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Exploring Diverse Effects of Four Types of Mobility on University Entrepreneurship

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FOREWORD by EDITOR-in-CHIEF

We are very pleased to present the second issue of the Science, Technology and Innovation Policy and Management (STIPM) Journal. We are very excited that the journal has attracted papers from many countries. The variety of paper submissions has supported the international-level initiatives of the journal. Since the beginning of the year, a number of articles have been sent to us. Six articles are published in this issue, while others are still under the first or second phase of review and will follow in the subsequent issue.

In this issue, we present six articles on issues of technology and innovation development and policy at national-, regional-, and firm-level, written by scholars from Australia, Japan and Indonesia. The first article investigates the technological capability of the milk processing industry in Indonesia. The second article investigates mass production of innovation in the business model of start-up companies. The third article explores the diverse effects of four types of mobility on university entrepreneurship. The fourth article explores institutional transformations in local innovation systems used by the farmer community of Belu, East Nusa Tenggara, Indonesia. The fifth article analyzes the transition of bioplastic development in Indonesia, and the last article investigates the effectiveness of subsidies in technology adoption using the case study of reverse osmosis membrane technology in Mandangin Island, East Java, Indonesia. All articles have gone through editorial review by prominent experts.

I would like to thank the authors who have submitted articles to *STIPM Journal* for their trust, patience and timely revisions as well as for trusting Editor and Editorial Board. I encourage authors to submit their manuscripts. This scientific work is published widely on an open access policy.

My gratitude also goes to all members of the Editorial Board and reviewers who have contributed to this second issue, all of whom increase the quality of articles in this journal even more. We continue to welcome article submissions in the field of science, technology and innovation policy and management.

We wish you a 2017 Happy New Year!

Jakarta, December 2016

Editor-in-Chief

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Exploring Diverse Effects of Four Types of Mobility on University Entrepreneurship

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ABSTRACT

This study explores the mechanism by which mobility influences university entrepreneurship through an empirical analysis of Japanese scientists working for the University of Tokyo. It presents theory-driven typology of mobility and applies it to the knowledge-transfer context. First, this paper divides previously studied mobility into four types: job mobility (JM), sector mobility (SM), international mobility (IM), and educational background mobility (EBM). Then, it empirically shows that both JM and IM have positive and significant correlation with university entrepreneurship, whereas neither SM nor EBM does. Based on the result, this study discusses that JM and IM accelerate the formation of skills necessary for the commercialization of university research; however, SM and EBM may have no impact on it.

I. INTRODUCTION

The mobility of highly skilled people, particularly human resources in science and technology, has been drawing the attention of both scholars and policy makers. In 2001, the OECD was concerned about the growing shortage of highly skilled workers in its member countries; thus, they started a research project to analyze how the mobility of such people affects economic as well as innovation systems (OECD, 2001). During the same period, some academics discovered the exceptional contributions to the science and technology field by highly skilled people who are internationally mobile (Stephan & Levin, 2001; Saxenian, 2002). Other academics asserted that the inter-organizational mobility of scientists considerably contributed to innovation as it helps to transfer uncodified knowledge, a crucial component of innovation which otherwise could not have been transferred without mobility (Zucker & Darby, 2006).

The early studies mentioned above have jointly provided the foundation whereby scholars could further investigate the relationship between innovation and mobility. Consequently, many papers have empirically revealed the correlative relationship between high mobility and innovation. However, their causal relationship is still

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under investigation. Why is mobility associated with innovation?

The investigation on the causality between them runs along two lines. The first line of investigation examines whether mobility increases the productivity of individuals. Many papers compared the productivity, measured by patenting and publishing activities, of mobile scientists and that of non-mobile scientists. They confirmed that the former exhibited higher productivity than the latter (Fleming, Mingo, & Chen, 2007; Hunt & Gauthier-Loiselle, 2008; Jonkers and Tijssen, 2008).

The second line of investigation hypothesizes that mobility stimulates entrepreneurship in individuals. In this context, researchers consider mobility as the experience of moving beyond company and national borders. They further discuss that such experience impacts an individual's intrinsic factors and abilities, which, in consequence, jointly change his/her value system toward appreciating and thus conducting entrepreneurial activities. Ahmad and Seymour (2008) defined the entrepreneurial activity as "the enterprising human action in pursuit of the generation of value, through the creation or expansion of economic activity" (Ahmad & Seymour, 2008. p.14). Hormiga and Bolívar-Cruz (2012) found that immigration experiences improve individuals' risk perception, and thus, stimulate the activity. Edler, Fier, and Grimpe (2011) showed that international mobility increases an individual's propensity toward knowledge transfer that frequently entails the commencement of the entrepreneurial activity. Zelekha (2013) argues that immigrants' disadvantages in host economies stimulated entrepreneurship, driving them to create new businesses; thus, they were able to avoid useless competition with incumbent corporations.

This paper is based on the above literature and hypothesizes that mobility increases entrepreneurship among scientists. Furthermore, it attempts a more focused approach to 'human mobility', measured by data collected from individuals' curriculum vitae (CV) or equivalent. It examines university scientists, as they constitute a major group of highly skilled people who are internationally mobile.

The objective of this paper is to describe how the mobility affects entrepreneurship among Japanese scientists. It draws upon literature on entrepreneurial activity of university scientists in the form of new firm creation (e.g. university spin offs). This paper focuses on academic entrepreneurs (AEs) that are defined as "university scientists creating university spinoff companies and developing their lab discoveries to meet industrial and social demands" (Shane, 2004). The study is based on the theory-driven assumption that "spinoff behavior of AEs is a reflection of individual actions and therefore is largely due to the personality, ability or willingness of the individual to engage successfully in entrepreneurial behavior" (O'Shea, Allen, O'Gorman, & Roche, 2004).

A new set of data comprising credible and wide-ranging information from CVs facilitated the empirical analyses of more than 500 scientists holding full-time positions at the University of Tokyo (UoT). First, the study distinguishes between Japanese academic entrepreneurs (AEs) and non-AEs. It then compares the career paths of AEs and non-AEs, highlighting four kinds of mobility: job mobility (JM), sector mobility (SM), international mobility (IM), and educational background mobility (EBM). The result of the probit analysis clearly shows that both JM and IM are positively related to university entrepreneurship among Japanese scientists, whereas SM and EBM are not.

II. BACKGROUND

In 1980, the US government enacted the Bayh–Dole Act (Law, Patent and Trademark Amendments Act, 1980). Japan has introduced similar legislation intending to catch up with the US system of innovation. Between 1998 and 2004, the Japanese government enacted several laws, all of which were expected to encourage university scientists to transfer and commercialize their research outcomes (Baba, Schichijo, & Sedita, 2009; Collins & Wakoh, 2000; Kneller, 2007; Walsh, Baba, Goto, & Yasaki, 2008; Harayama, Ujiie, & Degawa, 2009). During the same period, the government offered incentives to university researchers such as generous financial support in order to enhance their entrepreneurship.

However, some have been skeptical about the effectiveness of Japan's legislation in enhancing university entrepreneurship (Harayama, Ujiie, & Degawa, 2009; Collins & Wakoh, 2000). They argued that, for at least several years after the legislation was enacted, there was no robust evidence to show that the innovation system in Japan had shifted towards a US-like system, in which university scientists are very eager to create spinoff firms in order to transfer university inventions (Kneller, 2007). In the same vein, Harayama, Ujiie, and Degawa (2009) asserted that some of the policy initiatives carried out in accordance with the legislation actually hindered entrepreneurship among university scientists.

Though Japan attempted to introduce laws in line with the Bayh–Dole Act in order to adopt a US-style innovation system that encourages university spinoffs, it still substantially lags behind the US in the number of new spinoff firms and firm-founding scientists. Institutional differences between the US and Japan are considered among the major factors responsible for the lag.

In addition to that, the difference between the US and Japan is also attributable to the individual characteristics of scientists working for their universities. The individual characteristics associated with entrepreneurship include motivation (Sauerman, Cohen, & Stephan, 2010), value-orientation toward commercial activities (Lam, 2011), role identity (Libaers & Wang, 2012), and mobility. Scholars theorize that the mobility is reflected in individuals' career paths. Most of the research in this stream confirms that high mobility is significantly related to enhanced entrepreneurship among scientists (Stephan & Levin, 2001; Hunt & Gauthier-Loiselle, 2008; Edler, Fier, & Grimpe, 2011; Krabel, Siegel, & Slavtchev, 2012).

Though empirically robust, the findings of the above-mentioned papers might have underestimated the level of mobility of some of the scientists. Some of the articles proxy mobility used scientists' foreign-born backgrounds, and so might miss many native-born scientists who had stayed in foreign countries for a long time before returned home. Articles that collected data from online surveys may also not be free of underestimation since there is no guarantee that the scientists' career paths were disclosed in detail.

This study attempts to alleviate this underestimation problem. It collected individual scientists' career path data from their CVs posted on websites maintained by organizations that have the right or a good reason to collect scientists' career path information. Hence, the data examined in this paper provides richer information on individuals' mobility compared to previous studies.

Furthermore, detailed career path data enables the study to divide mobility into four categories: JM, SM, IM, and EBM. The study subsequently examines how respective categories influence the formation of entrepreneurial skills by a mobile scientist. Thus, this study will contribute to the literature through a detailed examination of how mobility encourages university scientists to become AEs.

III. ANALYTICAL FRAMEWORK

A. Definition and research streams of university entrepreneurship

Rothaermel, Agung, and Jiang (2007) published one of the most frequently cited papers on university entrepreneurship. The authors reviewed 173 academic articles published worldwide in a number of peer-reviewed scholarly journals between 1981 and 2005, and defined university entrepreneurship as activities involving "patenting, licensing, creating new firms, facilitating technology transfer through incubators and science parks, and facilitating regional economic development" (Rothaermel, Agung, & Jiang, 2007, p. 692).

Furthermore, they categorized the literature into four major research streams that have emerged since the end of the last century. Topics discussed in each stream include: (i) entrepreneurial research universities; (ii) productivity of technology transfer offices (TTOs); (iii) new firm creation; and (iv) environmental context, including networks of innovation (Rothaerme, Agung, & Jiang, pp. 692–693).

This paper exclusively investigates scientists' firm-creating activities, which fall into the research stream of (iii). Papers in this stream assume that the level of university entrepreneurship is measured based on information on the presence (or absence) of university spinoff firm(s). Therefore, this paper distinguishes scientists who have founded at least one university spinoff firm(s) as entrepreneurial scientists (or AEs).

B. Theoretical development and hypotheses

1) Job mobility and university entrepreneurship

This study divides scientists into two groups: scientists who have moved to their current affiliation from other universities fall into the high–job mobility (JM) group, while those who have stayed at their current affiliations since being hired full-time comprise the low–JM group.

Scholars who investigated the relationship between JM and entrepreneurship approached the topic from one of two perspectives: (i) researchers' intrinsic factors, such as motives and preference for entrepreneurial behaviors, or (ii) AEs' access to both knowledge and human networks as joint supports for their entrepreneurial endeavors.

Richardson & McKenna (2003) and Thorn (2009) are among those who highlighted researchers' intrinsic factors, indicating that scientists' career motives, not financial incentives, drive them to be mobile. Similarly, Lam (2011) focuses on intrinsic factors and reveals that heterogeneous motives drive academic scientists into commercial endeavors. She draws from social psychology theory to discuss how personal motivation affects scientists' commercial engagement. In the same vein, Sauermann, Cohen, and Stephan (2010) surveyed data on more than 2,000 US academic scientists and clearly shows the significant relationships between their motives and entrepreneurial activities.

Scholars who focus on AEs' access to both knowledge and networks often indicated that entrepreneurs seek innovation by recombining different types of knowledge. As the theory of "sticky knowledge" argues, place-specific or context-embedded knowledge is immobile (Asheim & Isaksen, 2002). This theory implies that JM enables entrepreneurs to access fresh knowledge embedded in the organization to which they have just moved. It also implies that when an entrepreneur envisions a new combination of the fresh knowledge with the familiar knowledge that he/she had learned at the previous affiliation, the entrepreneur clearly recognizes an opportunity for innovation.

Entrepreneurial mobile scientists are also able to build relationships with new colleagues, some of whom contribute ideas for innovation. As a *quid pro quo*, entrepreneurs may transfer knowledge from their previous affiliations, which would be considered fresh by their new colleagues. This process of knowledge exchange facilitates mobile entrepreneurs' skill formation that is important for the commercialization of university research.

From the discussion above, this study postulates a proposition regarding JM: in academia, JM fosters entrepreneurial savvy, and thus JM and the likelihood of creating spinoff firms are positively correlated. This proposition leads to the first hypothesis:

> H1: University scientists' with job mobility (JM) are more likely to be academic entrepreneurs (AEs) than their non-mobile peers.

2) Sector mobility and university entrepreneurship

University scientists with work experience in the industrial sector comprise the high-sector mobility (SM) group, while those who have stayed in the university sector for their entire professional lives comprise the low-SM group.

The literature on knowledge transfer among universities and businesses frequently indicate the gap between these two sectors. Some scholars address the gap as a mismatch between the knowledge created in universities and the requirements for its commercial exploitation (Wright, Hmieleski, Siegel, & Ensley, 2007); others view this gap as a knowledge filter that prevents knowledge from becoming economically useful (Carlsson, Acs Audretsch, & Braunerhjelm, 2009).

The literature often indicates, however, that there are factors that help AEs fill the gap or overcome the filter. For example, direct communication among the persons involved—those participating in knowledge exchange from both universities and companies—has been extensively studied. Research in this stream often show that direct communication is supported by face-to-face interactions among academic scientists and company researchers (Balconi & Laboranti, 2006); by consultancy and joint research conducted by both academics and business people (D'Este & Patel, 2007); and by social networks of academics developed through prior experience(s) of owning firm(s) (Mosey &Wright, 2007).

From the discussion above, this study postulates a proposition regarding SM: SM provides scientists with opportunities to have direct communication with business people, which subsequently helps scientists, fill the gap or overcome the filter between academia and industry. This proposition leads to the second hypothesis:

> H2: University scientists with sector mobility (SM) are more likely to be academic entrepreneurs (AEs) than their non-mobile peers.

3) International mobility and university entrepreneurship

Research on international mobility (IM) often observes that entrepreneurship is associated with their overseas experience or foreign backgrounds. These studies mainly draw on theories developed in three fields: labor migration, sociology, and innovation studies.

Studies employing the labor migration theory indicate that overseas experience improves migrants' risk perception, making them less risk averse. Individuals who are less risk averse are more likely to engage in entrepreneurial activities such as firm creation (Hormiga & Bolívar-Cruz, 2012).

Sociology scholars have also found a positive relationship between migration experience and entrepreneurial behavior. Tracing the diffusion of knowledge that follows the migration of highly skilled people, they found a new phenomenon called brain circulation—the process by which highly skilled immigrants take advantage of their ethnicity to enhance their entrepreneurial opportunities. These circulating brains serve as mediators linking knowledge in their host countries to the distant regions from which they have come (Saxenian, 2002; Chalamwong, 2004; Davenport, 2004; OECD, 2008). Through a close analysis of migrant professionals in Silicon Valley, Saxenian (2007) argues that foreign-born professionals skillfully recognize the opportunities in one country that are not available in others.

Innovation studies approached the topic from one of two different viewpoints: scientific productivity or entrepreneurship status. Some scholars have shown that overseas experience increases scientists' productivity, measured mainly by their publishing and patenting activities (Stephan & Levin, 2001; Lee, 2004; Crespi, Geuna, & Nesta, 2007; Hunt & Gauthier-Loiselle, 2008). Drawing on the theory of "star scientists" (Zucker & Darby, 2006) and "Pasteur's quadrant" (Stokes, 1997), scholars in this stream also show that the higher scientists' productivity is, the more entrepreneurial they are. Therefore, they conclude that scientists with IM are more entrepreneurial than are their less mobile peers.

Other innovation scholars investigate the direct relationship between IM and entrepreneurial traits. This strand of literature does not emphasize the importance of scientific productivity in stimulating entrepreneurship; rather, it underlines the intrinsic factors influenced by overseas experience or foreign birth and which eventually make them more entrepreneurial than their peers. These intrinsic factors include role identity (Libaers & Wang, 2012), social and human capital (Edler et al. 2011; Krabel et al.2012), and entrepreneurial propensity (Bercovitz & Feldman, 2007).

The literature often indicates a positive relationship between IM and entrepreneurship, regardless of the level of scientific productivity. Hence, this study postulates a third proposition: IM is positively related to entrepreneurship. This leads to the hypothesis below:

> H3: University scientists with international mobility (IM) are more likely to be academic entrepreneurs (AEs) than their non-mobile peers.

4) Educational background mobility and university entrepreneurship

Educational background mobility (EBM) indicates a multi-institute background. A scientist who received a bachelor's degree and a PhD from different universities falls into the high-EBM group; one who received a bachelor's degree and a PhD from the same university is categorized as low-EBM group.

This study was unable to find research investigating this topic. Nevertheless, considering the discussion regarding JM, SM, and IM, EBM is supposed to have a similar impact on the entrepreneurship among Japanese scientists. Hence, this study postulates a fourth proposition: EBM is positively related to university entrepreneurship. This leads to the following hypothesis:

> H4: University scientists with educational background mobility (EBM) are more likely to be academic entrepreneurs (AEs) than their non-mobile peers.

Table 1.
Number of AEs in Japan's Top Ten Universities

Name of university	Number of faculty members involved in spinoff firms (as of March 2003)
Osaka University	22
University of Tokyo (UoT)	21
Hokkaido University	21
Kobe University	14
Nagoya University	13
University of Tokushima	11
University of Tsukuba	9
Tokyo Institute of Technology	8
Kagawa University	8
Kyushu Institute of Technology	7
Total (top 10 universities)	134
Total (all national universities)	265

Source: Ministry of Education, Culture, Sports, Science and Technology (MEXT)

C. Methodology and Data

1) Data Selection

This study collected data on Japanese scientists who had full-time positions at the University of Tokyo (henceforth UoT) in or near 2012. It employed this timeframe because it marked a decade since the Japanese government initiated its organizational reform of national universities intended to enhance entrepreneurship among Japanese scientists; it is thus the best period for observing the state of entrepreneurship among scientists.

From 1998 to 2004, the Japanese government initiated an organizational reform of Japanese national universities to catch up to the US model, in which many AEs conduct knowledge transfer. The Japanese government provided various incentives to motivate university researchers to commence knowledge transfer, including substantial financial support for AEs. Thus, the 1998–2004 periods were an era of opportunity.

However, unexpectedly, most Japanese professors did not respond to the incentives, nor attempt to seize the opportunities. Nevertheless, a small but constant number of scientists working for national universities successfully recognized the opportunity and created spinoff firms to gain from it.

Table 1 displays the number of AEs involved in the formation of university spinoff firms. The table shows the number of AEs affiliated with the top ten national universities in Japan. It shows data from 2003, the earliest year for which figures are available and the midpoint from the start of the reform that legitimated firm creation by national university staff for the first time to the present day. Meanwhile, Table 2 shows how many AEs were produced at the UoT during the 2003–2012 period.

Two features that jointly show the appropriateness of the data selection of this study are displayed in Table 1 and 2. First, AEs were clustered in the top 10 universities, which produced 51% of AEs in 2003. Among them, UoT was one of the most important sources of AEs. Therefore, researching AEs at UoT should reveal the factors shaping the current system of innovation in Japan.

Second, Table 2 shows that the number of AEs at UoT has been constant since 2003. Every year since 2003, between 20 and 40 AEs have reported involvement in university spinoff firms. However, AEs at UoT were a minority within

Table 2.
Number of UoT Faculty Members Involved in Spinoff Firms

Fiscal year	Number of UoT faculty members involved in spinoff firms in each of the fiscal year	Total number of UoT professors, associate professors, and lecturers
2003	21	2,793
2004	24	2,808
2005	21	2,828
2006	38	2,429
2007	33	2,424
2008	29	2,489
2009	29	2,436
2010	30	2,428
2011	31	2,472
2012	32	2,430

Source: University of Tokyo (UoT)

their organization. Each year, AEs constitute from 0.8% to 1.5% of all UoT professors, associate professors, and lecturers. This number was slightly larger than that for all of Japan's national universities. As a whole, however, AEs formed a fringe group among full-time researchers in all of Japan's national universities, including UoT. This suggested that research on UoT would elucidate the mechanism in which entrepreneurial traits of Japanese scientists are incubated.

It is important to note that a small but constant number of AEs have been stimulated by the government-led reform and have successfully recognized the opportunity to create spinoff firms. Why did they view the reform positively and recognize the opportunity to begin entrepreneurial activities while their peers did not? The remaining part of this paper explored this research question.

2) Data Sample

As Table 1 and 2 clearly show, the UoT was one of the main sources of AEs; accordingly, this study investigated scientists working there. As of May 2012, the UoT had 2,430 professors, associate professors, and lecturers with full-time positions. This number included not only scientists but also humanities and social science specialists. Of 2,430 UoT researchers, this study selected a sample of 551 scientists specializing in one of the following disciplines: engineering, computer science, medicine, pharmaceutical science, and chemistry. This sample group accounted for approximately 23% of all UoT faculty members.

To identify the four types of mobility in the sample, an original database was constructed by consulting various sources, including: the official UoT website on which the CVs of many scientists are posted; databases run by Japanese governmental agencies; archived interviews conducted mainly by journalists and UoT students; and the websites of other credible organizations, such as established publishers, large online bookshops, and reputable preparatory schools.

Information disclosed in accordance with the Rules of the National Personnel Authority (NPA) enhanced the quality of the database because it provided data regarding UoT researchers' involvement in commercial activities such as creating university spinoff firms or becoming involved in such firms as management board members.

3) Dependent variable

This study adopted one dependent variable—the probability of becoming an AE—represented by a dummy variable. The dummy variable took the value 1 if the scientist has become an AE and 0 otherwise. By referring to the previous study that defined AEs as "university scientists creating university spinoff companies and developing their lab discoveries to meet industrial and social demands" (Shane, 2004), this paper identified AEs as follows: scientists who have full-time

Table 3.
AEs and Non-AEs at UoT

AEs	Engineering or computer science fields	Engineering/Computer Science	27	60
		Bio Medical Engineering	5	
	Life science field	Life Science	28	
Non-AEs	Engineering or computer science fields	Engineering	341	491
		Computer Science	48	
	Life science fields	Medicine	63	
		Pharmaceutical Science	21	
		Chemistry	18	
Total				551
Data available				506
(Total number of profs., associate profs. and lecturers at UoT)				(2430)

positions at UoT and have also created at least one university spinoff firm or are otherwise members of such a firm's management board.

4) Independent variables

This study adopted four independent variables: JM, SM, IM, and EBM. JM, referring to job-switching experience, was a dummy variable taking the value 1 if the scientist has moved from one organization to another after taking a full-time position either at a university or at a company, and 0 otherwise.

SM refered to the experience of working for a private company. This was represented by a dummy variable and took the value 1 if the scientist was hired by a private company on a lifetime employment contract before joining the UoT and 0 otherwise.

IM refered to the scientist's past experience of living abroad.This was represented by a dummy variable and took the value 1 if the scientist worked for a foreign organization or studied at foreign universities for at least three years. The IM dummy took the value 1 if the scientists stayed in a foreign country for at least three years whether or not they already had full-time positions. This led to the expectation that, all else being equal, IM might be more popular than JM and SM.

EBM refered to the educational background of each scientist. This was represented by a dummy variable and took the value 1 if the scientist received a bachelor's degree and a PhD from different universities and 0 otherwise.

IV. RESULT AND DISCUSSION

A. Results

Table 4 provides the descriptive statistics. It shows the means, medians, mode, standard deviations, and minimum and maximum values. Table 5 contains the correlation matrix. None of the correlation coefficients reach the threshold value of 0.7. To further assess the potential for multicollinearity, this study calculated the variance inflation factors (VIF). For all the models, the maximum VIF value was 1.16. Hence, the results did not suffer from multicollinearity.

11% of UoT scientists were AEs who have created at least one university spinoff firm or were otherwise members of such a firm's management board. Meanwhile, roughly half of UoT scientists (53%) experienced job switching, after obtaining a full-time position at an organization other than the UoT; the remaining half of the sample consisted of stayers who have been at the UoT since securing their positions.

By contrast, SM was quite low (18%), as was IM: only 12% of UoT scientists lived in foreign countries for at least three years. Contrary to expectations, IM was the lowest form of mobility among UoT scientists. EBM was also low (17%), which implied that the majority of UoT scientists trained mainly at UoT.

Table 6 presents the result of a probit analysis of the relationship between the probability of becoming an AE and the four kinds of mobility. The model in Table 6 supports H1 and H3, confirming that both JM and IM influence

Table 4.
Descriptive Statistics

	Number of Obs.	Mean	Median	Mode	SD	Min.	Max.
Dependent variable							
Firm creation	506	0.11	0	0	0.31	0	1
Independent variables							
JM (Job mobility)	506	0.53	1	1	0.50	0	1
SM (Sector mobility)	506	0.18	0	0	0.38	0	1
IM (Intn'l mobility)	506	0.12	0	0	0.33	0	1
EBM (Edu. background mob.)	506	0.17	0	0	0.37	0	1

Table 5.
Correlation Matrix (Spearman)

	EBM	IM	SM	JM
JM	0.032	0.056	0.435	1.000
SM	0.084	-0.033	1.000	
IM	0.247	1.000		
EBM	1.000			

UoT scientists to engage in knowledge transfer by creating university spinoff firms.

A limitation of this analysis should be noted. The empirical analysis did not employ control variables such as gender or age. The sample analyzed in this study was overwhelmingly dominated by male scientists (only 9 out of 506 UoT scientists in the sample have female-sounding names); thus, the control variable for gender would not increase the explanatory power of the probit analysis. Very limited information about the year of birth of individuals in the sample was available, and, therefore, the study could not include a control variable for age. This might impose some limitation on the explanatory power of the model.

B. Discussion

The result of the empirical analysis suggests that, among UoT scientists, enhanced entrepreneurship of scientists in the form of firm-creating activities is associated with JM and IM. This result is corroborated by the existing literature, which argues that moving beyond boundaries enhances entrepreneurship of individuals. Mobile scientists are better positioned than their less mobile peers to form entrepreneurial skills because they have access to rich networks and have gained heterogeneous knowledge through their experience.

Furthermore, scientists with experience of doing research in foreign countries such as the US or the UK, which have a wealth of best practices developed by pioneering AEs, may have positive motivations and preferences for entrepreneurial activities. Shane (2004) argues that the growth of spinoff activities is consistent with the contagion effect, through which scientists are influenced by pioneering AEs who have already founded spinoff companies. Pioneering AEs encourage their peers to devote themselves to entrepreneurial activities; as a consequence, several peer scientists decide to start their own spinoffs.

This contagion effect may spread not only among native-born peers but also among peers from other countries, including Japan. Japanese scientists who have visited pioneering AEs in foreign countries and shared research activities with them may have witnessed how well those pioneers had achieved knowledge transfer. They may also have learned how skillfully the pioneering AEs have managed the complicated tasks inherent to entrepreneurial activities. Therefore, the Japanese scientists who have shared research activities with pioneering AEs in foreign countries were able to obtain a role model that would help them develop entrepreneurship.

In contrast to JM and IM, SM does not have a positive relationship with entrepreneurship. This

Table 6.
Results

Independent variables	Firm creation
JM	0.41 (0.17)**
SM	-0.30 (0.22)
IM	0.70 (0.20)***
EBM	-0.03 (0.20)
Constant	-1.53 (0.13)***
LR chi2	21.03
Pseudo R2	0.0597
Number of obs.	506

Results of probit estimation. Standard errors in parentheses.
: significant at 5%. *: significant at 1%.

implies that previous experience in the business sector does not incubate skills necessary for the commercialization of university research. This counterintuitive insight needs further investigation. A comparative study of sector-mobile scientists and those with JM and/or IM may provide a clue to this puzzle. Crespi, Geuna, and Nesta (2007) found differences in factors which determine mobility towards universities or business (the former is equivalent to JM and the latter to SM in this study). Their finding implies that sector mobility has a different impact on human capital formation than JM and IM.

Another possibility for solving the puzzle concerns the difficulty of combining knowledge. Both JM and IM enable AEs to access fresh knowledge embedded in the organization to which they have just moved. Simultaneously, the AEs continue to utilize the familiar knowledge embedded in their previous affiliations, due to the openness of the university sector. Consequently, JM and IM facilitate combining new knowledge with familiar knowledge.

In contrast, sector mobility may not allow mobile scientists to combine the two sources of knowledge due to the knowledge gap between universities and companies. Strict non-disclosure rules imposed on scientists who move to academia from private companies may also hamper the combination.

In the same vein, EBM shows an equally small impact on entrepreneurship among UoT scientists. Among UoT scientists, those who have multi-educational background consists the minority; meanwhile, in that minority group, the experience of having trained in the heterogeneous research environments have nothing to do with entrepreneurship. The reason for this relation is under-investigated.

The results of this empirical research clearly showed that among the previously-studied mobility, some, such as JM and IM, enhance entrepreneurship; others—SM and EBM—do not. In order to understand the impact of mobility on the status of entrepreneurship among scientists, scholars may need to divide mobility into types according to the positive effect or negative effect on the skill-formation of entrepreneurs.

V. CONCLUSION

This study explores the mechanism by which mobility influences university entrepreneurship through an empirical analysis of Japanese scientists working for the University of Tokyo (UoT). A new dataset composed of credible and varied information facilitated the analysis of more than 500 scientists currently holding full-time positions at UoT.

Drawing on a theoretical framework from existing literature, this study distinguished between Japanese AEs and non-AEs. This study then compared the career paths of AEs to those of non-AEs. Four kinds of mobility—JM, SM, IM, and EBM—were highlighted. The result of the probit analysis clearly showed that both JM and IM are positively related to university entrepreneurship among scientists at significant levels, whereas SM and EBM are not.

This result indicates that some kinds of mobility encourage Japanese scientists to behave in ways that allow them to gain opportunities for commercializing university research. However, other kinds of mobility do not affect entrepreneurship.

This study contributes to the existing literature by indicating a condition wherein mobility is associated with entrepreneurship. This paper suggests that, regarding positive impact on entrepreneurship, types of mobility that promote access to, acquisition of, and accumulation of knowledge necessary for spinoff-firm creation, should be distinguished from other forms of mobility. However, this paper has many shortcomings. Future studies with more robust empirical analyses would be beneficial to both universities and policy-makers who wish to encourage scientist mobility in order to increase university entrepreneurship.

Finally, the methodological limits on this study should be mentioned. Since the research was focused on UoT scientists, the general applicability of the analysis is limited. Although the examination of UoT's case provides a satisfactory explanation on the influences of mobility on Japanese scientists, it is not enough to draw a more general conclusion. Therefore, it would be necessary to collect corresponding data from several other national universities to ensure that the result is consistent across Japan's academic institutions. Moreover, samples from different regions in Japan should be used in order to confirm that the result is robust and consistent across regions. Further research is needed to investigate how each type of mobility interrelates with the university entrepreneurship.

REFERENCES

Ahmad, N., & Seymour, R.G. (2008). Defining entrepreneurial activity: Definitions supporting frameworks for data collection.*OECD Statistics Working Paper. Retrieved* from http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=std/doc(2008)1.

Asheim, B.T., & Isaksen, A. (2002). Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge. *The Journal of Technology Transfer, 27*(1): 77–86.

Baba, Y., Shichijo, N., & Sedita, S. (2009). How do collaborations with universities affect firms' innovative performance? The role of "Pasteur scientists" in the advanced materials field. *Research Policy, 38*, 756–764.

Balconi, M., & Laboranti, A. (2006). University–industry interactions in applied research: The case of microelectronics. *Research Policy, 35*, 1616–1630.

Bercovitz, F., & Feldman, M. (2007). Academic entrepreneurs and technology transfer: Who participates and why? In F. Malerba & S.Brusoni (Eds.), *Perspectives on innovation*. Cambridge: Cambridge University Press.

Carlsson, B., Acs, Z.J., Audretsch, D.B., & Braunerhjelm, P. (2009). Knowledge creation, entrepreneurship, and economic growth: Historical review. *Industrial and Corporate Change, 18*(6), 1193–1229.

Chalamwong, Y. (2004). *The migration of highly skilled Asian workers in OECD member countries and its effects on economic development in East Asia*. Paper presented at A Joint MOF/PRI-OECD Research Project: The Impact and Coherence of OECD Country Policies on Asian Developing Economies, OECD. Retrieved 9 January 2015 from http://www.oecd.org/pcd/31857618.pdf

Collins, S., & Wakoh, H. (2000). Universities and technology transfer in Japan: Recent reforms in historical perspective. *Journal of Technology Transfer, 25*, 213–222.

Crespi, G.A., Geuna, A., & Nesta, L. (2007). The mobility of university inventors in Europe. *Journal of Technology Transfer, 32*, 195–215. DOI: 10.1007/s10961-006-9012-0

Davenport, S. (2004). Panic and panacea: Brain drain and science and technology human capital. *Research Policy, 33*, 617–630. DOI: 10.1016/j.respol.2004.01.006

D'Este, P., & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy, 36*(9): 1295–1313. DOI: 10.1016/j.respol.2007.05.002

Edler, J., Fier, H., & Grimpe, C. (2011). International scientist mobility and the locus of knowledge and technology transfer. *Research Policy, 40*(6), 791–805. DOI: 10.1016/j.respol.2011.03.003

Fleming, L., Mingo, S., & Chen, D. (2007). Collaborative brokerage, generative creativity, and creative success. *Administrative Science Quarterly, 52*(3), 443–475.

Harayama, Y., Ujiie, Y., & Degawa, T. (2009). *Driver of industrial innovation: Technology ventures fueling innovation ecosystem* [Sangyo kakushin no gensen]. Tokyo: Hakuto-Shobo.

Hormiga, E., & Bolívar-Cruz, A. (2012). The relationship between the migration experience and risk perception: A factor in the decision to become an entrepreneur. *International Entrepreneurship Management Journal*, 297–317. DOI:10.1007/s11365-012-0220-9

Hunt, J., & Gauthier-Loiselle, M. (2008). How much does immigration boost innovation? *NBER Working Paper, 14312*. National Bureau of Economic Research. Retrieved 9 January 2015 from http://www.nber.org/papers/w14312.pdf

Jonkers, K., & Tijssen, R. (2008). Chinese researchers returning home: Impacts of international mobility on research collaboration and scientific productivity. *Scientometrics, 77*(2), 309–333.

Kneller, R. (2007). The beginning of university entrepreneurship in Japan: TLOs and bio-ventures lead the way. *Journal of Technology Transfer, 32*(4), 435–456.

Krabel, S., Siegel, D., & Slavtchev, V. (2012). The internationalization of science and its influence on academic entrepreneurship. *Journal of Technology Transfer, 37*, 192–212. DOI: 10.1007/s10961-010-9182-7

Lam, A. (2011). What motivates academic scientists to engage in research commercialization: "gold," "ribbon" or "puzzle"? *Research Policy, 40*, 1354–1368. DOI: 10.1016/j.respol.2011.09.002

Lee, S. (2004). *Foreign-born scientists in the United States—do they perform differently than native-born scientists?* [Doctoral dissertation]. Georgia Institute of Technology. Retrieved 9 January 2015 fromhttp://archive.cspo.org/rvm/publications/pubs_docs/lee_sooho_200412_phd.pdf

Libaers, D., & Wang, T. (2012). Foreign-born academic scientists: Entrepreneurial academics or academic entrepreneurs? *R&D Management, 42*(3): 254–272.

Mosey, S., & Wright, M. (2007). From human capital to social capital: A longitudinal study of technology-based academic entrepreneurs. *Entrepreneurship Theory and Practice, November2007*, 909–935.

OECD. (2001). *International mobility of highly skilled*. Paris: OECD Publishing.

OECD. (2008). *The global competition for talent: Mobility of the highly skilled*. Paris: OECD Publishing.

O'Shea, R., Allen, T.J., O'Gorman, C.& Roche, F. (2004). Universities and technology transfer: Are view of academic entrepreneurship literature. *Irish Journal of Management,* 25(2), 11–29.

Patent and Trademark LAw Amendments Act, Pub. L. 96–517, 1980.

Richardson, J., & McKenna, S. (2003). International experience and academic careers: What do academics have to say? *Personnel Review,* 32(6), 774–795.

Rothaermel, F., Agung, S. & Jiang, L. (2007). University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change, 16*(4), 691–791.

Sauermann, H., Cohen, W., & Stephan, P. (2010). *Doing well or doing good? The motives, incentives, and commercial activities of academic scientists and engineers*. Paper presented at the DRUID Summer Conference 2010. Retrieved 9 January 2015 from http://www2.druid.dk/conferences/viewpaper.php?id=501180&cf=43

Saxenian, A. (2002). Brain circulation: How high-skill immigration makes everyone better off. *The Brookings Review, 20*(1): 28–31.

Saxenian, A. (2007). *The new Argonauts: Regional advantage in a global economy*. Cambridge, MA: HUP.

Shane, S. (2004). Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States. *Journal of Business Venturing, 19*, 127–151.

Stephan, P., & Levin, S.G. (2001). Exceptional contributions to US science by the foreign-born and foreign-educated. *Population Research and Policy Review, 20*, 59–79.

Stokes, D.E. (1997). *Pasteur's quadrant: Basic science and technological innovation*. Washington D.C: Brookings Institution Press.

Thorn, K. (2009). The relative importance of motives for international self-initiated mobility. *Career Development International, 14*(5), 441–464.

Walsh, J., Baba, Y., Goto, A., & Yasaki, Y. (2008). Promoting university-industry linkages in Japan: Faculty responses to a changing policy environment. *Prometheus, 26*(1), 39–54.

Wright, M., Hmieleski, K.M., Siegel, D.S., & Ensley, M.D. (2007). The role of human capital in technological entrepreneurship. *Entrepreneurship Theory and Practice, 31*(6), 791–806.

Zelekha, Y. (2013). The effect of immigration on entrepreneurship. *KYKLOS, 66*(3), 438–465.

Zucker, L., & Darby, M. (2006). Movement of star scientists and engineers and high-tech firm entry. *NBER Working Paper 12172.* Retrieved November 4, 2016 from *http://doku.iab.de/veranstaltungen/2006/CAFE_2006_B3_Zucker.pdf.*