RIETI Discussion Paper Series 24-E-081

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RIETI Discussion Paper, 24-E-081
December 2024

Labor Market Outcomes for Doctoral Graduates in Japan: Evidence from a large statistical survey*

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Abstract

Amid concerns about Japan's declining research capability, policies to support doctoral human resources are actively discussed. This study uses micro data from the 2022 Employment Status Survey to analyze the labor market outcomes of postgraduates by dividing them into doctoral and master's graduates. According to the analysis, first, the employment rate of doctoral graduates is higher than that of master's graduates, and the difference is particularly large for females. Second, doctoral graduates are paid 40% more than master's graduates. Third, controlling for detailed industries and occupations, the wage difference between doctoral and master's graduates reduces to about 10%. This suggests that doctoral graduates self-select into higher-paying industries and occupations. Fourth, the discounted present value of lifetime earnings for doctoral graduates is 17% higher for male and 36% higher for female than for master's graduates. The estimated internal rate of return on investment in doctoral education is around 10% for both males and females.

Keywords: doctoral graduate, master's graduate, employment rate, wage premium, rate of return
JEL Classification: I21, I26, J21, J24, J31

* I would like to thank Kyoji Fukao, Kenta Ikeuchi, Sagiri Kitao, Masataka Saburi, Eiichi Tomiura, and the seminar participants at RIETI for their helpful comments and suggestions. I am grateful to the Statistics Bureau, Ministry of Internal Affairs and Communications for providing the microdata of the Employment Status Survey used in this study. This research is supported by the JSPS Grants-in-Aid for Scientific Research (20H00071, 21H00720, 23K17548).

Labor Market Outcomes for Doctoral Graduates in Japan: Evidence from the Employment Status Survey

1. Introduction

The decline in Japan's research capabilities is raising concerns, and a decrease in the number of students entering doctoral programs has been indicated as one factor. Against this backdrop, the "Basic Policies for Economic and Fiscal Management and Reform 2023" states that to realize an environment in which talented young people aspire to doctoral degrees, support will be strengthened for "improving the treatment of doctoral students, ensuring an environment in which they can concentrate on challenging research, and developing career paths that enable doctoral degree holders to play a wide range of roles in industry and other fields." The Ministry of Education, Culture, Sports, Science and Technology (MEXT) created the "Plan for the Advancement of Doctoral Human Resources" in March 2024. These developments suggest that doctoral graduates are in an unfavorable situation in the labor market, but data-based evidence as to what the reality is needs to be confirmed.

Figure 1 depicts the number of graduates from universities and graduate schools who got jobs since 2000, based on the data published by the "School Basic Survey" (MEXT). In the 2000s, the number of master's and doctoral graduates employed increased significantly, outpacing the growth in the number of those employed with undergraduate education. Since 2010, however, the growth rate of employment for master's and doctoral graduates has slowed and is lower than that for undergraduate graduates: 0.7% for master's and 1.0% for doctoral graduates compared to 2.4% for undergraduate graduates, on an annual basis, between 2010 and 2023.

A number of empirical studies have been conducted on wages for workers with doctoral degrees in the United States and Europe (e.g., Engbom and Moser, 2017; Graham and Smith, 2005; Jaeger and Page, 1996; Song *et al*. 2008; Walker and Zhu, 2011). These studies have indicated that the wages of those who have doctoral degree are higher than the wages of those with master's degree—"doctoral wage premium."[1] Quantitative magnitudes vary among studies, but for

[1] The studies referred here have analyzed the relationship between doctoral or master's degrees

example, according to Engbom and Moser (2017) for the United States, doctoral degree holders earn 47% more than master's degree holders.

Several studies have compared the labor market outcomes of postgraduates with those of four-year university graduates in Japan (e.g., Morikawa, 2015; Suga, 2020; Yasui, 2019).[2] These studies have shown that, when various individual characteristics are controlled for, those with postgraduate education earn 20%–30% higher wages, and the employment rate is higher than that of four-year university graduates. As a result, the return on investment from postgraduate education is high—around 10%–20%. However, these studies have an important limitation in that they do not distinguish between master's and doctoral education owing to data limitation.

However, the Employment Status Survey (Ministry of Internal Affairs and Communications)—a representative large-scale government statistical survey on the Japanese labor market—has subdivided the education categories starting in 2022, making data separately available for master's and doctoral graduates. This study uses micro data from these statistics to analyze the labor market outcomes of postgraduates by separating doctoral and master's graduates.

The major findings are summarized as follows. First, the employment rate of doctoral graduates is higher than that of master's graduates, and the difference is particularly large for females. Second, the wages of master's graduates are more than 25% higher than those of undergraduates, but doctoral graduates are paid 40% more than master's graduates. Third, controlling for detailed industries and occupations, the wage difference between doctoral and master's graduates is reduced to about 10%. Within the four narrowly defined occupations with the largest number of doctoral graduates working—researchers, engineers, doctors, and university faculty—some occupations show no wage difference between doctoral and master's graduates, or even a reversal of the difference. This suggests that doctoral graduates self-select into higher-paying industries and occupations. Fourth, the discounted present value of lifetime earnings for doctoral graduates is 17% higher for male and 36% higher for female than for master's graduates. The estimated internal rate of return on investment (ROR) in doctoral education is 7–10% for males and 9–11% for females. For females, the contribution of the rate of employment to that of return on investment is large.

The rest of this paper is structured as follows. Section 2 provides an overview of the

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and wages, not the relationship between doctoral or master's course completion and wages.

[2] Inui *et al*. (2021) surveyed the studies on postgraduate education in Japan.

Employment Status Survey and method of analysis in this study. Section 3 reports the results of the employment rates and wages for master's and doctoral graduates. Finally, Section 4 summarizes the conclusions and describes the limitations of the analysis.

2. Data and Method of Analysis

This study uses micro data from the 2022 Employment Status Survey. This survey is a fundamental statistical survey based on the Statistics Law, and its purpose is to obtain basic data on employment structure. The Survey has been conducted every five years since 1982, and the 2022 one was conducted as of October 1, 2022, covering approximately 540,000 households and 1.08 million individuals. By correcting for sample weights, the survey reveals figures for the Japanese population as a whole. Survey items include gender, age, education, employment status, place of work, employment status, weekly hours worked, annual earnings, and tenure. Many of the survey items are multiple-choice format.

Among the survey items, education was classified into six categories until the 2017 survey: elementary/junior high school, high school, vocational school, two-year junior college/technical college, four-year university, and graduate school. The categories were subdivided in the 2022 survey into three categories for vocational schools (less than 2 years, 2–4 years, and 4 or more years) and three categories for graduate schools (master's, professional, and doctoral). Since the survey item asks about graduation, it does not necessarily mean the acquisition of a degree. Since past studies in foreign countries have generally analyzed the relationship between degree possession and labor market outcomes, we should be careful when making international comparisons.

Annual earnings from work are grouped into 16 categories: less than ¥500,000, ¥500,000–¥900,000, ¥1,000,000–¥1,490,000, ¥1,500,000–¥1,990,000, ¥200,000–¥249,000, ・・・・・, ¥900,000–¥999,000, ¥1,000,000–¥149,000, and over ¥15 million. In this study, the median value for each category is used for tabulation and estimation.[3]

The sample is limited to graduates excluding those in school. Since the labor market outcomes of doctoral and master's graduates are of interest, we use a sample of four-year university

[3] In this study, "earnings" and "wages" are used interchangeably.

graduates and above and compare the employment rates and wages of postgraduate graduates (doctoral and master's) with those of four-year university graduates. Although a category among postgraduates is that of professional graduate schools, the sample size is small; thus, we focus mainly on doctoral and master's graduates. In many studies of the Japanese labor market, such as the estimation of wage functions, male and female have been analyzed separately. In principle, this study also estimates employment probabilities and wage functions separately for male and female. To obtain results that are representative of the Japanese labor market as a whole, we use the extraction rate (the restoration multiplier) as a weight in the tabulations and estimations. Details of the variables used will be explained in detail in the next section.

3. Results

3.1. Employment rate

Table 1 shows the percentage of those working (employment rate) by education and gender, based on published data from the Employment Status Survey in 2022. The total for male and female is 30.3% for university graduates and 4.2% for postgraduate graduates. Among those with postgraduate education, 3.4% have completed a master's course; 0.1% have completed a professional graduate course, and 0.7% have completed a doctoral course. Males have a higher share of postgraduate education than females.

Figure 2 depicts the employment rate of graduates by age group and educational background. The employment rate of postgraduates is higher than that of undergraduates, and among postgraduates, the rate of doctoral graduates is higher than that of master's graduates. For males, the difference between master's and doctoral graduates is large in the age group of 60 and above, with a difference of more than 10 percentage points in the age group of 65 and above. For females, the employment rate of doctoral graduates is higher than that of master's graduates in almost all age groups.

Simple probit estimation with age group (in 10-year intervals) dummies and postgraduate education dummies (master's, professional, and doctoral) as explanatory variables confirms that postgraduates have a higher probability of working than four-year university graduates; furthermore, doctoral graduates have a higher probability of working than master's graduates (see

Figure 3). Both are significantly different from university graduates at the 1% level. Comparing males and females, the higher employment probability of postgraduate graduates is particularly pronounced for females, with those with a master's being +8.0% and those with a doctoral degree being +12.8% compared to four-year university graduates (+3.6% and +5.7% for males, respectively).

3.2. Wages

Next, we compare wages for working individuals with a four-year university graduate or higher. As noted in the previous section, the calculations are based on the median of the responses to the multiple choices. **Table 2** shows the mean and standard deviation of annual earnings calculated using the restoration multiplier as a weight for those working among graduates. The mean values confirm that the annual earnings of both male and female postgraduates are higher than those of four-year university graduates, and among postgraduates, the annual earnings of doctoral graduates are higher than those of master's graduates. Wages for doctoral graduates are 35.7% higher for males and 49.6% higher for females than for master's graduates.[4]

Standard deviation is largest for doctoral graduates—1.32 times that of master's graduates for males and 1.46 times that of master's graduates for females. The dispersion in wages among doctoral graduates is large. However, when the coefficient of variation (standard deviation/mean) is calculated, it is somewhat smaller for both male and female doctoral graduates than for master's graduates. In other words, the large standard deviation of wages for doctoral graduates reflects the higher mean.

Table 3 shows the results of the calculation of the share of workers with annual earnings of less than 3 million yen and 10 million yen or more, by educational background. Even among doctoral graduates, 12.8% earn less than 3 million yen annually (10.1% of males and 22.8% of females). Although these figures are lower than those of master's and four-year university graduates, some low-paid workers have a doctoral education. Conversely, 38.5% (43.1% of male and 21.8% of female) of doctoral graduates earn more than 10 million yen annually, indicating

[4] Although the comparison is based on final education and cannot be made simply owing to different estimation methods, it is not considerably different from the wage premium for a doctoral degree reported in studies for the United States.

that highly paid workers are many compared to master's or four-year university graduates.

Next, a standard wage function is estimated using a sample of four-year university graduates and above. Since wages (annual earnings) in the Employment Status Survey are expressed in a multiple-choice format, each category's median value is log-transformed and used as the dependent variable. The highest category of annual earnings, "15 million yen or more," is treated as 17.5 million yen. Since the dependent variable is not wage per hour, weekly working hours are log-transformed and used as the control variable. Additionally, age category (in 10-year intervals), dummies, and tenure (log) are used as explanatory variables for baseline estimation. Estimates are also conducted using employment status, industry (3-digit classification) dummies, occupation (3-digit classification) dummies, and firm size dummies (13 categories) as additional explanatory variables. In all cases, weighted-least squares (WLS) regression is conducted using the restoration multiplier (extraction rate) as a weight.

Estimation results show that doctoral graduates earn higher wages than master's graduates, and these are somewhat larger for females (see columns (1) and (3) of **Table 4** and **Figure 4**). When we control only for hours worked, age, and tenure, the male wages of master's and doctoral graduates are 0.228 log points and 0.569 log points higher than those of four-year university graduates, respectively. The figures for female are 0.287 log points and 0.627 points, respectively.

However, the distribution of industries and occupations in which doctoral graduates work differs considerably from that of four-year university and master's graduates, as can be observed from the published data of the Employment Status Survey (see **Table 5**). Looking at the distribution of industries in which doctoral graduates work, 59.7% of males and 67.8% of females work in the school education and health care industries alone. A substantial difference exists with the figures for master's and four-year university graduates—9.5% and 26.2% of master's graduates, respectively, and 9.1% and 20.7% of undergraduates, respectively. By occupation, researchers, physicians, and teachers alone account for more than 60% (60.5% for males and 61.2% for females) of the total number of doctoral graduates—a considerably higher share than the 10.2% of male and 16.6% of female of master's graduates and the 5.9% of male and 9.4% of female undergraduates.

Columns (2) and (4) of **Table 4** show the estimated results of the wage function with additional controls for employment type, industry, occupation, and firm size. In this case, the wage premium of doctoral and master's graduates relative to four-year university graduates shrinks substantially, although qualitative results remain the same: wages for doctoral graduates are higher than those for master's graduates, and the wage premium for doctoral and master's graduates is larger for females than for males.[5] The estimated wage premium of doctoral graduates is 0.189 log points for males and 0.187 log points for females, and the wage premium of master's graduates is 0.089 log points for males and 0.119 log points for females.

To determine what, among these additional variables, contributes significantly to the wage premium contraction for postgraduate education, the estimation results of selectively adding these four variables to the baseline specification are reported in **Table 6**. All these four variables contribute slightly to the wage premium contraction of master's graduates relative to four-year university graduates. However, the difference between doctoral and master's graduates shrinks substantially when we control for the three-digit occupation categories (see columns (3) of **Table 6**). The contributions of employment type and industry are limited, with firm size having an opposite contribution. In other words, master's graduates tend to work in larger-sized workplaces compared to doctoral graduates.

Furthermore, when estimates are limited to the four occupations that make up most doctoral graduates' occupations (researchers, engineers, physicians, and university faculty), the wages of doctoral and master's graduates are reversed for some occupations (see **Table 7**). Wages for both male and female engineers and university faculty are higher for doctoral graduates than for master's graduates, but wages for male researchers (especially in the humanities and social sciences) and for male and female physicians are higher for master's graduates than for doctoral graduates.

These results indicate that postgraduates' self-selection into high-wage occupations is a significant factor in their high mean wages. In other words, if one can get a job as a researcher, only master's graduation is not a disadvantage for wages, but doctoral graduates are more likely to get that job (see **Table 5** above). Since doctoral graduates have acquired deeper skills in specific fields than master's graduates, matching them to jobs where they can make use of these skills is extremely important. In other words, if they cannot find a job that matches their skills, their doctoral education may become a waste of time. The above results cannot be observed from the published data from the Employment Status Survey and were only revealed using micro data.

When we estimate the wage premium by age group, controlling only for hours worked per

[5] The Employment Status Survey has 12 categories for firm size (the number of employees): "1," "2–4," "5–9," "10–19," ..., "300–499," "500–999," "1,000 or more," and "public sector."

week and years of service, the doctoral premium is generally larger with increasing age (see columns (1) and (3) of **Table 8**). This may be due to (1) the "cohort effect" (i.e., the scarcity of doctoral graduates at older ages), and (2) the "learning effect" or the promotion being greater for doctoral graduates. However, when we additionally control for employment type, industry, occupation, and firm size (columns (2) and (4) of **Table 8**), the increase in relative wages of doctoral graduates with age is observed—albeit weakly—for females, but no such relationship is observed for males. Although this is a conjecture, possible reasons include the fact that doctoral graduates—especially males—are more likely than master's graduates to be promoted to managerial occupations with age (and consequently move to other occupational categories) or to move to firms with higher wage levels through job changes.

Finally, we compare the wages of postgraduates, combining doctoral, professional, and master's graduates, using the same specification as Morikawa (2015), who used 2007 data. Specifically, we use hours worked per week (dummy), tenure and its square, and age dummies (in increments of 5 years) as control variables in the wage function and observe the coefficient on the postgraduate dummy. According to the estimation, the wage premium for postgraduates changed from +0.348 (2007) to +0.281 (2022) for males and from +0.373 (2007) to +0.321 (2022) for females—both shrinking compared to 2007. This may reflect the increase in the stock of workers with postgraduate education and the improved wages of female with four-year university education during the 15 years.

The analysis in this study does not explicitly take into account the possible selection bias arising from ability sorting. While previous studies that have analyzed the wages of higher education by controlling for cognitive ability variables, instrumental variable estimation, and estimation using twin samples have generally shown that this bias is not serious (e.g., Card, 1999; Oreopoulos and Petronijevic, 2013; Song *et al*., 2008; Suga, 2020), we reserve this as a limitation of this study due to using cross-sectional data.

3.3. Lifetime income and rate of return

Finally, we compare lifetime earnings and rates of return on educational investment for master's and doctoral education. First, we would like to observe age and wage profiles from the published data of the Employment Status Survey (see **Figure 5**). In the case of males, the wage increase for doctoral graduates is significant after the age of 35, after which the gap with master's graduates widens until older age. In the case of females, the wage gap between doctoral and master's graduates widens at a relatively young age, although the overall curve is not smooth owing to the small sample size of doctoral graduates.

By multiplying the annual earnings by the labor participation rate for each age group (5 years interval) and then cumulating these figures throughout the age categories, we can approximate the average lifetime income that takes into account the probability of working.[6] According to such calculations, a doctoral graduate's lifetime income is 34% higher for males and 56% higher for females compared to that of a master's graduate. Assuming a discount rate of 3%, the discounted present value of lifetime income is 17% higher for males and 36% higher for females.[7] Owing to the delay in labor market participation due to entering a doctoral program, we observe three years of lost income compared to master's graduates, but even after this loss is accounted for, a doctoral graduate's lifetime income is considerably higher.

We estimate the ROR by considering tuition and opportunity cost (lost income) as a private investment in graduate school. Baseline tuition and other expenses are assumed to be 1.5 million yen per year, and lost income is based on wages by age for undergraduates calculated from the Employment Status Survey.[8] All calculations assume a discount rate of 3%. The return on investment for postgraduate education is 11.4% for males and 10.6% for females with a master's education, and 9.5% for males and 11.5% for females with a doctorate education (see column (1) of **Table 9**).[9]

The return on investment of postgraduate education arises from two factors: (1) the effect of higher annual earnings relative to a four-year university graduate, and (2) the effect of a higher labor participation rate. If we calculate the ROR assuming that the employment rate after age 25 for master's graduates and after age 30 for doctoral graduates was the same as that of university

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[6] The calculation assumes that master's graduates start working at age 25 and doctoral graduates start working at age 28. The calculations assume retirement at age 90 for all academic backgrounds.

[7] Comparing four-year university and master's graduates, the discounted present value of additional lifetime earnings for master's graduates is +21% for male and +37% for female.

[8] Tuition (including entrance fee) for a graduate school student varies by university and major, but is approximately 700 thousand yen at a national university and 1,100 thousand yen at a private university. In addition to this, we have assumed a figure of 1.5 million yen, taking into account the various costs associated with studying at a graduate school.

[9] Column (2) of **Table 9** indicates when assuming tuition and other expenses as 3 million yen per year.

graduates, we can infer that the difference from the estimates above is the contribution of the difference in employment rates. The results are shown in **Figure 6**: 1.6% for males and 3.9% for females of the return on investment for master's programs are due to differences in employment rates. In the case of doctoral programs, the portion attributable to differences in employment rate is slightly negative for males and 1.8% for females, with the remainder attributable to differences in annual earnings.

Assuming a case in which students advance from master's programs to doctoral programs, the same calculation of return on investment for doctoral education using a master's education as a comparison category would be 6.7% for males and 9.7% for females (see the bottom line of **Table 9**). Assuming annual tuition and other expenses of 3 million yen, the ROR for doctoral education would be 5.3% for males and 7.5% for females. At least on average, doctoral education is an effective human capital investment in Japan, with particularly high rates of return for females, but the results vary depending on the cost of tuition and other expenses. Therefore, reducing the private burden of attending graduate school—especially doctoral programs, including scholarships—would be effective in encouraging graduate school enrollment.

4. Conclusion

This study, using micro data from the 2022 Employment Status Survey, which introduced a questionnaire that subdivides final education, analyzes the labor market outcomes of doctoral graduates in comparison with master's graduates. The contribution of this study is that by using large-scale official statistical data, we can obtain results that are representative of the Japanese labor market as a whole. Additionally, we can control for various individual characteristics—especially detailed industry and occupational classifications—that are not available from publicly available aggregated data.

The results can be summarized as follows. First, doctoral graduates have a higher probability of working than master's graduates, with the difference being particularly large for female. Second, master's graduates are paid 25% more than four-year university graduates, but doctoral graduates are paid an additional 40% more than master's graduates. This is a comparable figure to past studies in Europe and the United States. Third, the wage difference between doctoral and master's graduates shrinks to less than 10% when detailed occupations are controlled for. In other words, the fact that doctoral graduates self-select into high-paying occupations is a major factor explaining the difference in mean wages with master's graduates. Fourth, the discounted present value of lifetime earnings of doctoral graduates is 17% higher for males and 36% higher for females than for master's graduates. Under some assumptions, the estimated ROR in doctoral education compared to a four-year university is 7–10% for males and 9–11% for females. On average, doctoral education is an effective human capital investment in Japan, and doctoral students are not underrepresented in the labor market owing to low earnings.

However, among doctoral graduates are also non-regular workers and those working for less than 3 million yen per year (10% of males and 23% of females). Additionally, the wage dispersion of doctoral graduates is larger than that of master's graduates. Although the low-wage workers are fewer than four-year university and master's graduates, the investment in doctoral education involves risk. Moreover, while this paper has analyzed graduates, some enter doctoral programs but do not graduate, and some take a long time to graduate. Although this is outside the scope of this study, the social rate of return, which takes into account the effects that doctoral graduates generate through innovation and educational activities, is likely to exceed the private rate of return (e.g., Onishi and Nagaoka, 2020). Given these circumstances, while obtaining long-term loans from private financial institutions is difficult, having policies to support students who have the ability but cannot go on to higher education owing to financial constraints through scholarship programs and the Japan Society for the Promotion of Science (JSPS) Fellowship Program is important.

This study relies on cross-sectional data for the year 2022, which have various limitations. First, the data are not panel data that follow individuals or cohorts; thus, calculations of lifetime earnings and investment returns, for example, must be interpreted with caution. Second, wage (annual earnings) data are in a multiple-choice format, and since many highly educated individuals have high annual earnings, measurement error owing to top coding is possible. For example, even if doctoral and master's graduates have the same annual earnings of "15 million yen or more," these data do not indicate the extent of the difference in their actual annual earnings. Third, although the impact of ability sorting is not considered serious in past studies of labor market outcomes for postgraduates, this analysis does not explicitly take this into account.

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Table 1. Composition of workforce by education

	(1) All		(2) Male		(3) Female	
	Million	(%)	Million	(%)	Million	(%)
Four-year University	19.54	30.3%	12.58	35.5%	6.96	23.9%
Postgraduate	2.72	4.2%	2.10	5.9%	0.61	2.1%
Master's	2.21	3.4%	1.71	4.8%	0.50	1.7%
Professional	0.07	0.1%	0.05	0.1%	0.02	0.1%
Doctoral	0.44	0.7%	0.35	1.0%	0.09	0.3%

Notes: Calculated from the published data of the Employment Status Survey (2022). Those in school are excluded.

Table 2. Annual earnings by education

	(1) All		(2) Male		(3) Female	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Four-year university	4.84	3.37	5.64	3.57	3.40	2.37
Postgraduate	6.32	4.13	7.11	4.08	4.16	3.43
Master's	6.51	3.72	7.06	3.68	4.63	3.22
Professional	6.20	4.34	6.98	4.56	4.48	3.19
Doctoral	9.01	4.95	9.58	4.87	6.93	4.71

Note: The figures are expressed as million yen.

Table 3. Percentages of low-wage and high-wage workers by education

	Four-year university	Postgraduate		
		Master's	Professional	Doctoral
A. All				
Less than 3 million	32.0%	15.7%	23.8%	12.8%
10 million or more	7.3%	16.2%	16.4%	38.5%
B. Male				
Less than 3 million	22.3%	10.5%	19.8%	10.1%
10 million or more	10.5%	19.2%	19.2%	43.1%
C. Female				
Less than 3 million	49.4%	33.6%	32.4%	22.8%
10 million or more	1.6%	5.9%	10.4%	21.8%

Table 4. Wage premium of doctoral and master's graduates

	(1) Male		(2) Male		(3) Female		(4) Female	
Master's	0.228	***	0.089	***	0.287	***	0.119	***
	(0.000)		(0.000)		(0.001)		(0.001)	
Professional	0.229	***	0.064	***	0.228	***	0.031	***
	(0.004)		(0.003)		(0.004)		(0.003)	
Doctoral	0.569	***	0.189	***	0.627	***	0.187	***
	(0.001)		(0.001)		(0.003)		(0.003)	
Age	yes		yes		yes		yes	
Working hours	yes		yes		yes		yes	
Tenure (log)	yes		yes		yes		yes	
Employment type	no		yes		no		yes	
Industry (3-digit)	no		yes		no		yes	
Occupation (3-digit)	no		yes		no		yes	
Firm size	no		yes		no		yes	
Nobs.	13,546,271		13,546,271		6,847,719		6,847,719	
R-squared	0.2822		0.5748		0.3659		0.6724	
Master's - Undergraduate	0.228		0.089		0.287		0.119	
Doctoral - Master's	0.341		0.100		0.340		0.068	

Notes: WLS estimation results with robust standard errors in parentheses. ***: $p < 0.01$. The samples are four-year university graduates or higher. The dependent variable is annual earnings expressed in logarithm.

Table 5. Industry and occupation by education

(1) Industry

	(1) Male			(2) Female		
	Undergraduates	Master's	Doctoral	Undergraduates	Master's	Doctoral
Manufacturing	16.0%	30.6%	11.7%	8.0%	13.3%	6.1%
Information and communications	9.0%	14.5%	3.7%	6.7%	9.5%	2.4%
Professional/technical services	6.4%	14.7%	13.8%	5.8%	11.8%	13.0%
Education	6.5%	9.0%	33.9%	14.3%	22.3%	42.9%
School education	5.0%	7.4%	32.7%	10.8%	18.0%	39.8%
Healthcare and welfare	7.4%	3.4%	28.3%	18.9%	13.5%	29.5%
Healthcare	4.1%	2.1%	27.0%	9.9%	8.2%	28.1%

(2) Occupation

	(1) Male			(2) Female		
	Undergraduates	Master's	Doctoral	Undergraduates	Master's	Doctoral
Professional and technical occupations	26.2%	53.6%	80.6%	32.9%	53.0%	83.4%
Researcher	0.2%	3.1%	8.8%	0.2%	2.2%	7.8%
Engineer	11.6%	33.9%	11.1%	4.2%	12.5%	4.5%
Physician	1.4%	0.4%	22.8%	0.9%	0.6%	18.9%
Teacher	4.3%	6.7%	29.0%	8.4%	13.7%	34.5%

Notes. Calculated from the published data of the Employment Status Survey (2022). The percentages indicate the share of workers' industry/occupation in the education categories.

Table 6. Postgraduate wage premium by using different control variables

(1) Male

	(1) Male	(2) Male	(3) Male	(4) Male
Master's	0.195 ***	0.154 ***	0.161 ***	0.180 ***
	(0.000)	(0.000)	(0.000)	(0.000)
Professional	0.338 ***	0.119 ***	0.068 ***	0.297 ***
	(0.003)	(0.003)	(0.003)	(0.004)
Doctoral	0.499 ***	0.415 ***	0.227 ***	0.536 ***
	(0.001)	(0.001)	(0.001)	(0.001)
Age	yes	yes	yes	yes
Working hours	yes	yes	yes	yes
Tenure (log)	yes	yes	yes	yes
Employment type	yes	no	no	no
Industry (3-digit)	no	yes	no	no
Occupation (3-digit)	no	no	yes	no
Firm size	no	no	no	yes
Nobs.	13,546,271	13,546,271	13,546,271	13,546,271
R-squared	0.4406	0.3908	0.4375	0.3443
Master's - Undergraduate	0.195	0.154	0.161	0.180
Doctoral - Master's	0.304	0.261	0.066	0.356

(2) Female

	(1) Female	(2) Female	(3) Female	(4) Female
Master's	0.207 ***	0.213 ***	0.188 ***	0.262 ***
	(0.001)	(0.001)	(0.001)	(0.001)
Professional	0.205 ***	0.123 ***	0.109 ***	0.240 ***
	(0.004)	(0.004)	(0.004)	(0.004)
Doctoral	0.542 ***	0.511 ***	0.200 ***	0.617 ***
	(0.003)	(0.003)	(0.003)	(0.003)
Age	yes	yes	yes	yes
Working hours	yes	yes	yes	yes
Tenure (log)	yes	yes	yes	yes
Employment type	yes	no	no	no
Industry (3-digit)	no	yes	no	no
Occupation (3-digit)	no	no	yes	no
Firm size	no	no	no	yes
Nobs.	6,847,719	6,847,719	6,847,719	6,847,719
R-squared	0.5895	0.4529	0.4814	0.4164
Master's - Undergraduate	0.207	0.213	0.188	0.262
Doctoral - Master's	0.335	0.298	0.012	0.354

Notes: WLS estimation results with robust standard errors in parentheses. ***: $p < 0.01$. The samples are four-year university graduates or higher. The dependent variable is annual earnings expressed in logarithm.

Table 7. Wage premium of education for specific occupations

	(1) Male			(2) Female		
	Undergraduates	Master's	Doctoral	Undergraduates	Master's	Doctoral
Researcher	0.100	0.019	-0.081	0.009	0.482	0.473
Natural science	0.149	0.083	-0.067	0.018	0.557	0.540
Humanities and social science	0.034	-0.094	-0.128	—	-0.368	—
Engineer	0.228	0.569	0.341	0.287	0.627	0.340
Physician	0.120	0.080	-0.040	0.232	-0.105	-0.336
University faculty	0.028	0.175	0.147	0.072	0.184	0.111

Notes: The figures are the difference from four-year university graduates in log wages: the coefficients for doctoral and master's dummies based on WLS estimation results. Control variables are age, hours worked per week, and tenure. The dependent variable is log of annual earnings. All but the master's degree for female researchers is statistically significant at the 1% level.

Table 8. Wage premium of master's and doctoral education by age categories

Age	(1) Male		(2) Male		(3) Female		(4) Female	
	Master's	Doctoral	Master's	Doctoral	Master's	Doctoral	Master's	Doctoral
25-34	0.191	0.248	0.096	0.151	0.244	0.385	0.135	0.249
35-44	0.230	0.512	0.109	0.202	0.327	0.498	0.158	0.085
45-54	0.237	0.567	0.094	0.157	0.279	0.717	0.068	0.125
55-64	0.258	0.582	0.074	0.162	0.203	0.748	0.038	0.139
65-74	0.406	0.860	0.132	0.121	0.530	1.283	0.134	0.214
75-	0.022	1.144	0.074	0.357	0.576	0.425	0.735	2.001

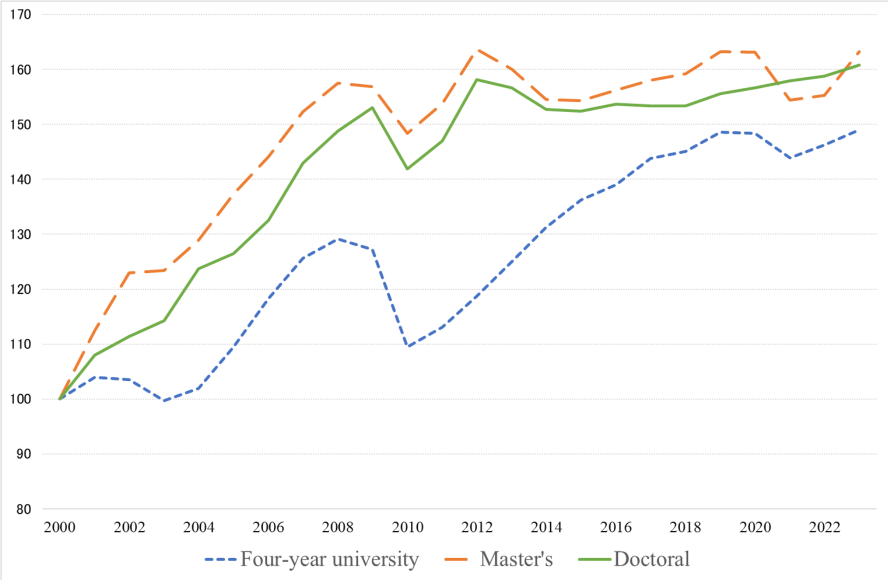
Notes: The figures are the coefficients for doctoral and master's dummies based on WLS estimation results. Columns (1) and (3) control hours worked per week and tenure. Columns (2) and (4) additionally control employment type, industry, occupation, and firm size. All coefficients are statistically significant at the 1% level.

Table 9. Rate of return on postgraduate education

	(1)		(2)	
	Male	Female	Male	Female
Master's (compared to undergraduate)	11.4%	10.6%	8.5%	7.8%
Doctoral (compared to undergraduate)	9.5%	11.5%	7.3%	8.5%
Mdoctoral (compared to master's)	6.7%	9.7%	5.3%	7.5%

Notes: Investments are the sum of tuition and other expenses and opportunity cost (lost income). Column (1) and (2) assumes tuition and other expenses to be 1.5 million yen per year and 3 million yen per year, respectively. The discount rate is assumed to be 3%.

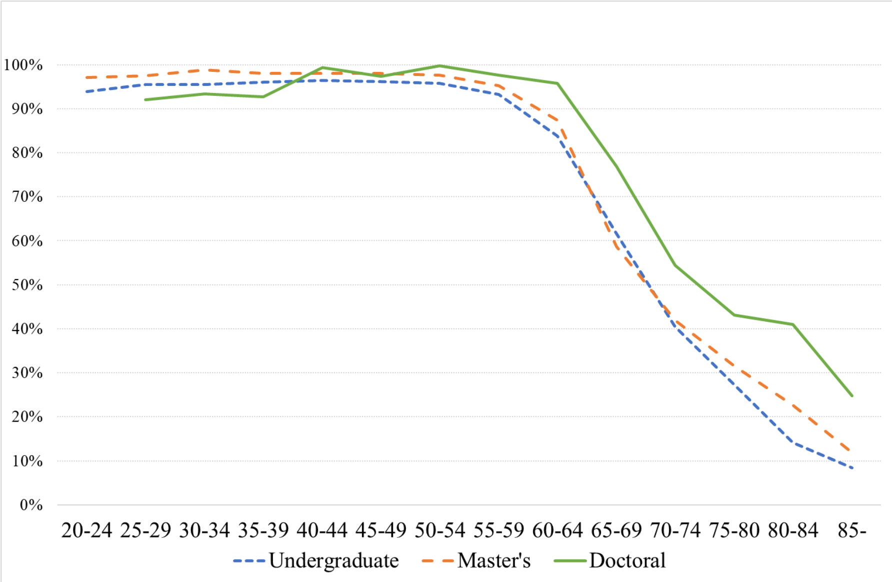
Figure 1. Trend in the number of graduates from universities and graduate schools who got jobs (Year 2000 = 100)



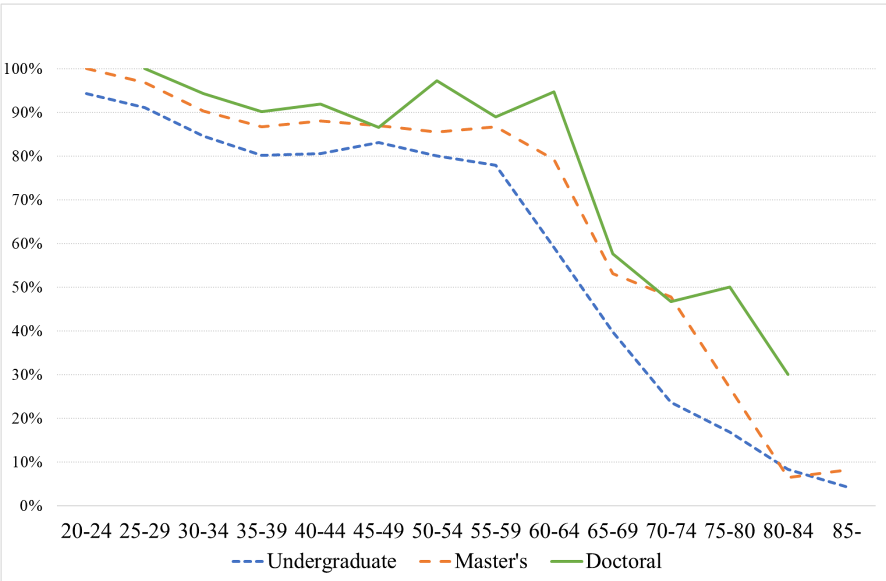
Notes: The figure is drawn from the "School Basic Survey" (MEXT).

Figure 2. Employment rates by education and age categories

(1) Male

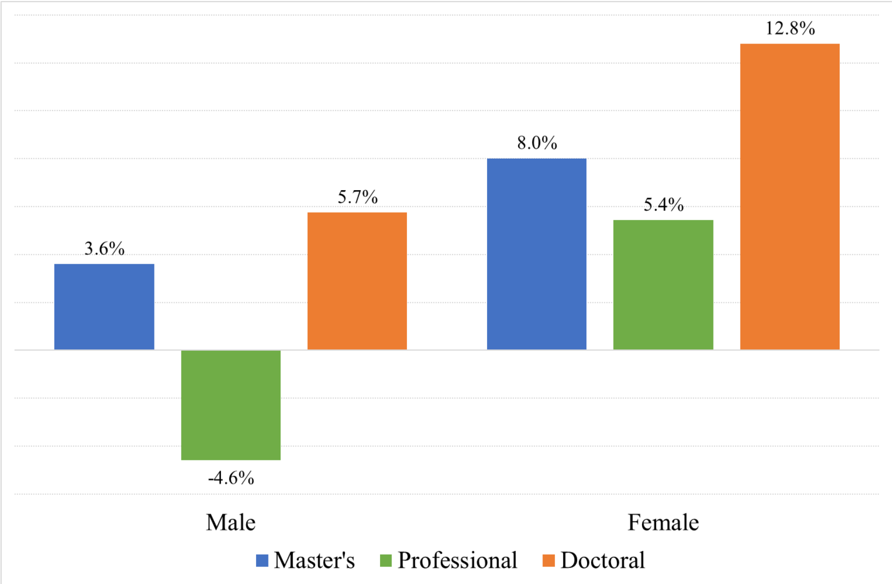


(2) Female



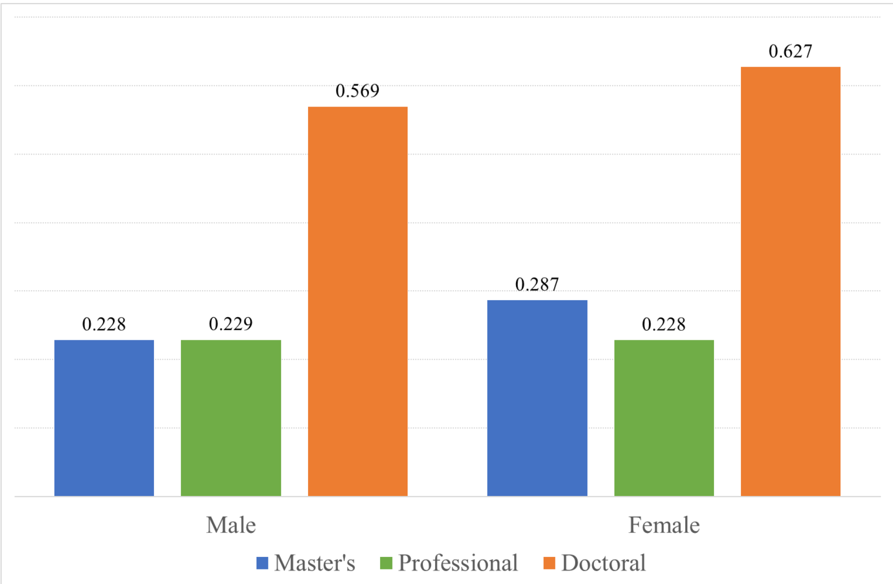
Note: The figures are drawn from the published data of the Employment Status Survey (2022). Those who are in school are not included.

Figure 3. Postgraduates' probability of working relative to four-year university graduates



Notes: The figure is depicted from probit estimations where age categories are used as explanatory variables. The sample are those with four-year education or higher.

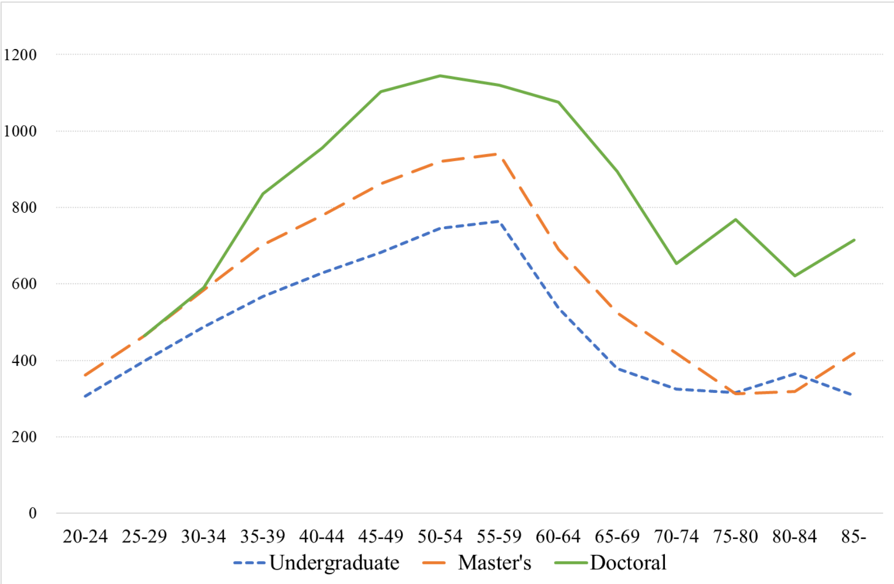
Figure 4. Wage premium of postgraduate education



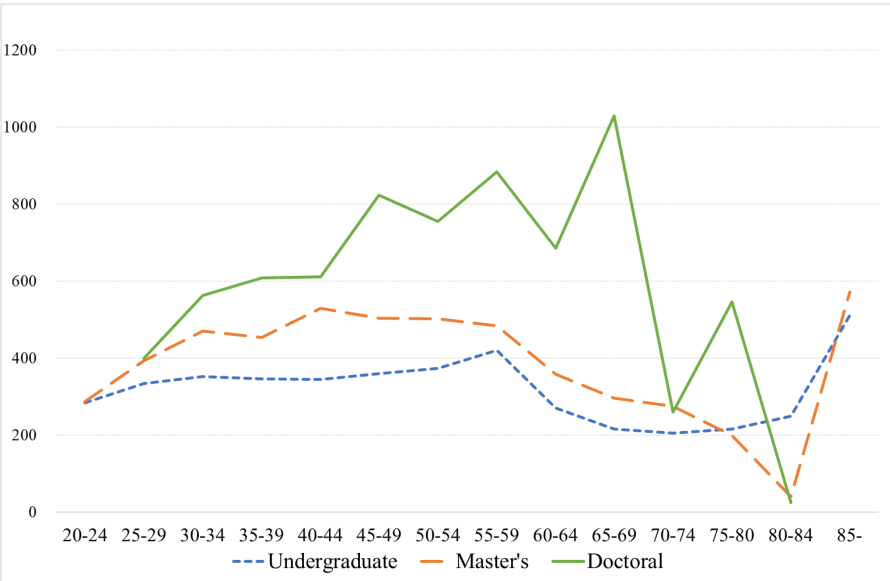
Notes: The figure is depicted from the WLS estimations (columns (1) and (3) of **Table 4**).

Figure 5. Age-wage profile by education

(1) Male

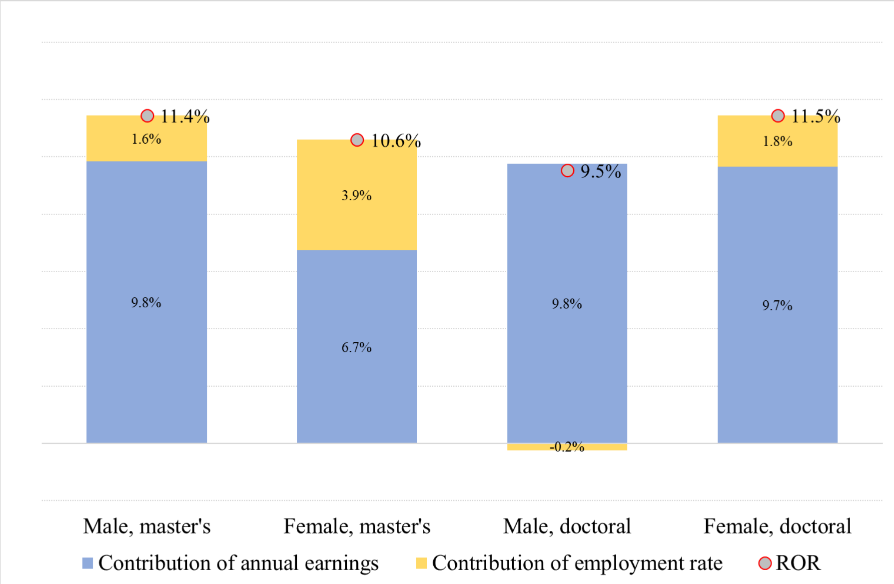


(2) Female



Note: The figures are drawn from the published data of the Employment Status Survey (2022).

Figure 6. Decomposition of the rate of return to postgraduate education



Notes: The figure is drawn from the estimation results reported in column (1) of **Table 7**. The contributions of employment rate are calculated as the differences with the hypothetical figures applying the employment rate of university graduates for master's and doctoral graduates over 25 and 30 years old, respectively, and the residual is the contribution of the difference in annual earnings.