.20	-	
13. Year of Ph.d	.25	.17	.16	.08	.14	-.15	.23	.28	-.24	-.22	-.35	-.04	-
Mean	3.83	2.92	2.87	5.11	3.65	.36	3.93	3.28	1.80	.91	.33	.16	1994
S.D	.63	.86	1.13	.91	.97	.19	1.29	.61	1.86	1.77	.86	.37	1.31

Note: Correlations greater than .23 are significant at .05 level; correlations greater than .27 are significant at .01 level.

Table 2-7 Regression results: Study 2 (N=122)

Table 2-7a. Predicting Entrepreneurial Intention, Entrepreneurial Information Seeking , and Entrepreneurial Preparation

Dependent Variables Model		Entrepreneurial Intention					Entrepreneurial Information seeking					Entrepreneurial Preparation				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	PROM	.25**	.22**	.20**	.21**	.20**	.24**	.17*	.17†	.17†	.21*	.18	.09	.1	.1	.13
2.	PREV	-.11†	-.08	-.08	-.08	-.08	-.08	-.05	-.05	-.05	-.05	.03	.07	.07	.07	.07
3.	Overconfidence		.15	.13	.14	.14		-.28	-.29	-.31	-.41		-.77	-.75	-.77	-.81
4.	Illusion of Control		.14**	.13**	.13**	.13**		.24**	.24**	.24**	.24**		.32**	.32**	.33**	.32**
5.	Entp. Environment (EE)			.07	.07	.07			.05	.05	.02			-.07	-.08	-.09
6.	PROM*EE				-.02					.05					.08	
7.	PROM*PREV					.00					.12†					.06
8.	License	.22**	.19*	.20*	.20*	.20*	.1	.05	.05	.05	.03	.29*	.21†	.21†	.21	.20
9.	Founder	-.08	-.08	-.08	-.08	-.08	.86**	.86**	.86**	.86**	.87**	1.06**	1.06**	1.06**	1.06**	1.07**
10.	Year of Ph.D	.02**	.01*	.01*	.01*	.01*	.02†	.01	.00	.00	.00	.02*	.01	.01	.01	.01
Constant		36.36**	27.08*	25.67†	26.25†	-25.90	28.85†	-9.69	-8.61	-7.45	-3.08	45.11*	-18.17	-19.7	-17.57	-16.79
R ²		.21	.27	.27	.27	.27	.23	.33	.33	.33	.35	.23	.34	.34	.34	.35
R ² Change		.21	.06	.00	.00	.00	.23	.10	.00	.00	.02	.23	.11	.00	.00	.00
Mode F		6.20**	5.93**	5.22**	4.60**	4.60**	6.84**	7.93**	6.91**	6.11**	6.72**	6.99**	8.39**	7.32**	6.50**	6.56**

Note: In Model 4, 8, and 12, all the variables involved in interaction terms are centered.

** p<=.01 (2-tailed).

* p<=.05 (2-tailed).

† p<=.1 (2-tailed).

Table 2-7b. Predicting Mediators (N=122)

DV		Overconfidence	Illusion of Control
Model		1	2
1.	PROM	.00	.31*
2.	PREV	-.03	-.124
Constant		.46**	2.82**
R ²		.02	.05
Model F		1.40	3.00*

** p<=.01 (2-tailed).

* p<=.05 (2-tailed).

† p<=.1 (2-tailed).

Table 2-7c. Sobel test results:

Dependent Variables	Illusion of Control	
	Entp. Intention	Entp. Information Seeking
Sobel Test Statistics	2.02	2.11
P (2-tailed)	.04	.04

FIGURES

Figure 1-1a Descriptive Statistics (pooled sample) – by faculty

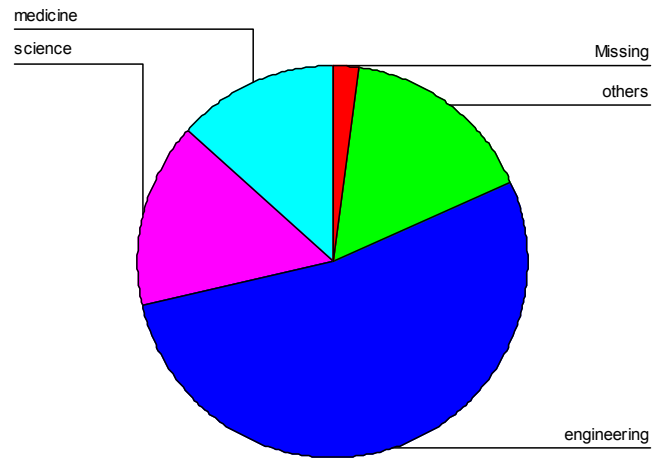


Figure 1-1b Descriptive Statistics (pooled sample) – by academic rank

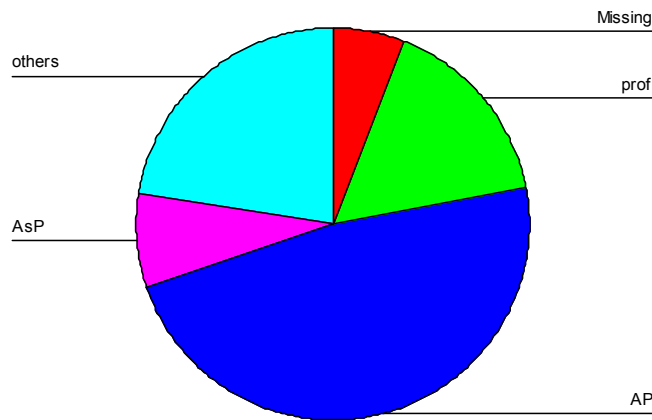
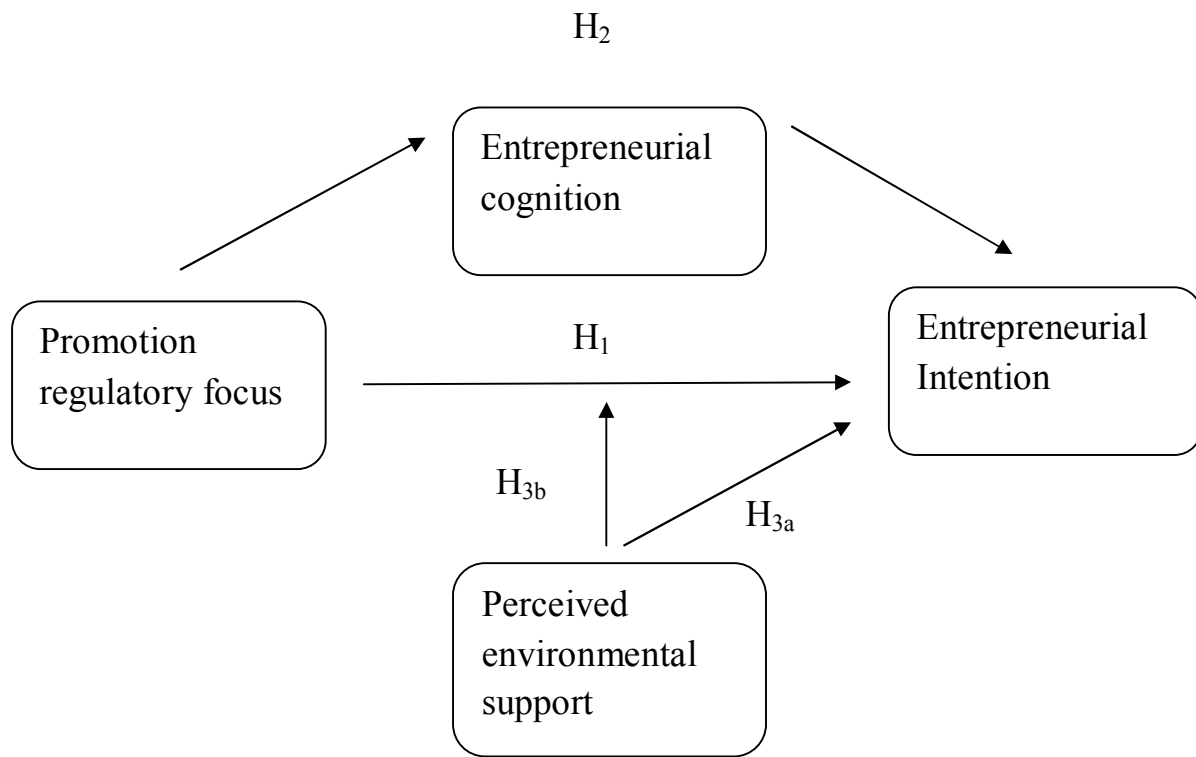


Figure 2-1. Proposed integrated model of entrepreneurial intention



APPENDICES

Appendix A1 Interview Guide 1

First Round Conversation with Faculty Inventors/Entrepreneurs Structured Interview Guide

Ruan Yi

Feb 2, 2007

Introduction

My name is Ruan Yi. I am a 4th year Ph.D student in Business School. My thesis is to understand in what situation faculty inventors start up venture firms to commercialize their own inventions, how they balance between research and entrepreneurial activities, and how their venture firms perform.

Section I: open question (1)

1. At the time you decided to start up a firm, what was the biggest force that helped the decision?
2. At that time, what did you think was the most important to the venture firm's success?
3. What kind of resources did you have at that time?
4. What was the legal regulation or university culture like about faculty entrepreneurship at that time?
5. What was the industry like at that time?
6. What kind of personality or character do you think is essential for an entrepreneur?

Section II: Entrepreneur

1. Have you ever founded a firm before? If you did, how much do you think that experience help in making the decision of starting the current one and in the process of running the current one?
2. Did you write a business plan before starting up the firm? How do you think the business plan help?
3. How much effort did you predict you need to put in the venture before you started it, and how much are you putting? Do you find the entrepreneurial involvement distracting you from academic research?
4. What do you think in your own characteristics or personality is the origin of your entrepreneurial spirit? Does your family have such tradition?

Section III: Resources

1. What do you think of your patent or invention? What made you believe that there is great market potential of this invention?
2. Did you know anybody working in technology transfer office in NUS before you started up your firm? Have they helped in promoting and licensing your technology to established firms or other entrepreneurial firms? If you had found you buyers of your technology, have you thought of getting involved in developing the technology with other firms?

3. do you think the personal relationship with decision makers of the big company will help?
4. Did you know anybody working in or related with venture capital firms?

Section IV: Environment

1. Do you find Singapore an active entrepreneurial environment, in terms of government regulation, industry, and financial market condition?
2. What do you think of NUS policy about faculty entrepreneurship?
3. What is the competition like in the industry and in the technology field?

Section V: open question (2)

1. What do you think is the most important factor to venture success?
2. Which goal do you want to achieve at the present stage of your venture: spin off from the incubator, first sale/revenue, or IPO?
3. How do you understand entrepreneurial success? What do you think is a success of your entrepreneurial effort?
4. As the inventor and founder, what do you care about most, successful commercialization of the tech, successful IPO of the company, or profit? Did your goal of starting up the venture change over time?
5. As one of the very few faculty entrepreneurs in NUS, what makes you different among the other faculty members in your department/faculty? (e.g. more confident, always feel a pressure to start up firm, more passionate, more risk-seeking,)

The interview will last less than an hour, which will be voice recorded for research purposes. The information you provide will be used for research purposes only. Remember that your responses will be completely confidential. Your answers will be aggregated and used to design further survey questionnaire in the near future.

Appendix A2 Interview Guide 2

Second Round Conversation with Faculty Members Structured Interview Guide

Ruan Yi

Mar 3, 2008

Introduction

My name is Ruan Yi. I am a 5th year Ph.D student in Business School.
My thesis is to understand in what situations faculty members apply for patents and in what situations faculty inventors license their technology or start up venture firms, and how they make such decisions.

Questions

1. Perceived situation

How innovative do you find your department to be? How about your faculty/school, and even the whole university?

How do you sense the department head's opinion on entrepreneurship activities? How about your colleagues'? How about the dean of the faculty/school?

How do you interpret the relevant NUS policy about faculty patenting/licensing/venturing issues?

Do you feel the encouragement and support by the Singapore government on innovation & entrepreneurship? Have you seen any advertisement/email/newsletter/flyer about such opportunity? If so, how often do you see them?

2. Social capital

Who do you usually work with? A) people from the same department/lab/faculty/school/university; or B) people from other research institutes/university; or C) people from the industry/government

Have you been associated/affiliated with other A) university/research institute; B) company/organization? If so, when was that?

Have any of your family members or friends been involved in entrepreneurship or venture capital industry?

3. Reasons for why or why not patent-inventing / venture-founding

open question

4. Intentions for venturing

Are you interested in reading books/ attending workshop or seminar or conference/ taking a course about university technology commercialization in the next 2 years? If not, have you done so in the past 2 years?

Do you have any business plan about setting up venture firms in the next 2 years?
If not, have you already written any business plan in the past 2 years?

In the next 2 years, are you willing to start up your own firm to commercialize your technology?

Are you familiar with the university technology commercialization process? If not, would you like to learn about it in the next 2 years?

Do you pay attention to the possible opportunity of commercializing your invention/patent/technology?

5. Licensing option

Do you consider licensing your technology to incumbent firms? Have you ever licensed any of your technology to any firms?

How many existing companies are interested in your patented technology?

If you have licensed one of your technologies, how often do you meet with the licensee? How active you are engaged in further developing that technology? Do you sit on their advisory board or work part-time with their company?

The interview will last less than an hour, which will be voice recorded for research purposes. The information you provide will be used for research purposes only. Remember that your responses will be completely confidential. Your answers will be aggregated and used to design further survey questionnaire in the near future.

Section II. The way I see things...

Part A. All about Singapore

The questions in this section address your knowledge of facts about Singapore.

Your task is to provide a “low” and “high” estimate so that you are 90% certain that the correct answer falls within the range of your estimates.

Provide what you think is your best estimate. If you have absolutely no idea where the answer lies, please fill in the maximum range possible for the question (e.g. 0 to 1,000).

Please do **NOT** use Internet or any other resources to check the correct answer!

	Lower Limit	Upper Limit
1. The birth rate in 2007 (per 1,000 populations)?	___ per 1,000	___ per 1,000
2. Percentage (%) of population aged 15 years & over who were literate in 2007?	___ %	___ %
3. People per doctor 2007?	___ per doctor	___ per doctor
4. Percentage (%) of the households that have personal computers?	___ %	___ %
5. The number of visitor arrivals (million) in 2007?	___ million	___ million
6. The unemployment rate (%) in 2007?	___ %	___ %
7. The number of aircraft landings (thousand) in 2007?	___ thousand	___ thousand
8. The number of crime cases per 100,000 populations in 2007?	___ per 100,000	___ per 100,000
9. The amount of official foreign reserves (S\$ in billion) in 2007?	___ billion	___ billion
10. The number of polytechnic graduates (thousand) in 2007?	___ thousand	___ thousand

Part B. Cities around the world

Compare the pairs of cities given below. For each pair, circle the one with the larger population (in 2007), and then indicate how confident you are that your choice is correct on a scale of 50% to 100% (e.g. 50% indicates that your answer is a total guess, 70% indicates that you think you have seven chances out of ten of being right, and 100% indicates that you are totally confident that your answer is right.)

Please do NOT use Internet or any other resources to check the correct answer!

			Confidence Level (50% to 100%)
1.	A) Cairo	B) Los Angeles	
2.	A) Shanghai	B) Moscow	
3.	A) Chennai	B) Bangkok	
4.	A) Toronto	B) Milan	
5.	A) Mexico City	B) Paris	

Part C. Your estimation

Suppose you are about to commercialize a product (your own idea/invention). With this in mind, please answer the following questions by indicating how much you agree with each statement. Using the scale below, please write the appropriate number in the blank beside each item.

1	2	3	4	5	6	7
Not at all			Somewhat true of me			Very true of me

1. ___ I can accurately forecast the total demand for my product (or service, or invention).
2. ___ I can accurately forecast when larger competitors will enter the market
3. ___ I can make my business a success, even though others may fail.

Part D. Two decisions to make

Problem 1: Equipment Purchase Decision

Mr. Tan is about to invest in a new machine and has narrowed his options to Machine A, which is made in Japan or Machine B, which is made in China. Both machines are equally capable of performing the same function. In considering this decision, Mr. Tan said to his friend, “You know, it seems that every time I buy a piece of equipment made by a Chinese manufacturer, it breaks down in the first month of use.”

After further discussion, Mr. Tan’s friend remembers a recent industrial report that gives a significantly higher ranking to Machine B (the made-in-China one) than to Machine A. This report bases its recommendation on extensive testing as well as on feedback from dozens of users.

If you were in Mr. Tan’s position, which machine would you purchase? Why?

Decision _____

Reason 1 _____

Reason 2 _____

Reason 3 _____

Problem 2: Automation Update Decision

The president is urging the board of directors to accept the purchase of a state-of-the-art computerized machine that would fundamentally change their operations. After describing the capability of this machine, the president cites a recent nationwide study which examined 120 businesses making similar upgrades. Results indicated that at least 85% showed a sizable increase in productivity. In a parallel control group of firms not making the upgrade, about half as many firms (40%) showed a sizable increase in productivity. Based on this study, the president concludes that the computerized machine needs to be purchased.

One of the directors now takes the floor giving two reasons why computerized equipment is not the real reason for increased productivity. First, the managers of businesses that make such changes are likely to be more energetic and adventurous, thus creating an environment for superior performance. Second, any change is likely to lead to superior performance because of the increased interest and commitment on the part of management.

If you were participating in such a decision, whose line of reasoning (president or director) would you be more likely to accept? Why?

Decision _____

Reason 1 _____

Reason 2 _____

Reason 3 _____

Appendix B2 Email advertisement for Study 1



Dear Prof. _____:

The NUS Entrepreneurship Center (NEC) is conducting a study on NUS faculty members' opinions about technology commercialization and the factors that shape these opinions. The involvement of inventors is crucial to any technology commercialization effort by NUS. We understand that you have one or more inventions (either disclosed or patented), and as such would like to conduct a short interview with you to understand your views on this topic so as to improve our work in promoting the environment for Technology Commercialization in NUS.

A Ph.D student of mine, Ms. Ruan Yi, will contact you shortly to make an appointment to meet with you. She is conducting this research, under my supervision, as part of her Doctoral Dissertation work and I am most grateful for any assistance you can provide to her. In particular, we know that your time is extremely valuable and hence have designed the interview to be completed well **within 30 minutes**. Also, please be assured that your responses will be kept **completely confidential** and used only for statistical analysis in this research project.

Thank you in advance for your kind assistance.

Best regards,

WONG Poh Kam (Prof) :: Director, NUS Entrepreneurship Centre and Professor, NUS Business School & LKY School of Public Policy :: National University of Singapore :: E3A 6th floor, 10 Kent Ridge Crescent, Singapore 119260 :: 65-6516 6323(DID) :: 65-6773 2269 (Fax) :: pohkam@nus.edu.sg <mailto:pohkam@nus.edu.sg> (E) :: www.nus.edu.sg/nec (W) :: Company Registration No: 200604346E

Appendix B3 Questionnaire (Study 1)



Are You Interested in Commercializing your Inventions?

2008 NUS Entrepreneurship Center (NEC) Survey

Dear Professors,

The NUS Entrepreneurship Center (NEC) is conducting a study on faculty members' opinions about technology commercialization (patenting, licensing, and spinoff venturing). As the pioneers of science and technology and one of the major sources of innovation in society, university faculty members are becoming increasingly involved in more and more commercial activities. This survey addresses your views on this topic and the factors that have shaped your perspective.

The survey should take ***no more than 30 minutes*** to complete. Please take your time and do not rush through it. As much as possible, please try not to miss any questions or pages. There is no right or wrong answer.

Your response to our survey is very important. If we do not have a representative sample of people answering our survey, the information will not be very useful. The information you provide will be used for research purposes only. Remember that ***your responses will be completely confidential.*** Your answers will be aggregated and only aggregate scores will be reported.

If you have any questions about this study, please contact **Ruan Yi** by email (ruanyi@nus.edu.sg) or phone (9276-5697).

Your help to our research is highly appreciated! We will provide a summary report of the findings of this study on NEC website, and will inform you when it is in place.

Best regards,

Yi RUAN

Ph.D candidate
Dept. of Business Policy, Business School
National Univ. of Singapore

Section I. The way you make decisions

Part A. Cities around the world

Compare the pairs of cities given below. For each pair, circle the one with the larger population (in 2007), and then indicate how confident you are that your choice is correct on a scale of 50% to 100% (e.g. 50% indicates that your answer is a total guess, 70% indicates that you think you have seven chances out of ten of being right, and 100% indicates that you are totally confident that your answer is right.)

		Confidence Level (50% to 100%)
A) Cairo	B) Los Angeles	_____ %
A) Shanghai	B) Moscow	_____ %
A) Chennai	B) Bangkok	_____ %
A) Toronto	B) Milan	_____ %
A) Mexico City	B) Paris	_____ %

Part B. Your estimation

Suppose you are about to commercialize a product (your own idea/invention). With this in mind, please answer the following questions by indicating how much you agree with each statement. Please give a response to each question that best reflects your answer using the scale provided.

Not at all true of me						Somewhat true of me			Very true of me
1	2	3	4	5	6	7			7

- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| ▪ I can accurately forecast the total demand for my product (or service, or invention). | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I can accurately forecast when larger competitors will enter the market | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I can make my business a success, even though others may fail. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Part C. Two decisions to make

Problem 1: Equipment Purchase Decision

Mr. Tan is about to invest in a new machine and has narrowed his options to Machine A, which is made in Japan or Machine B, which is made in China. Both machines are equally capable of performing the same function. In considering this decision, Mr. Tan said to his friend, "You know, it seems that every time I buy a piece of equipment made by a Chinese manufacturer, it breaks down in the first month of use."

After further discussion, Mr. Tan's friend remembers a recent industrial report that gives a significantly higher ranking to Machine B (the made-in-China one) than to Machine A. This report bases its recommendation on extensive testing as well as on feedback from dozens of users.

If you were in Mr. Tan's position, which machine would you purchase? Why?

Decision _____

Reason _____

Problem 2: Automation Update Decision

The president is urging the board of directors to accept the purchase of a state-of-the-art computerized machine that would fundamentally change their operations. After describing the capability of this machine, the president cites a recent nationwide study which examined 120 businesses making similar upgrades. Results indicated that at least 85% showed a sizable increase in productivity. In a parallel control group of firms not making the upgrade, about half as many firms (40%) showed a sizable increase in productivity. Based on this study, the president concludes that the computerized machine needs to be purchased.

One of the directors now takes the floor giving two reasons why computerized equipment is not the real reason for increased productivity. First, the managers of businesses that make such changes are likely to be more energetic and adventurous, thus creating an environment for superior performance. Second, any change is likely to lead to superior performance because of the increased interest and commitment on the part of management.

If you were participating in such a decision, whose line of reasoning (president or director) would you be more likely to accept? Why?

Decision _____

Reason _____

Section II. Entrepreneurial Environments

Please rate the following statements based on how much you agree with them with the scales provided:

Part A. Within my Department/School/Faculty

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

Within my department/school/faculty, starting a business is something good to do.	1	2	3	4	5
Within my department/school/faculty, resources/expertise are available to support faculty members who start businesses.	1	2	3	4	5
Within my department/school/faculty, those who start businesses should expect to receive criticism and scrutiny from others.	1	2	3	4	5
Within the last 5 years, support within my department/school/faculty for starting a business has increased substantially.	1	2	3	4	5

Part B. Within the University

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

The university administration makes it clear to faculty members that starting a business is something good to do.	1	2	3	4	5
The university administration makes it clear to faculty members that starting a business is not encouraged.	1	2	3	4	5
Within the last 5 years, support from the university administration has increased substantially.	1	2	3	4	5
ILO (Industry Liaison Office, previous INTRO) makes it easy for faculty members to license their technologies (inventions).	1	2	3	4	5
ILO has been making a credible effort to showcase the technologies developed by faculty members.	1	2	3	4	5
There is abundant resources/expertise in ILO to support faculty members who want to license their technologies (inventions).	1	2	3	4	5
ILO tends to give exclusive license or other favorable terms to faculty	1	2	3	4	5

inventors who want to start up spinoff firms.

You are well aware of the university technology commercialization process.	1	2	3	4	5
Within the last 5 years, support from the ILO has increased substantially.	1	2	3	4	5
You are well aware of what NEC (NUS Entrepreneurship Center) can do to help if you want to start up a spinoff firm.	1	2	3	4	5
You have heard about or attended workshops, forums, or seminars organized by NEC before.	1	2	3	4	5
There is abundant resources/expertise in NEC to support faculty members who want to start up spinoff firms	1	2	3	4	5
Within the last 5 years, support from NEC has increased substantially.	1	2	3	4	5

Part C. Within Singapore

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

There is abundant financial support from the government for faculty members who want to start up spinoff firms.	1	2	3	4	5
Within the last 5 years, support from the government has increased substantially.	1	2	3	4	5
There are active venture capital firms searching for startup investment opportunities.	1	2	3	4	5
There are local customers who are willing to try out products/services of university spinoff firms.	1	2	3	4	5
University spinoffs from NUS have promising prospect in the regional markets.	1	2	3	4	5
Within the last 5 years, the entrepreneurial environment of Singapore has become more active.	1	2	3	4	5

Section III. Entrepreneurial Intention

Please rate the following statements based on how much you agree with them with the scales provided:

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

I am willing to further develop my technology with representatives from industry if they approach me. 1 2 3 4 5

Commercializing my technology is worth pursuing. 1 2 3 4 5

It is feasible to commercialize my own technology given the situation. 1 2 3 4 5

I would like to start up my own business to commercialize my technology in the next **two** years. 1 2 3 4 5

In what ways have you taken steps to better familiarize yourself with the process of commercializing inventions?

	Have done so before (Yes/No)	Plan to do so next year (Yes/No)
By taking courses/attending seminars.	Yes / No	Yes / No
By reading books/publications.	Yes / No	Yes / No
By discussing with professionals and industry contacts.	Yes / No	Yes / No
By consulting with other colleagues who have already commercialized innovations.	Yes / No	Yes / No

In what ways have you taken steps to prepare yourself to start a business?

	Did so within the last year (Yes/No)	Plan to do so next year (Yes/No)
By identifying potential business associates (colleagues, students) to assist in starting a business.	Yes / No	Yes / No
By exploring sources of startup capital.	Yes / No	Yes / No
By exploring places to locate business operations.	Yes / No	Yes / No
By preparing a business plan.	Yes / No	Yes / No
By exploring the customer base to support business operations.	Yes / No	Yes / No
By starting to serve initial users (free or otherwise).	Yes / No	Yes / No
By promoting the technology to potential business associates and/or customers.	Yes / No	Yes / No

Section IV. Social Relations

- Who do you usually work with?
A) People from the same department/lab
B) People from the same faculty/school
C) People from the same university
D) People from other research institutes/university
E) People from the industry
F) People from the government agencies
G) Others, please specify _____
- How long have you been working in NUS?
A) Below 3 years
B) 3~6 years
C) Over 6 years, please specify ____ years
- Have you taken any full-time positions in other organizations before you joined NUS?
(1) Yes / No

(2) What kind of organization? (multiple choices allowed)
A) University/research institute B) Company (private sector)
C) Singapore government D) Your own startup firm
E) Financial institutes (bank, venture capital firm, or hedge fund, etc.)
F) Others, please specify _____

(3) How long have you worked there? ____ years
- Do you have any friend or former colleague or family member who ...
A) works with investment agencies of Singapore government
B) works with venture capital firm or investment bank
C) is an business angel
D) has connections with the above organizations or person
- Has any of your friends or family members been involved in entrepreneurship?
A) Yes B) No
If yes, please specify your relationship with them

Section V. Demographics

- Your gender: Female / Male
- Your age:
A) 25~34 B) 35~44 C) 45~54 D) 55~60 E) Above 60
- Your current salary (before tax):
A) Less than S\$25K B) S\$ 25~35K C) S\$ 35~45K
D) S\$ 45~55K E) S\$ 55~65K F) S\$ 65~75K
G) S\$ 75~100K H) S\$ 100~200K I) Above S\$ 200K
- Your race:
A) Chinese B) Malay C) Indian D) Caucasian
G) Others, please specify _____
- Your citizenship:
A) Singapore citizen
B) Singapore PR (permanent resident)
C) Others, please specify _____
- When did you get your Ph.D degree? _____
- How many patents do you have? _____
- How many of your patents do you think are marketable? _____
- Are you married? **Yes / No**
How many kids do you have? _____
- Are you an entrepreneur? **Yes / No**
If yes, when did you start up your first company? _____
how long have you been running that company? _____

Section VI. Something about yourself

Please give a response to each question that best reflects your answer using the scale provided.

Not at all true of me				Somewhat true of me				Very true of me
1	2	3	4	5	6	7		

- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| ▪ Growing up, not being careful enough got me into trouble at times. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ Growing up, I would often “cross the line” by doing things that my parents would not tolerate. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ Growing up, I often did well at different things I tried. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I have found very few hobbies or activities in my life that capture my interest or motivate me to put effort into them. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ In general, I am focused on achieving positive outcomes in my life. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I often imagine myself experiencing bad things that I fear might happen to me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I often imagine myself experiencing good things that I hope will happen to me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I often worry that I will fail to accomplish my goals. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I often think about how I will achieve success. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ▪ I am anxious that I will fall short of my responsibilities and obligations. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

You have reached the end of the survey.

**Once again, we sincerely thank you
for your invaluable help in this study!**



Appendix C1 Questionnaire (Study 2)

NUS Entrepreneurship Center (NEC) 2008 Inventor Survey

1. Introduction

Dear Professors,

Welcome to NUS Entrepreneurship Centre 2008 Inventor Survey! The Purpose of this survey is to better understand the factors that influence faculty inventor views on technology commercialization and academic entrepreneurship.

The survey should take no more than 15 minutes to complete. Please take your time and do not rush through it. We value your voluntary participation, and want to reassure you that your responses will be kept completely confidential and used only for research purposes.

While you will not be 'compensated' for participating in this study, we will prepare for you a summary report of aggregate findings. If you have any questions about this survey, please contact the study administrator, Ruan Yi, by email (ruanyi@nus.edu.sg) or phone (9276-5697).

Thanks again for participating in this study!

Sincerely,

RUAN YI

Ph.D candidate
Dept. of Business Policy, Business School
National Univ. of Singapore

1. I understand the nature and scope of the study, and understand that the responses that I provide will be kept confidential. My participation in this study is voluntary.

- Agree
 Disagree

2. We would appreciate your assistance in providing your NUS email address so that we may update our contact records for this study. This enables us to maintain accurate information on study participation, and better target our follow-up efforts.

2. Entrepreneurial Environments

First of all, we want to understand your view on the environment for entrepreneurship. Please indicate how much you agree with the following statements using the scales provided.

1. The environment within the Department/School/Faculty

	Strongly Disagree		Neutral		Strongly Agree
Within my department/school/faculty, starting a business is something good to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within my department/school/faculty, resources/expertise are available to support faculty members who start businesses.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within my department/school/faculty, those who start businesses should expect to receive criticism and scrutiny from others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within the last 5 years, support within my department/school/faculty has increased for academic entrepreneurship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

NUS Entrepreneurship Center (NEC) 2008 Inventor Survey

2. The environment within NUS

	Strongly Disagree		Neutral		Strongly Agree
The university administration makes it clear to faculty members that starting a business is something good to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The university administration makes it clear to faculty members that starting a business is not encouraged.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within the last 5 years, support from the university administration has increased for academic entrepreneurship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ILO (Industry Liaison Office, previously called INTRO) makes it easy for faculty members to license their technologies (inventions).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ILO has been making effort to showcase the technologies developed by faculty members.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are resources/expertise in ILO to support faculty members who want to license their technologies (inventions).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ILO tends to give exclusive license or other favorable terms to faculty inventors who want to start up spinoff firms.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am aware of the university technology commercialization process.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within the last 5 years, support from the ILO has increased for academic entrepreneurship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am aware of what NEC (NUS Entrepreneurship Center) can do to help if I want to start up a spinoff firm.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have heard about or attended workshops, forums, or seminars organized by NEC before.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are resources/expertise in NEC to support faculty members who want to start up spinoff firms.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within the last 5 years, support from NEC has increased for academic entrepreneurship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. The environment within Singapore

	Strongly Disagree		Neutral		Strongly Agree
There is financial support from the government for faculty members who want to start up spinoff firms.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within the last 5 years, support from the government has increased for academic entrepreneurship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are active venture capital firms searching for startup investment opportunities.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are local customers who are willing to try out products/services of university spinoff firms.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
University spinoffs from NUS have promising prospect in the regional markets.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Within the last 5 years, the entrepreneurial environment in Singapore has become more active.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. The way you make decisions

Next we want to find out your decision-making style. The questions on this page are designed by some social psychologists and are definitely NOT tests about your general knowledge. Please do NOT use the Internet to search for or confirm your answers.

Part A. Cities around the world

Compare the 5 pairs of cities given below. For each pair, choose the one with the larger population (in 2007), and then indicate how confident you are that your choice is correct on a scale of 50% to 100%.

For example: A) London (if chosen) B) Singapore

Confidence level (%): 80 (This means you are 80% confident that London has a bigger population than Singapore.)

1. Which city had a bigger population in 2007?

A) Cairo B) Los Angeles

Confidence level (%)

NUS Entrepreneurship Center (NEC) 2008 Inventor Survey

2. Which city had a bigger population in 2007?

- A) Shanghai B) Moscow

Confidence level (%)

3. Which city had a bigger population in 2007?

- A) Chennai B) Bangkok

Confidence level (%)

4. Which city had a bigger population in 2007?

- A) Toronto B) Milan

Confidence level (%)

5. Which city had a bigger population in 2007?

- A) Mexico City B) Paris

Confidence level (%)

Part B. Your estimation

Suppose you are about to commercialize a product (based on your own invention). With this in mind, please indicate how much you agree with the following statements using the scales provided.

6. Please select the response to each statement that best reflects your answer.

	Not at all true of me		Somewhat true of me		Very true of me
I can accurately forecast the total demand for my product (or service, or invention).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can accurately forecast when larger competitors will enter the market.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can make my business a success, even though others may fail.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Entrepreneurial Intention

Facing the real decision of whether to become an entrepreneur yourself, what would be your response? Please indicate how much you agree with the following statements using the scales provided.

1. How do you feel about commercializing your invention(s)?

	Strongly Disagree		Neutral		Strongly Agree
I am willing to further develop my technology with representatives from industry if they approach me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commercializing my technology is worth pursuing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is feasible to commercialize my own technology, given the situation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to start up my own business to commercialize my technology in the next two years.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

NUS Entrepreneurship Center (NEC) 2008 Inventor Survey

2. How did you learn about the process of technology commercialization?

	Strongly Disagree		Neutral		Strongly Agree
I have taken courses/attended seminars about technology commercialization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have read books/publications on technology commercialization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have discussed with professionals and industry contacts about how to commercialize inventions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have consulted with other colleagues who have already commercialized innovations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How did you prepare yourself to commercialize your invention(s)?

	Strongly Disagree		Neutral		Strongly Agree
I have identified potential business partners (e.g. colleagues, students) to co-found a startup firm.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have explored sources of startup capital.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have explored places to locate business operations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have prepared a business plan.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have explored the customer base to support business operations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have tried to serve some initial users (free or otherwise).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have promoted my technology to potential business partners and/or customers in conferences or other social events.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. Something about yourself

This section contains questions developed by social psychologists, by which we seek to understand your attitudes towards things in your life...

1. Please give a response to each question that best reflects your answer using the scale provided.

	Not at all true of me		Somewhat true of me		Very true of me
I often worry that I will fail to accomplish my goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see myself as someone who is primarily striving to become the self I "ought" to be - to fulfill my duties, responsibilities, and obligations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Growing up, I would often "cross the line" by doing things that my parents would not tolerate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am anxious that I will fall short of my responsibilities and obligations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I often think about the person I am afraid I might become in the future.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I often imagine myself experiencing good things that I hope will happen to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My major goal in life right now is to avoid becoming a failure in my career.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I frequently imagine how I will achieve my hopes and aspirations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Growing up, I often did well at different things I tried.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I typically focus on the success I hope to achieve in the future.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In general, I am focused on achieving positive outcomes in my life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I often think about how I will achieve success.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I often imagine myself experiencing bad things that I fear might happen to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have found very few hobbies or activities in my life that capture my interest or motivate me to put effort into them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I frequently think about how I can prevent failures in my life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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I often think about the person I would ideally like to be in the future.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Growing up, not being careful enough got me into trouble at times.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In general, I am focused on preventing negative events in my life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see myself as someone who is primarily striving to reach my "ideal self" - to fulfill my hopes, wishes, and aspirations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My major goal in life right now is to achieve my career ambitions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Social Relations

We would like to know whether your social relations affect your decision on technology commercialization.

1. How often do you work with ...?

	Not at all	Not often	Sometimes	Often	Very often
People from the same department/lab	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People across departments in the same faculty/school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People across faculties in the same university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People from other research institute/university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People from industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People from government agencies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify)					

2. How many year(s) have you been working in NUS?

3. How many year(s) of full-time working experience do you have before joining NUS (National Service excluded)?

4. What kind of organization(s) have you worked with (full-time) before joining NUS? (you may select more than one answer)

- University/research institute
- Company (private sector)
- Singapore government
- Your own startup firm
- Financial institution (e.g. bank, venture capital firm, hedge fund, etc.)
- Other (please specify)

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5. Do you have any friend or family member who ... (you may select more than one answer)

- works with the investment agencies of Singapore government (e.g. EDB)
- works with a venture capital firm or an investment bank
- is an business angel
- has connections with the above organizations or person
- None of the above

6. Do you have friends or family members who have founded their own businesses?

- Yes
- No

Please specify your relationship with him/her

7. Demographics

Lastly, we would like to have some basic information about you.

1. Your gender

- Female
- Male

2. Your age

- 25~34
- 35~44
- 45~54
- 55~60
- Above 60

3. Your race

- Chinese
- Malay
- Indian
- European
- American
- Other (please specify)

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4. With which faculty/school are you primarily affiliated?

- Faculty of Engineering
- Faculty of Science
- School of Medicine
- School of Computing
- School of Design & Environment
- Other (please specify)

5. In which year did you receive your Ph.D degree?

6. What is your current academic ranking?

- Professor
- Associate Professor
- Assistant Professor
- Senior Lecturer
- Adjunct Professor
- Research Fellow
- Other (please specify)

7. Are you married?

- Yes
- No

8. How many children do you have?

- 0
- 1
- 2
- 3
- Other (please specify)

9. How many technology disclosures have you filed with ILO (previously called INTRO)?

10. How many U.S patents do you have?

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11. How many inventions have you licensed to the industry (including your own startup firm)?

12. Have you ever founded or co-founded any startup firm(s) before?

Yes

No

In which year did you found the firm(s)?

13. This concludes the survey. Thank you for participating. Space is provided below for any additional information you feel may be useful. Once again, we appreciate your insights!

If you have any questions about this survey, please contact the study administrator, Ruan Yi, by email (ruanyi@nus.edu.sg) or phone (9276-5697).

Appendix C2 Email advertisement for Study 2



Dear Professor _____ :

Greetings! If you had an invention or business idea, would you want to develop it further? What factors would you consider in making this sort of decision? This is the focus of the NUS Entrepreneurship Centre's Inventor Survey.

I am writing to ask you for **15 minutes** of your time to help answer this question. This study is being conducted for the NUS Entrepreneurship Centre by Ruan Yi, a PhD Student in the NUS Business School, under my supervision. The study also forms part of her doctoral dissertation. All faculty members who have filed technology disclosure(s) with the NUS Industry Liaison Office (ILO) are being invited to participate. The findings of this research will have important implications for the services offered to inventors here at NUS by the Industry Liaison Office (ILO) and the NUS Entrepreneurship Centre.

Because this work has both research and practical implications, I want you to know that participation is voluntary, and the information you share will be kept completely confidential—only Ms. Ruan Yi will have access to your responses, and only aggregated data will be presented in summary reports and analyses.

We look forward to your involvement in this study. If you have 15 minutes, you can participate right now (www.tinyurl.com/nus-ent). I am told by people who have completed the survey that it is short and straightforward, even fun! If you have any questions about the study, please feel free to contact Ruan Yi directly (ruanyi@nus.edu.sg / Tel: 9276 5697).

Thanks, in advance, for your help with this!

Best regards,

WONG Poh Kam (Prof) :: Director, NUS Entrepreneurship Centre and Professor, NUS Business School & LKY School of Public Policy :: National University of Singapore :: E3A 6th floor, 10 Kent Ridge Crescent, Singapore 119260 :: 65-6516 6323(DID) :: 65-6773 2269 (Fax) :: pohkam@nus.edu.sg <<mailto:pohkam@nus.edu.sg>> (E) :: www.nus.edu.sg/nec (W) :: Company Registration No: 200604346E

Important: This email is confidential and may be privileged. If you are not the intended recipient, please delete it and notify us immediately; you should not copy or use it for any purpose, nor disclose its contents to any other person. Thank you.

Appendix C3 Email reminder 1 (Study 2)



Dear Professor _____:

We are conducting a university-wide study among faculty inventors about university technology commercialization. As one of the faculty inventors filed in ILO (NUS Industry Liaison Office), you should have received an invitation to participate in our survey (2008 NUS Entrepreneurship Center Inventor Survey) earlier this week. If you have already completed the survey, we would like to **thank you** once again for your invaluable input to our study! A brief report of the findings will be sent to you once it is in place.

If you have NOT participated in the study yet, we would like to ask you to spare **10 minutes** of your time to go through the questions. The link to our survey is www.tinyurl.com/nus-ent. The questions are short and straightforward, some even fun! There is absolutely NO sensitive question and we would like to assure you that the information you share will be kept completely confidential.

If you have any questions about the study, please feel free to contact Ruan Yi (ruanyi@nus.edu.sg / Tel: 9276 5697). We look forward to your involvement in the study and we thank you for your help!

Best regards,

Ruan Yi

RUAN Yi :: Ph.D candidate, NUS Business School :: BIZ 2 Building, 1 Business Link, Singapore 117592 :: Tel +65 9276 5697 :: Fax +65 6779 5059 :: Email ruanyi@nus.edu.sg

P.S. If you have already participated in the survey and had difficulty completing the last page, we sincerely apologize for the inconvenience caused. Although we have fixed the problem, your responses might not have been registered fully in our system. Hence we wonder whether you would spare 5 minutes to run through the questions one more time. We thank you for your kind feedback!

Appendix C4 Email Reminder 2 (Study 2)



Dear Professor _____:

Seasons greetings!

We are conducting a university-wide study among faculty inventors about university technology commercialization. As one of the faculty inventors filed in ILO (NUS Industry Liaison Office), you should have received an invitation to participate in our survey (2008 NUS Entrepreneurship Center Inventor Survey) three weeks ago. By now more than 120 faculty inventors have already participated in the study.

If you have NOT participated in the study yet, we would like to ask you to spare **10 minutes** of your time to go through the questions. The link to our survey is www.tinyurl.com/nus-ent. The questions are **short and straightforward**, some even fun! There is absolutely **NO sensitive question** and we would like to assure you that the information you share will be kept completely confidential.

If you have any questions about the study, please feel free to contact Ruan Yi (ruanyi@nus.edu.sg / Tel: 9276 5697). We look forward to your involvement in the study and we thank you for your help!

Best regards,

Ruan Yi

RUAN Yi :: Ph.D candidate, NUS Business School :: BIZ 2 Building, 1 Business Link, Singapore 117592 :: Tel +65 9276 5697 :: Fax +65 6779 5059 :: Email ruanyi@nus.edu.sg

Appendix C5 Email Reminder 3 (Study 2)



Dear Professor «inventor»:

Happy New Year!

We have been conducting a university-wide study among faculty inventors about university technology commercialization in the last few weeks. You should have received a phone call from our research assistant about the study and you have promised us to participate in our survey. However according to our record, it seems that we have NOT received your answers yet. (Please ignore this email if you have done it. We thank you again for your help!)

As the closing date of our survey is coming around, we are wondering whether you may spare **10 minutes** of your time to help us in the study. The link to our survey is www.tinyurl.com/nus-ent. If you have any questions about the study, please feel free to contact Ruan Yi (ruanyi@nus.edu.sg / Tel: 9276 5697).

We thank you for your invaluable input and we wish you a wonderful semester ahead!

Sincerely,

Ruan Yi

RUAN Yi :: Ph.D candidate, NUS Business School :: BIZ 2 Building, 1 Business Link, Singapore 117592 :: Tel +65 9276 5697 :: Fax +65 6779 5059 :: Email ruanyi@nus.edu.sg