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An empirical analysis of the relationship between individual characteristics and research productivity

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Abstract This paper provides an analysis of the relationship between research performance and individual characteristics (e.g., career path information) of researchers, based on information provided in the curriculum vitaes of 565 excellent researchers within the life sciences and medical sciences fields in Japan. I specifically analyzed the relationship between the experiences of practical physicians and research performance. As a result, I found that the experience as a practical physician had a statistically positive relationship with the number of research papers, but there was not a significant relationship with the number of citations. Moreover, the diversity of a researcher's career related significantly to the number of citations and patents. An employment experience at a young age with a company or independent administrative agency had a significant and positive relationship with number of coauthors. However, a significant relationship between work experience in a foreign country and research performance was not observed.

Keywords Research productivity · Curriculum vitae · Career path · Practical physician · Diversity of career · Research grant

Introduction

A researcher's characteristics, such as the affiliated research organization, international work experience, college degrees, and funding from research grants, differ considerably from one researcher to the next. Therefore, it is important to clarify the relationship between a researcher's individual characteristics, including career path and research performance, quantitatively.

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This paper offers an empirical analysis regarding the factors that contribute to research productivity (e.g., number of papers, citations, patents, and coauthors) in the life sciences and medical sciences fields in Japan. I analyzed the relationship between the experiences of practical physicians and research performance, that had not been examined previously. In addition, I have provided an explanation of the relationships between research performance and career path (e.g., employment experience in an administrative agency, independent agency, company, or university).

Previous studies have analyzed the relationships between career path and research productivity; for example, Dietz et al. (2000) assessed the utility of the curriculum vitae (CV) as a data source for examining the career paths of scientists and engineers. As a result of an ordinary least squares (OLS) regression using CV data of 190 researchers in biotechnology and microelectronics areas, three independent variables—number of publications during Ph.D. studies, time in assistant professorship rank, and patents—related significantly and positively to the number of publications per year after receipt of the doctoral degree. Dietz and Bozeman (2005) showed that career patterns and some degree of career diversity (independent variables) are associated with both publication and patent productivity (dependent variables); their findings were based on CV data of scientists and engineers working at university-based research centers in the United States.

Jonkers and Tijssen (2008) debated the relationship between scientific mobility and international collaboration using 76 plant molecular life scientists at the senior level of professor/principal investigator in China's research organizations. As a result of their analysis, they showed that overseas experience and time since returning to China had significantly positive correlations with the number of publications and international co-publications. Time spent abroad also correlated with international co-publications. Cañibano et al. (2008) showed that international mobility in the post- or pre-doctoral stage had no statistically positive association to publication productivity, based on CVs of 266 researchers in Spain. Moreover, as a result of categorizing researchers into four groups (i.e., mobile, immobile, excellent, and entrepreneurial) based on data from CVs of 326 researchers who were grant holders at a Swedish research foundation, Sandström (2009) showed that immobile scientists are less productive and less entrepreneurial, while entrepreneurial researchers dedicated to patenting and groundbreaking activity have changed their affiliations many times in their careers. Su (2011) showed that post-doctoral training resulted in an increase of 17 % for published articles within 3 years of earning doctorate degrees, although this positive effect appears to have faded quickly. Furthermore, findings showed that industry experience within 3 years after earning a doctoral degree resulted in a 28 % decrease in publications, based on the CVs of tenured scientists and engineers working at research universities. The CV appears to be useful when investigating a researcher's career, as noted in many previous studies (Gaughan and Bozeman 2002; Gaughan and Ponomariov 2008; Gaughan 2009; Jonkers 2011; Cañibano et al. 2011).

Moreover, a trend within the medical sciences and clinical sciences fields has been observed in recent years in Japan; Kanda and Kuwahara (2011) showed that the largest ratio of research time (53.3 %) was devoted to basic medicine; further, clinical fields[1] researchers were identified as having the smallest ratio (22.0 %), based on four activities (research activity,[2] education, social service,[3] and others) in the faculty teacher in 2008. In

[1] Clinical fields were classified as internal medicine and surgery.

[2] Research activity includes collecting data and information associating research, data processing, measurements and experiments, and research meetings.

[3] Diagnosis and treatment activity is included in the social services classification.

addition, a decrease in time devoted to research was noted when compared with 2002 findings, and this decrease was especially large in national and public universities and local national universities. On the other hand, the ratio of time devoted to social services, including diagnosis and treatment activity, increased. The authors pointed out, "National universities turn into independent administrative entities, and having changed the organization and management greatly cause the phenomenon of increasing the social service activity ratio, like the diagnosis and treatment in the university attachment hospital in the clinical sciences fields." [4].

Toyoda (2012) showed that the number of papers in clinical medicine fields has displayed a slight uptrend at reputable national universities and private universities, but a stagnation tendency was observed for public universities; furthermore, a decreasing tendency has been noted for local universities in Japan since 2000.

Therefore, it is suggested that the ratio of time devoted to research decreases in the clinical medicine fields, and time devoted to diagnosis and treatment activity becomes greater as social services increase. Additionally, the number of published papers from reputable national universities and private universities has experienced a slight uptrend.

Furthermore, this study includes an analysis of the relationship between the experiences of the practical physician and research productivity. In other words, it verifies whether the experience as a practical physician has a negative relationship to research activities by decreasing research time, or if it has positive relationship based on the acquisition of knowledge for diagnosis and treatment activities. In addition, the relationship between a researcher's career path and research productivity is verified. Until now, there has been no study with an empirical analysis about the relationship among the researcher's features, career path, and productivity through econometrics for researchers in Japan.

This paper is organized as follows. "Hypotheses" section describes the hypothesis. "Data" section provides details regarding data. "Methods of analysis" section explains the method of analysis. "Estimated results" section describes the estimation results, and "Conclusion" section presents discussions and conclusions.

Hypotheses

This section provides a description of the hypotheses pertaining to the relationship between features of the researcher and research productivity. First, I have examined the relationship between a researcher's experience as a practical physician and research productivity has not been analyzed. There are two hypotheses in this respect:

(1) Experience as a practical physician

- Except the residency period, experience as a practical physician has a negative relationship with research performance as it decreases the time devoted to research.
- The experience and knowledge obtained by the practical physician are positively associated with research productivity.

[4] The independent administrative agency system is a system designed to give an independent corporate status to the organization. This system has aimed to improve the quality, efficiency, transparency of operations, and autonomous management.

Next, this study analyzes the three hypotheses concerning career and research productivity largely based on research by Dietz and Bozeman (2005) who have analyzed the relationship between career patterns and number of papers and patents:

(2) Job changes
Job changes throughout one's career provide access to new social networks, resulting in higher productivity (Dietz and Bozeman, 2005). They divided the organization into three sectors: academic, industry, and government. I have used variables of employment experience in career divisions of three types of agencies (an administrative agency, a company, and an independent administrative agency) and employment experience in a foreign country.[5] In this study, academic is assumed a typical career, an administrative agency corresponds to "government," and a company represents "industry." An independent administrative agency is not under an administrative agency, but is created on the basis of the concept of separation of governmental ministries and agencies into planning functions and operations. Therefore, it is different from an administrative agency. I have also used diversity of career as a variable. The variable of first employment experience in these divisions clarifies the relationship between productivity and research experience at a young age. Dietz and Bozeman (2005) used the Tobit model to show that patent rates were associated with careers in industry. Additionally, Jonkers and Tijssen (2008) observed, "Foreign experience is expected to have an effect on the researcher's English proficiency, which influences his [or her] ability to publish in English language international journals."

(3) Traditional career path
Homogeny hypothesis: Traditional career path, defined as spending one's entire post-Ph.D. career at a university, will yield higher productivity (Dietz and Bozeman, 2005). They indexed as intersectoral job changes the extent to which a career pattern conforms to the "typical." They note that more traditional academic career paths results in higher number of publications. I used the variables of pursuing a career at the same university from which one graduated or obtained a doctorate, or holding all positions at the same institution, to verify these results.

The concepts of diversity of career, career at the same university (graduated or doctoral), and all career at the same institution correspond to Dietz and Bozeman's (2005) notion of homogeny. In particular, diversity of career implies intersectoral job changes based on the traditional career pattern of only those belonging to academia.

(4) Precocity
Early career experiences obtained through graduate assistantships and post-doctoral research experiences, and early productivity, indicated by publishing before obtaining a doctoral degree, will yield higher productivity (Dietz and Bozeman 2005). They used the cumulative number of publications at the doctorate year. They showed that the relationship between precocity and productivity appears to be weak. Moreover, they observed that postdoctoral research positions might potentially inhibit productivity. I examined the experience of researchers selected for the Research Fellowship for Young Scientists[6] and Assistants. It is possible that fellowship experience is

[5] Experience as a researcher in a research institution in a country other than Japan is referenced.

[6] Japan Society for the Promotion of Science (JSPS) provides a special program that grants fellowships to (1) young Japanese postdoctoral researchers who conduct research activities at Japanese universities or research institutions on a non-employment basis and to (2) graduate students who conduct research in Japanese university doctoral programs. Please refer to http://www.jsps.go.jp/english/e-pd/index.html.

positively related to research activities because of the provision of an environment that promotes productive research from a young age. Under this program, research grants are provided to excellent young researchers. According to the JSPS website, 4,876 people have been applying on average for the past 4 years (2009–2012) in medical sciences fields, and 1,152 people were adopted for this program (23.6 %). These researchers can be regarded as highly efficient because as many as 93,933 students were doing doctoral courses in this period (Report on the Survey of Research and Development, Statistics Bureau, 2009–2012). The assistantship experience is especially applicable to the medical sciences field. While an assistant learns a lot on the job, actual time spent on research activities is very short. According to the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) (2008), the engagement ratio of an assistant in research activities is 36.6 %, while the average stands at 39.1 %. Moreover, although the ratio of time usually devoted to social service activities and office work (including diagnosis/treatment) is on an average 23.4 %, an assistant devotes 31.5 % of his/her time to such activities. Additionally, it can be said that the experience of both research fellows and assistants are proxy variables associated with independence as researcher

Data

In this analysis, data were obtained from researchers in the life sciences and medical sciences fields who had been selected for the 21st Century Centers of Excellence (COE) program established in 2002 by the Japan Society for the Promotion of Science. The objective of this program is to cultivate a competitive academic environment among Japanese universities. Dietz and Bozeman (2005) used data from the Research Value Mapping Program, a project funded by the U.S. Department of Energy and the National Science Foundation. Their data sources were not a "general sample of university scientists and engineers, but rather academic faculty who are affiliated with research centers that were designed to have industrial ties." On the other hand, this study used data from the 21st COE program, which aimed to cultivate a competitive academic environment among Japanese universities by providing targeted support for the creation of a world-class research and education base. This study sample comprises 39 universities and various researchers affiliated to academic faculties and research centers. The sample includes a number of well-known and excellent researchers in diverse fields. Moreover, Dietz and Bozeman's (2005) dataset differs in that it focus on whether the relationship with the industry is strong.

First, I used the Scopus database to document each researcher's data (i.e., number of papers and citations) because Scopus assigns author IDs to prominent researchers, facilitating full name searches and researcher's institution searches. The author ID function on the Scopus database is not completely error-free, thus leading to problems in identifying authors with affiliation changes. To avoid problems in data accuracy, the collected data were filtered by matching affiliations and departments. Since this process could lead to the accidental omission of researchers who had changed their affiliations a number of times, I contacted each researcher via e-mail to confirm his/her list of publications. Moreover, I counted the number of coauthors per paper.

The number of patents, for which I used Espacenet Patent search, offered by the European Patent Office. Espacenet offers free access to more than 80 million patent documents worldwide, and it contains information about inventions and technical developments since 1836. Furthermore, it is possible to search by connecting with Scopus (using SciVerse Hub); searches can be conducted according to author's name, institution, year, and field. For this study, searches were conducted for number of patents, author's full name, and institutions where employed. I refer to publication date in this paper; it represents the date that a patent application was published. Thus, it represents the date the document became available to the public. It is necessary to note that the patent used for this analysis were limited to the ones for which researchers were identified as inventors.

In addition, I used the KAKEN[7] database for the research grant. KAKEN is the database of Grants-in-Aid for Scientific Research. It was established and provided by the National Institute of Informatics, with the support of the MEXT and the JSPS. Grants-in-Aid are awarded to promote creative and pioneering research across a wide spectrum of scientific fields, ranging from the humanities and social sciences to the natural sciences. Grants are awarded to projects organized by individual researchers or research groups at Japanese universities or research institutes. Research results obtained under these grants are published in a number of academic journals. In this study, I analyzed only those research studies headed by researchers, and I used only direct expenses.

Moreover, information on each researcher's career was obtained from the CV that was publicly available on the Web and ReaD&Researchmap database. ReaD&Researchmap[8] is a service that the Japan Science and Technology Agency provides on the Internet to support the researchers' database and performance management system constructed by the university and research institutions. This database can search for 22,000 researchers based on names and affiliated institutions. The template for a CV was developed for this database; it contains career information, as well as research fields and papers published.

Out of 1,255 researchers in this field, 23 researchers did not have any paper. Although I searched for the CVs of all 1,255 researchers, I obtained only 565 complete CVs, based on which, this study targeted 565 researchers with complete career information after graduation from university. The cross-section data covers 1996–2009.

Methods of analysis

Regarding methodology used for this study, the numbers of papers and citations reflect research performance, and the numbers of patents and coauthors used for explained variables. The decline in citations of recent papers is a major problem. To address it, some studies have used normalization, which is used with forward citation of patents (Hall et al. 2001). The normalization approach has been applied in this study by dividing each citation by the corresponding year's citation mean. Citation per person, per year was calculated for sample of this study and the citation of each researcher for each year was divided by this citation mean. Additionally, each explained variable was divided by the researcher's career length to resolve problems associated with differences in length of researchers' careers. Because researchers' birth dates were not available, this study is based on the assumption that a researcher was employed initially at age 28. Furthermore, the retirement age was established as age 65 in 2009. As an example, if the first year of employments was 1999, the career length was 10 years (i.e., $2009 - 1999 = 10$). Career length was defined based

[7] http://kaken.nii.ac.jp/.

[8] http://researchmap.jp/.

on the method noted above; it assumes career length as 37 years if it spans 38 years or more.

Because each explained variable is nonnegative, use of the Tobit model, Poisson model, and negative binomial model were appropriate for this study (Dietz and Bozeman 2005). The explanatory variables were: experience of those selected for the Research Fellowship for Young Scientists, first employment according to three career divisions (i.e., administrative agency,[9] company, or independent administrative agency[10]), experience accrued in the above three career divisions, and diversity of career. Diversity is associated with the number of divisions through which a researcher belongs (i.e., 0–3). I examined diversity of employment excluding academia as it related to research activities. In addition, assistant experience, research careers in foreign countries, experience as a practical physician (residency period is excluded), gender (male = 1), amount of Grants-in-Aid for Scientific Research, career with the university from which one graduated, career at the same university where doctorate was received, all positions at the same institution, doctoral degree from foreign countries, type of doctoral degree (e.g., doctoral degree from foreign country, medical science, science, medical dentistry, engineering, agriculture, pharmacology), and cross-term of fellowship experience and assistant were considered. Table 1 shows the variables used.

Estimated results

This section shows the estimation results of selection probability for disclosing career information, and estimation results of the relationship between researcher's features and performance, according to the Tobit model, Poisson model, and negative binomial model. When the null hypothesis that data follows the Poisson distribution (i.e., assumes the average to be equal to variance) is rejected, findings of this study support the results of the negative binomial model.

Selection probability of career information disclosure

This study includes an analysis of the relationship between research performance and disclosed career information, based on data from 1,232 researchers. I estimated the odds ratio using a logit model; explained variables included verification of complete researcher information (1 = Yes, 0 = No), and the number of papers and citations for the explanatory variables.

The odds ratio is the ratio of the odds of an event occurring in one group to the odds of it occurring in another group. Odds are the ratio of the probability of a variable becoming one or zero. Table 2 shows the findings from the logit model and the odds ratio.

According to the odds ratio, the ratio of the probability of disclosing career information to the probability of not disclosing, according to an increase in the number of published

[9] It includes research institute under the direct control of the administrative agency in this analysis.

[10] This variable refers to independent administrative agencies as of October 2012, other than the incorporated national university. It includes foundations and the Inter-University Research Institute Corporation (IURIC). IURIC is classified as an independent administrative agency in this study to distinguish it from a university, though it is based on an incorporated national university. IURIC has made an important contribution to the development of Japan's academic research by conducting effective joint research and providing researchers with benefits that are difficult for individual universities to maintain (e.g., large-scale facilities, considerable amounts of data, and academic materials).

Table 1 Description of variables

Variable	Description
Number of papers	Cross-section data of the number of papers of each researcher (divided by researcher's career length)
Number of citations	Cross-section data of the number of papers by researcher (divided by number of average citations each year and researcher's career length)
Number of patents	Cross-section data of number of patents for each researcher (divided by researcher's career length)
Number of coauthors	Cross- section data of number of coauthors per paper (divided by researcher's career length)
Research Fellowship for Young Scientists	Experience and encouragement received from grant awarded to young researcher (1 = Yes, 0 = No)
Diversity of career	How many career experiences were obtained in the three divisions: administrative agency, company, and independent administrative agency? (0–3, i.e., 0 = They belonged only to academia)
First employment with an administrative agency	1 = Yes, 0 = No
Employment experience in an administrative agency	1 = Yes, 0 = No
First employer with a company	1 = Yes, 0 = No
Employment experience with a company	1 = Yes, 0 = No
First employment with independent administrative agency	1 = Yes, 0 = No
Employment experience in an independent administrative agency	1 = Yes, 0 = No
Assistant experience	1 = Yes, 0 = No
Foreign research experience	1 = Yes, 0 = No
Experience as a practical physician	The residency period is excluded: 1 = Yes, 0 = No
Male gender	1 = Yes, 0 = No
Amount of Grants-in-Aid for scientific research	Grants-in-Aid are awarded to promote creative and pioneering research across a wide spectrum of scientific fields. Grants are awarded to projects organized by individual researchers or research groups at Japanese universities or research institutes. The logarithm was taken after 1 was added to the grant.
Career at university from which the researcher graduated	Is career as faculty member at the same university from which one graduated? 1 = Yes, 0 = No

Table 1 continued

Variable	Description
Career at the same university as doctoral program	Is career at same university as doctoral program? 1 = Yes, 0 = No
All careers at the same institution	1 = Yes, 0 = No
Doctoral degree from a foreign country	1 = Yes, 0 = No
Doctor of Medical Science (DMSc)	1 = Yes, 0 = No
Doctor of Science	1 = Yes, 0 = No
Doctor of Dentistry	1 = Yes, 0 = No
Doctor of Engineering	1 = Yes, 0 = No
Doctor of Agriculture	1 = Yes, 0 = No
Doctor of Pharmacology	1 = Yes, 0 = No
Other doctoral degree	1 = Yes, 0 = No
Experience as research fellow for young scientists and as assistant	Cross-term of experience in research fellowship and assistant (1 = Yes, 0 = No)

papers, was 1.340. In other words, this means that the probability of disclosing career information to the public increased relatively by 34 %. The number of citations was not related necessarily to the selection probability of disclosing, because a significant result was not obtained by the citation count. Therefore, because the probability of disclosure is high for a highly published researcher, it is necessary to note that productivity of researchers targeted by this analysis was higher than that of researchers excluded from analysis because of non-disclosure. Additionally, this study cannot explain all the trends in the field of life sciences and medical sciences since this analysis was applied only to researchers who attracted large-scale competitive research funding (21st COE program).

Estimated results for number of papers

The following estimation is based on the analysis of 565 researchers who disclosed career information. Model 1 uses the diversity of career variable (the value of this variable was zero if a researcher belonged only to academia. The value of this variable was two if the researcher had employment experience in a company as well as an administrative agency). Model 2 uses the first employment variable. This model analyzed the relationship between three career divisions for first employment (i.e., the career at the young age) and productivity. Model 3 uses the employment experience variable. This model is not restricted to first employment, and the relationship between the three career divisions and productivity is analyzed. The logarithm was taken after 1 was added to the grant.

Table 3 presents the estimated results for number of papers. The main results are given below:

- Experience as a practical physician: experience as a practical physician, except the residency period, was positively associated with number of papers. It is suggested that the knowledge obtained by the practical physician has a positive influence on the number of papers.
- *Job changes* first job experience with an independent administrative agency was positively associated with number of papers. However, first job or experience in an administrative agency showed a significantly negative relationship with the number of papers in the negative binomial model. A significant relationship was not seen for diversity of career. Research experience in a foreign country had no significant relationship with number of papers.
- *Traditional career path* employment with one's graduate university was positively associated. It is suggested that the researcher who works at his/her graduate university has excellent research productivity.
- *Precocity* research fellowship was positively associated. It is suggested that fellowship grants to young postdoctoral researchers or graduate students promotes research productivity.

Male gender and grant amount were also statistically positive.

Estimated results for number of citations

Table 4 presents the estimated results for number of citations.

- Experience as a practical physician: it was not significant but the sign was negative. It is suggested that decreasing research time leads to difficulty in producing papers with strong impact.

Table 2 Selection probability of career information disclosure

Variables	Coef.(std. err.)	Odds ratio	$P > \|z\|$
The number of papers	0.293*** (0.0477)	1.340	0.000
The number of citations	0.101 (0.134)	1.106	0.439
Constant	−0.775*** (0.0854)		

Log likelihood is −790.2. Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

- *Job changes* diversity of career and first employment or experience in an independent administrative agency had a statistically positive relationship with citations. The findings suggest that a variety of employment experiences are advantageous for producing impactful papers. A career with an independent administrative agency such as the Inter-University Research Institute Corporation also results in impactful research by enabling the use of large-scale research facilities.
- *Traditional career path* employment with the university of one's graduation and all careers at the same institution were not significant.
- *Precocity* research fellowship experience did not relate significantly.

Grant amount was also statistically positive

Estimated results for number of patents

Table 5 presents the estimated results for number of patents.

- Experience as a practical physician: a significant relationship was not detected.
- *Job changes* experience with an independent administrative agency and career diversity had significantly positive relationship with patent activity for all models.
- *Traditional career path* employment with the graduation university and all careers at the same institution were not significant.
- *Precocity* assistantship experience had a significantly negative relationship. Moreover, although research fellowship experience showed a statistically negative relationship, cross-term of the fellowship and assistant experiences showed a positive relationship with patents. This positive relationship suggested that the time required to become an independent researcher is associated with patent productivity.

Grant amount did not relate to patents, since grants-in-aid for scientific research primarily support academic research and do not statistically relate to number of patents. From the study sample, 359 researchers did not have patents (63.5 %) and 75.4 % of researchers had zero or one patent. Therefore, it is shown that patent activity was not the main focus of researchers and the characteristics of researchers who had several patents differed from those of general researchers.

Estimated results regarding number of coauthors

Though the number of papers and experience as a practical physician showed significantly positive relationships, joint authorship through research collaboration was shown in previous studies to have a positive relationship to research productivity (Price and Beaver 1966; Zuckerman 1967; Pao 1982; Pravdic and Oluic-Vukovic 1986; Lee and Bozeman

Table 3 Estimated results for number of papers

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	0.866** (0.340)	0.915*** (0.338)	0.873** (0.339)	0.237** (0.0982)	0.268*** (0.0971)	0.243** (0.0980)
Diversity of career	−0.139 (0.274)			−0.0465 (0.0848)		
Administrative agency (first)		−1.558 (1.279)			−1.990** (0.835)	
Administrative agency			−0.715 (0.812)			−0.623** (0.293)
Company (first)		−0.115 (0.719)			0.00676 (0.245)	
Company			−0.509 (0.556)			−0.188 (0.185)
Independent administrative agency (first)		1.248** (0.577)			0.526*** (0.172)	
Independent administrative agency			0.0394 (0.319)			0.0466 (0.0968)
Foreign research experience	−0.0237 (0.291)	−0.0379 (0.290)	−0.0397 (0.291)	0.0117 (0.0878)	0.0122 (0.0876)	0.00745 (0.0877)
Career at same university (graduated)	0.757* (0.428)	0.783* (0.428)	0.772* (0.428)	0.324** (0.137)	0.347** (0.136)	0.328** (0.137)
Career at same university (doctoral)	−0.0879 (0.451)	−0.0838 (0.455)	−0.109 (0.450)	−0.0320 (0.147)	−0.0101 (0.149)	−0.0292 (0.147)
All careers at the same institution	0.397 (0.452)	0.477 (0.444)	0.389 (0.452)	0.122 (0.134)	0.156 (0.131)	0.119 (0.133)
Research Fellowship	1.641*(0.845)	1.569* (0.835)	1.608* (0.845)	0.603** (0.251)	0.499** (0.246)	0.586** (0.251)
Assistant experience	−0.398 (0.328)	−0.281 (0.331)	−0.437 (0.330)	−0.127 (0.0970)	−0.0731 (0.0974)	−0.139 (0.0974)
Research fellow and assistant (cross-term)	−0.978 (0.978)	−0.791 (0.962)	−0.967 (0.977)	−0.327 (0.290)	−0.175 (0.284)	−0.326 (0.290)
Male gender	1.333* (0.780)	1.348* (0.776)	1.337* (0.779)	0.678** (0.285)	0.702** (0.283)	0.673** (0.284)
Amount of Grants-in-Aid	0.175*** (0.0588)	0.176*** (0.0585)	0.174*** (0.0588)	0.0632*** (0.0175)	0.0662*** (0.0174)	0.0624*** (0.0175)
Doctoral degree from foreign country	−0.389 (1.083)	−0.251 (1.083)	−0.341 (1.084)	−0.171 (0.345)	−0.0404 (0.347)	−0.129 (0.346)
Doctor of Medical Science (DMSc)	3.299*** (1.064)	3.174*** (1.069)	3.344*** (1.066)	0.697*** (0.265)	0.666** (0.264)	0.881*** (0.280)
Doctor of Science	2.876*** (1.087)	2.661** (1.093)	2.950*** (1.088)	0.503* (0.274)	0.448* (0.271)	0.698** (0.287)

Table 3 continued

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Doctor of Dentistry	2.446** (1.235)	2.329* (1.239)	2.497** (1.235)	0.379 (0.324)	0.351 (0.322)	0.561* (0.335)
Doctor of Engineering	2.253** (1.118)	2.144* (1.118)	2.407** (1.125)	0.0952 (0.275)	0.0865 (0.271)	0.338 (0.292)
Doctor of Agriculture	2.171* (1.177)	2.040* (1.172)	2.324* (1.184)	0.0570 (0.318)	0.0526 (0.315)	0.301 (0.335)
Doctor of Pharmacology	3.942*** (1.136)	3.698*** (1.139)	4.036*** (1.140)	0.837*** (0.274)	0.775*** (0.270)	1.048*** (0.290)
Other doctoral degree	3.209*** (1.121)	2.977*** (1.123)	3.263*** (1.122)	0.662** (0.310)	0.517* (0.307)	0.814** (0.320)
Constant	−3.611*** (1.384)	−3.706*** (1.400)	−3.624*** (1.388)	−1.039** (0.409)	−1.179*** (0.416)	−1.217*** (0.421)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 4 Estimated results for number of citations

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	−0.0583 (0.142)	−0.0566 (0.141)	−0.0567 (0.142)	−0.0598 (0.142)	−0.0541 (0.141)	−0.0587 (0.141)
Diversity of career	0.211* (0.115)			0.290** (0.119)		
Administrative agency (first)		−0.357 (0.535)			−2.426 (2.174)	
Administrative agency			−0.0674 (0.343)			−0.266 (0.433)
Company (first)		0.318 (0.301)			0.509 (0.361)	
Company			0.216 (0.233)			0.385 (0.271)
Independent administrative agency (first)		0.722*** (0.241)			0.901*** (0.222)	
Independent administrative agency			0.245* (0.134)			0.332** (0.136)
Foreign research experience	0.114 (0.122)	0.114 (0.122)	0.109 (0.122)	0.171 (0.132)	0.183 (0.133)	0.168 (0.133)
Career at same university (graduated)	0.168 (0.180)	0.177 (0.179)	0.175 (0.180)	0.260 (0.203)	0.280 (0.209)	0.283 (0.206)
Career at same university (doctoral)	−0.104 (0.189)	−0.0780 (0.191)	−0.108 (0.189)	−0.138 (0.217)	−0.0607 (0.227)	−0.148 (0.219)
All careers at the same institution	0.0704 (0.189)	0.0480 (0.186)	0.0676 (0.189)	0.132 (0.213)	0.108 (0.210)	0.130 (0.213)
Research Fellowship	−0.0399 (0.354)	0.123 (0.349)	−0.0472 (0.354)	−0.106 (0.401)	0.0991 (0.402)	−0.119 (0.403)
Assistant experience	0.0263 (0.138)	0.0647 (0.139)	0.0221 (0.139)	−0.0131 (0.145)	0.0490 (0.147)	−0.00661 (0.145)
Research fellow and assistant (cross-term)	0.194 (0.409)	0.0803 (0.403)	0.205 (0.409)	0.365 (0.458)	0.214 (0.456)	0.390 (0.461)
Male gender	0.264 (0.326)	0.284 (0.324)	0.270 (0.326)	0.589 (0.477)	0.638 (0.478)	0.595 (0.478)
Amount of Grants-in-Aid	0.0978*** (0.0246)	0.100*** (0.0245)	0.0981*** (0.0246)	0.159*** (0.0324)	0.166*** (0.0323)	0.160*** (0.0325)
Doctoral degree from foreign country	−0.211 (0.453)	−0.0370 (0.453)	−0.186 (0.454)	−0.405 (0.617)	−0.121 (0.612)	−0.357 (0.617)
Doctor of Medical Science (DMSc)	0.844* (0.445)	0.845* (0.447)	0.873* (0.446)	0.974*** (0.378)	1.062*** (0.385)	1.164*** (0.406)
Doctor of Science	0.419 (0.455)	0.399 (0.457)	0.446 (0.456)	0.405 (0.391)	0.484 (0.396)	0.578 (0.416)
Doctor of Dentistry	0.392 (0.517)	0.391 (0.518)	0.419 (0.517)	0.332 (0.488)	0.444 (0.494)	0.513 (0.509)

Table 4 continued

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Doctor of Engineering	0.169 (0.468)	0.189 (0.468)	0.209 (0.471)	−0.136 (0.404)	−0.00807 (0.405)	0.0596 (0.438)
Doctor of Agriculture	0.122 (0.493)	0.143 (0.491)	0.168 (0.496)	−0.490 (0.531)	−0.325 (0.532)	−0.276 (0.558)
Doctor of Pharmacology	0.548 (0.475)	0.488 (0.477)	0.590 (0.477)	0.600 (0.394)	0.621 (0.397)	0.804* (0.425)
Other doctoral degree	0.266 (0.469)	0.178 (0.470)	0.291 (0.470)	0.0293 (0.488)	−0.0214 (0.489)	0.173 (0.497)
Constant	−1.199** (0.579)	−1.276** (0.586)	−1.235** (0.581)	−3.321*** (0.657)	−3.634*** (0.677)	−3.541*** (0.681)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 5 Estimated results for number of patents

	Tobit model			Poisson model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	0.0309 (0.0700)	0.0179 (0.0703)	0.0327 (0.0698)	−0.0878 (0.426)	−0.135 (0.425)	−0.0885 (0.427)
Diversity of career	0.136** (0.0570)			0.756** (0.332)		
Administrative agency (first)		−0.0631 (0.276)			−0.253 (1.826)	
Administrative agency			−0.199 (0.191)			−0.700 (1.455)
Company (first)		0.255* (0.141)			0.694 (0.758)	
Company			0.154 (0.114)			0.457 (0.705)
Independent administrative agency (first)		0.119 (0.120)			0.432 (0.616)	
Independent administrative agency			0.167** (0.0653)			0.946*** (0.360)
Foreign research experience	0.000830 (0.0610)	0.00263 (0.0616)	−0.00178 (0.0609)	0.0812 (0.384)	0.0813 (0.386)	0.0621 (0.385)
Career at same university (graduated)	0.105 (0.0962)	0.110 (0.0972)	0.115 (0.0967)	0.335 (0.637)	0.488 (0.679)	0.450 (0.666)
Career at same university (doctoral)	−0.0530 (0.100)	−0.0429 (0.103)	−0.0578 (0.101)	−0.389 (0.665)	−0.474 (0.712)	−0.512 (0.691)
All careers at the same institution	0.0754 (0.0934)	0.0477 (0.0925)	0.0729 (0.0931)	0.331 (0.664)	0.0762 (0.648)	0.325 (0.667)
Research Fellowship	−0.744** (0.290)	−0.610** (0.280)	−0.766*** (0.295)	−3.590 (4.076)	−3.139 (4.075)	−3.585 (4.076)
Assistant experience	−0.172*** (0.0660)	−0.172** (0.0677)	−0.176*** (0.0663)	−0.884** (0.374)	−0.950** (0.381)	−0.890** (0.375)
Research fellow and assistant (cross-term)	0.821*** (0.309)	0.697** (0.299)	0.848*** (0.315)	4.817 (4.113)	4.332 (4.107)	4.824 (4.115)
Male gender	−0.0407 (0.162)	−0.0292 (0.163)	−0.0364 (0.161)	0.289 (1.204)	0.400 (1.200)	0.286 (1.204)
Amount of Grants-in-Aid	0.0120 (0.0122)	0.0135 (0.0123)	0.0124 (0.0122)	−0.0331 (0.0658)	−0.0323 (0.0678)	−0.0340 (0.0657)
Doctoral degree from foreign country	0.184 (0.227)	0.252 (0.230)	0.210 (0.227)	−0.00631 (1.456)	0.201 (1.418)	0.105 (1.428)
Doctor of Medical Science (DMSc)	0.158 (0.211)	0.187 (0.215)	0.234 (0.218)	0.879 (0.989)	0.992 (1.052)	1.335 (1.199)
Doctor of Science	0.0481 (0.218)	0.0813 (0.221)	0.122 (0.224)	0.206 (1.042)	0.416 (1.096)	0.666 (1.239)
Doctor of Dentistry	0.118 (0.248)	0.141 (0.251)	0.193 (0.253)	0.366 (1.454)	0.419 (1.501)	0.821 (1.612)
Doctor of Engineering	0.103 (0.219)	0.125 (0.221)	0.197 (0.228)	−0.0666 (1.014)	0.171 (1.081)	0.604 (1.275)
Doctor of Agriculture	0.104 (0.236)	0.144 (0.237)	0.199 (0.245)	−0.366 (1.274)	0.0954 (1.296)	0.388 (1.490)

Table 5 continued

	Tobit model			Poisson model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Doctor of Pharmacology	0.326 (0.220)	0.343 (0.223)	0.412* (0.227)	1.280 (0.986)	1.386 (1.058)	1.763 (1.216)
Other doctoral degree	−0.0373 (0.235)	−0.0436 (0.237)	0.0251 (0.238)	−0.170 (1.371)	−0.109 (1.365)	0.249 (1.431)
Constant	−0.434 (0.281)	−0.469 (0.290)	−0.519* (0.288)	−3.127* (1.603)	−3.114* (1.694)	−3.587** (1.775)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.0$; *** $p < 0.01$

2005; Sooryamoorthy 2013). Beaver (2001) showed that one of the purposes for collaboration is to enhance efficiency and productivity. Therefore, the possibility exists that the researcher who is experienced as a practical physician and who collaborates with many coauthors can maintain a high level of research productivity despite limited time for research. Consequently, I analyzed the relationship between the number of coauthors and each variable identified in this study.

Table 6 presents the estimated results for number of coauthors.

- *Experience as a practical physician* a significantly positive relationship was not identified between experience as a practical physician and number of coauthors. The findings suggested that experience as a practical physician does not have a positive relationship with joint authorship.
- *Job changes* although experience in various career divisions was related to the number of coauthors, diversity of career was not a significant factor. There were many coauthors when a company or an independent administrative agency initially employed a researcher. Therefore, work experience in a nonacademic career at a young age appears to have an influence on the number of coauthors due to an expanding network of collaborators. However, a significantly negative association with the number of coauthors was detected in the case of a first job with an administrative agency.
- *Traditional career path* employment with the graduation university and all careers at the same institution were not significant.
- *Precocity* although fellowship or assistantship experience had significantly positive relationship, their combined experience resulted in a significantly negative relationship with the number of coauthors. Therefore, the negative relationship appears to be linked with the time required to become an independent researcher.

Estimations for researchers who are Doctors of Medical Science (DMSc)

Out of the sample of 565 researchers, 296 researchers had DMSc, out of whom 172 researchers had experience as practical physicians. Overall, 188 researchers had experience as practical physicians out of the sample of 565 researchers, implying that 16 such researchers did not have DMSc. Since half of the total number of sample researchers have DMSc and more than half of the researchers who have DMSc have practical physician experience, I have analyzed only 296 researchers with DMSc. Tables 7, 8, 9 show the estimated results for number of papers, citations, and coauthors. For researchers who were DMSc, the first job with an independent administrative agency related significantly to each explained variable.

Experience as a practical physician and grant amount had a significantly positive relationship with number of papers. Regarding number of citations, experience with a company was significantly positive in the negative binomial model. Cross-term of the fellowship experience and employment as an assistant were associated positively with citations.

Regarding number of coauthors, first employment with or experience with a company, and first employment with an independent administrative agency were significantly positive. Thus, the experience of nonacademic careers at a young age related to the number of coauthors. Experience as a practical physician did not have a significantly positive relationship with number of coauthors. Moreover, though diversity of career had no relationship with number of papers, it had a positive relationship for citations.

Table 6 Estimated results for number of coauthors

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	0.293 (0.235)	0.322 (0.229)	0.292 (0.234)	0.0803 (0.0621)	0.0864 (0.0606)	0.0819 (0.0617)
Diversity of career	0.0968 (0.190)			0.0365 (0.0536)		
Administrative agency (first)		−1.443* (0.869)			−0.837** (0.393)	
Administrative agency			−0.894 (0.560)			−0.353* (0.191)
Company (first)		1.392*** (0.489)			0.449*** (0.138)	
Company			0.618 (0.383)			0.208* (0.110)
Independent administrative agency (first)		1.684*** (0.392)			0.447*** (0.0996)	
Independent administrative agency			0.0773 (0.220)			0.0330 (0.0613)
Foreign research experience	0.106 (0.201)	0.125 (0.197)	0.0910 (0.200)	0.0373 (0.0563)	0.0408 (0.0555)	0.0320 (0.0562)
Career at same university (graduated)	0.196 (0.296)	0.210 (0.291)	0.227 (0.295)	0.0634 (0.0831)	0.0724 (0.0830)	0.0806 (0.0834)
Career at same university (doctoral)	−0.187 (0.312)	−0.0847 (0.309)	−0.185 (0.311)	−0.0517 (0.0879)	−0.0172 (0.0891)	−0.0583 (0.0881)
All careers at the same institution	0.366 (0.313)	0.472 (0.302)	0.357 (0.312)	0.111 (0.0862)	0.137 (0.0836)	0.108 (0.0859)
Research Fellowship	2.615*** (0.585)	2.862*** (0.567)	2.610*** (0.582)	0.642*** (0.139)	0.694*** (0.134)	0.639*** (0.139)
Assistant experience	0.221 (0.227)	0.425* (0.225)	0.242 (0.228)	0.0679 (0.0639)	0.126** (0.0638)	0.0751 (0.0640)
Research fellow and assistant (cross-term)	−1.871*** (0.677)	−1.933*** (0.654)	−1.814*** (0.674)	−0.422** (0.167)	−0.422*** (0.160)	−0.404** (0.166)
Male gender	0.225 (0.540)	0.286 (0.527)	0.255 (0.537)	0.0716 (0.154)	0.0882 (0.151)	0.0802 (0.153)
Amount of Grants-in-Aid	0.0242 (0.0407)	0.0305 (0.0397)	0.0277 (0.0405)	0.00644 (0.0112)	0.00754 (0.0109)	0.00721 (0.0111)
Doctoral degree from foreign country	−0.887 (0.750)	−0.512 (0.736)	−0.796 (0.748)	−0.254 (0.223)	−0.132 (0.220)	−0.226 (0.223)
Doctor of Medical Science (DMSc)	1.071 (0.736)	1.044 (0.726)	1.192 (0.735)	0.322* (0.192)	0.341* (0.198)	0.389* (0.202)
Doctor of Science	−0.0410 (0.753)	−0.210 (0.743)	0.0262 (0.751)	−0.00536 (0.198)	−0.0250 (0.203)	0.0466 (0.207)
Doctor of Dentistry	0.210 (0.855)	0.174 (0.842)	0.309 (0.852)	0.0780 (0.229)	0.0952 (0.233)	0.139 (0.237)

Table 6 continued

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Doctor of Engineering	−0.465 (0.774)	−0.635 (0.760)	−0.402 (0.776)	−0.181 (0.207)	−0.216 (0.212)	−0.136 (0.220)
Doctor of Agriculture	−0.840 (0.815)	−1.014 (0.796)	−0.753 (0.817)	−0.324 (0.226)	−0.341 (0.229)	−0.271 (0.236)
Doctor of Pharmacology	0.302 (0.786)	0.0501 (0.774)	0.440 (0.786)	0.114 (0.207)	0.0658 (0.212)	0.190 (0.219)
Other doctoral degree	0.761 (0.776)	0.514 (0.763)	0.846 (0.773)	0.201 (0.199)	0.141 (0.202)	0.253 (0.205)
Constant	1.994** (0.958)	1.580* (0.951)	1.793* (0.957)	0.776*** (0.259)	0.631** (0.266)	0.685** (0.268)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 7 Estimated results for number of papers (Only DMSc)

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	0.812* (0.416)	0.879** (0.413)	0.821** (0.416)	0.239** (0.111)	0.279** (0.111)	0.237** (0.112)
Diversity of career	−0.341 (0.482)			−0.0762 (0.130)		
Administrative agency (first)		−2.567 (2.393)			−2.565 (1.607)	
Administrative agency			1.960 (1.493)			0.379 (0.366)
Company (first)		0.0806 (3.375)			0.0832 (0.959)	
Company			1.176 (2.058)			0.356 (0.537)
Independent administrative agency (first)		1.529 (1.158)			0.584* (0.305)	
Independent administrative agency			−0.656 (0.509)			−0.170 (0.141)
Foreign research experience	0.550 (0.461)	0.462 (0.465)	0.609 (0.460)	0.166 (0.125)	0.135 (0.125)	0.168 (0.125)
Career at same university (graduated)	0.681 (0.721)	0.700 (0.726)	0.640 (0.725)	0.218 (0.200)	0.232 (0.200)	0.223 (0.200)
Career at same university (doctoral)	0.123 (0.818)	0.175 (0.838)	0.173 (0.819)	0.0331 (0.231)	0.102 (0.239)	0.0128 (0.231)
All careers at the same institution	0.974 (0.719)	1.017 (0.713)	1.001 (0.715)	0.271 (0.189)	0.280 (0.188)	0.269 (0.188)
Research Fellowship	−0.952 (1.742)	−1.376 (1.720)	−1.113 (1.786)	−0.298 (0.490)	−0.356 (0.491)	−0.355 (0.503)
Assistant experience	−0.711 (0.469)	−0.566 (0.471)	−0.705 (0.470)	−0.209* (0.124)	−0.156 (0.124)	−0.213* (0.124)
Research fellow and assistant (cross-term)	0.840 (2.047)	1.366 (2.008)	0.967 (2.084)	0.321 (0.575)	0.414 (0.570)	0.374 (0.586)
Male gender	1.533 (1.305)	1.487 (1.301)	1.483 (1.298)	0.729* (0.427)	0.689 (0.425)	0.726* (0.425)
Amount of Grants-in-Aid	0.159** (0.0800)	0.158** (0.0796)	0.162** (0.0803)	0.0398* (0.0204)	0.0433** (0.0204)	0.0407** (0.0207)
Doctoral degree from foreign country	−1.317 (1.950)	−1.247 (1.944)	−1.231 (1.940)	−0.513 (0.600)	−0.467 (0.598)	−0.475 (0.598)
Constant	−0.479 (1.587)	−0.684 (1.584)	−0.509 (1.589)	−0.175 (0.485)	−0.317 (0.488)	−0.161 (0.488)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 8 Estimated results for number of citations (Only DMSc)

	Tobit model			Negative binomial model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	−0.0787 (0.202)	−0.0562 (0.198)	−0.0566 (0.203)	−0.0657 (0.161)	−0.0152 (0.160)	−0.0310 (0.162)
Diversity of career	0.295 (0.234)			0.322* (0.175)		
Administrative agency (first)		−0.717 (1.145)			−3.413 (4.671)	
Administrative agency			0.548 (0.727)			0.310 (0.493)
Company (first)		−0.0345 (1.615)			−0.00423 (1.414)	
Company			1.526 (1.002)			1.553** (0.670)
Independent administrative agency (first)		1.956*** (0.554)			1.412*** (0.350)	
Independent administrative agency			0.226 (0.248)			0.277 (0.192)
Foreign research experience	0.174 (0.224)	0.162 (0.223)	0.195 (0.224)	0.213 (0.183)	0.240 (0.186)	0.229 (0.184)
Career at same university (graduated)	0.273 (0.350)	0.233 (0.347)	0.315 (0.353)	0.362 (0.283)	0.354 (0.289)	0.421 (0.286)
Career at same university (doctoral)	−0.141 (0.397)	−0.0103 (0.401)	−0.173 (0.399)	−0.269 (0.312)	−0.110 (0.330)	−0.331 (0.314)
All careers at the same institution	0.186 (0.349)	0.154 (0.341)	0.201 (0.348)	0.239 (0.286)	0.236 (0.283)	0.254 (0.286)
Research Fellowship	−0.552 (0.846)	−0.657 (0.823)	−0.792 (0.869)	−0.620 (0.679)	−0.595 (0.695)	−0.912 (0.708)
Assistant experience	−0.144 (0.228)	−0.0663 (0.225)	−0.115 (0.229)	−0.176 (0.181)	−0.126 (0.181)	−0.139 (0.183)
Research fellow and assistant (cross-term)	1.340 (0.993)	1.405 (0.961)	1.577 (1.014)	1.393* (0.779)	1.337* (0.785)	1.701** (0.803)
Male gender	0.532 (0.633)	0.462 (0.622)	0.517 (0.631)	0.768 (0.641)	0.674 (0.638)	0.757 (0.641)
Amount of Grants-in-Aid	0.102*** (0.0388)	0.104*** (0.0381)	0.108*** (0.0391)	0.116*** (0.0336)	0.131*** (0.0338)	0.131*** (0.0350)
Doctoral degree from foreign country	−0.490 (0.947)	−0.346 (0.930)	−0.467 (0.944)	−0.866 (1.023)	−0.633 (1.011)	−0.850 (1.022)
Constant	−0.648 (0.771)	−0.722 (0.758)	−0.740 (0.773)	−2.040*** (0.731)	−2.287*** (0.732)	−2.222*** (0.742)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 9 Estimated results for number of coauthors (Only DMSc)

	Tobit model			Poisson model		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Experience as a practical physician	0.169 (0.262)	0.260 (0.256)	0.234 (0.261)	0.0427 (0.0632)	0.0642 (0.0633)	0.0591 (0.0636)
Diversity of career	−0.415 (0.303)			−0.103 (0.0761)		
Administrative agency (first)		−1.819 (1.484)			−0.699 (0.530)	
Administrative agency			−0.844 (0.936)			−0.246 (0.258)
Company (first)		6.186*** (2.092)			1.043*** (0.347)	
Company			2.654** (1.290)			0.504** (0.255)
Independent administrative agency (first)		1.308* (0.718)			0.292* (0.159)	
Independent administrative agency			−0.462 (0.319)			−0.114 (0.0809)
Foreign research experience	0.0660 (0.290)	0.0834 (0.288)	0.100 (0.288)	0.0160 (0.0705)	0.0205 (0.0717)	0.0239 (0.0707)
Career at same university (graduated)	−0.0324 (0.454)	−0.00263 (0.450)	0.120 (0.454)	−0.00760 (0.108)	−0.000945 (0.110)	0.0339 (0.111)
Career at same university (doctoral)	0.151 (0.515)	0.363 (0.520)	0.0245 (0.513)	0.0402 (0.124)	0.0931 (0.129)	0.00389 (0.125)
All careers at the same institution	0.263 (0.452)	0.417 (0.442)	0.296 (0.448)	0.0632 (0.107)	0.100 (0.107)	0.0711 (0.108)
Research Fellowship	1.395 (1.097)	1.097 (1.066)	0.726 (1.119)	0.323 (0.240)	0.238 (0.237)	0.160 (0.251)
Assistant experience	−0.181 (0.295)	0.0410 (0.292)	−0.0944 (0.295)	−0.0422 (0.0712)	0.0126 (0.0724)	−0.0217 (0.0721)
Research fellow and assistant (cross-term)	0.262 (1.288)	0.671 (1.245)	0.942 (1.306)	0.0249 (0.278)	0.136 (0.273)	0.192 (0.287)
Male gender	0.0107 (0.821)	−0.0969 (0.807)	−0.0102 (0.813)	0.00199 (0.191)	−0.0245 (0.191)	−0.00116 (0.191)
Amount of Grants-in-Aid	−0.0105 (0.0503)	−0.0128 (0.0494)	0.00666 (0.0503)	−0.00315 (0.0120)	−0.00365 (0.0119)	0.00105 (0.0121)
Doctoral degree from foreign country	−0.868 (1.228)	−0.712 (1.206)	−0.842 (1.215)	−0.256 (0.340)	−0.219 (0.340)	−0.250 (0.340)
Constant	3.976*** (0.999)	3.502*** (0.982)	3.702*** (0.996)	1.381*** (0.236)	1.264*** (0.236)	1.314*** (0.238)

Standard errors in parentheses

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Conclusion

As a result of analyzing the relationship between experience as a practical physician and research performance, experience as a practical physician had a significantly positive relationship with number of papers but not with number of citations. Regarding the hypothesis that assesses whether the experience as a practical physician has a negative or positive relationship to research, this paper suggests that knowledge obtained by the practical physician has a positive influence on the number of papers. On the other hand, it is suggested that decreasing research time leads to difficulty in producing papers with strong impact. However, since this analysis does not use research time and practical knowledge as variables, I cannot assert that a decrease in research time and knowledge acquired from experience as a practical physician influences research performance. Further, this study does not encompass all features of the field of clinical medicine, so it cannot explain fully the reason for a relationship between the practical physician and the number of papers.

Moreover, although it is possible that researchers who have many coauthors maintain their productivity even if research time is limited, my analysis indicated that the practical physician experience did not relate significantly to the number of coauthors. On the other hand, experience with a company or independent administrative agency at a young age had a positive relationship with number of coauthors. Though research experience in a foreign country was expected to relate to research performance, no significant relationship was noted.

As for the researcher's experience from a young age, research fellowship experience had a significantly positive relationship to the number of papers. There is a possibility that researchers selected as research fellows were either excellent scholars originally or individuals focused entirely on research from an early stage. Moreover, a career with an independent administrative agency related positively to the numbers of papers and citations. It also appears that using large-scale environmental facilities offered no educational function for students in the Inter-University Research Institute Corporation related positively to research.

As for diversity of career and research performance, there was no relation with number of papers. Though a career with the university from which one graduated and jobs at the same institution had a positive trend for number of papers, there was a positive relationship between citation count and career diversity. The findings suggest that a variety of employment experiences are advantageous for producing an impact of papers.

Although I searched for the CVs of all 1,255 researchers, I obtained only 565 complete CVs (45 %). Because the probability of disclosure is high for a highly published researcher, it is noteworthy that the productivity of researchers targeted by this analysis was higher than that of researchers excluded from analysis because of non-disclosure. Therefore, the characteristics of researchers with lower productivity are not completely captured in this study.

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