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Abstract

Using micro data from the 2007 Employment Status Survey, this paper analyzes the relationship between postgraduate education and labor market outcomes in Japan. According to the analysis, 1) the employment-population rates of females and elderly people with postgraduate education are higher than they are for those with undergraduate education. The negative effect of marriage on labor participation is small for postgraduate females. 2) The wage premium for postgraduates relative to undergraduates is approximately 30%. The postgraduate wage premium is similar in magnitude for male and female workers. 3) The wage reduction after age 60 is less for workers with a postgraduate education. 4) The private rate of return to postgraduate education exceeds 10%. Due to advanced technology and the growing demand for increased skills, the importance of postgraduate education to vitalize the economy is growing. At the same time, the expansion of postgraduate education may contribute to increasing the labor participation of females and elderly people.

Keywords: Postgraduate education; Human capital; Wage premium; Labor participation rate

JEL classifications: I21; J21; J24; J31

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1. Introduction

In advanced countries, including Japan, the number of workers with postgraduate degrees is increasing rapidly. These highly educated workers are important contributors to innovation and economic growth. However, the "highly educated working poor," regarded as a social problem in Japan, is a group that often receives attention from the mass media. Considering the trend toward a knowledge-based economy, the effect of investments in advanced education, especially postgraduate education, on human capital productivity is an important policy interest.

According to the School Basic Survey, conducted annually by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the numbers of new postgraduates with MA and Ph.D. degrees who obtained jobs in 2011 were approximately 54,000 and 10,000, respectively (Table 1), an increase of more than 3% per annum during the last ten years. This growth rate is higher than the rate for undergraduates (1.2% per annum). Table 2 presents the distribution of the fields of study among new postgraduates. Approximately 63% of MA graduates and 70% of Ph.D. graduates study natural sciences, including science, engineering, agriculture, and medical science. A large number of postgraduates obtain jobs in manufacturing, information and communications, and medical service industries (Table 3), which are characterized as industries of rapid technological progress. Professional and engineering jobs are the dominant occupations for postgraduates. However, a large number of people with Ph.D. degrees obtain jobs in the education services sector, indicating that these people are working as professors or teachers.

According to the 2007 Employment Status Survey (Ministry of Internal Affairs and Communications), the share of workers with postgraduate educations to the total number of workers is only 2.0%, but this share is higher for younger cohorts. For example, among workers aged 25 to 39, the share of workers with postgraduate educations to the total number of workers is 3.3% while the share of workers with bachelor's degree or higher exceeds 10% (Table 4, columns (4) and (5)).

Workers with postgraduate degrees are important contributors to innovation. According to the Inventor Survey, conducted by the Research Institute of Economy, Trade and Industry (RIETI), 28.6% of the important patents and 12.9% of the triadic patents (patents filed in Japan and the EPO and granted by the USPTO) are filed by Ph.D. holders (Nagaoka and Tsukada 2007; Nagaoka 2010). Although these figures are lower than comparable figures in the U.S. and Europe, it should be noted that the number of Ph.D. holders in Japan is relatively small. Jones (2009,

2010) noted that the educational burden on recent cohorts of innovators has increased due to the increase in the stock of knowledge, and the age at first invention has been increasing over time. To produce cutting-edge innovations today, a significant investment in higher education is required.

An estimation of the effect of postgraduate education has been lacking because official labor statistics in Japan did not differentiate between undergraduates and postgraduates until recently. However, this situation is gradually changing. The Basic Survey on Wage Structure (Ministry of Health, Labour and Welfare (MHLW)), which examines starting salaries, made a distinction between postgraduate and undergraduate education in its 2005 survey. According to the 2011 results, the average starting wages of postgraduates are higher than the wages of undergraduates by 14% for male employees and 20% for female employees. The Employment Status Survey, used in this paper, introduced a questionnaire that distinguishes postgraduates and undergraduates in its latest (2007) survey.

As reviewed in the next section, empirical studies in the U.S. and the UK generally determine a 10% to 30% postgraduate wage premium relative to undergraduates (Card, 1999; Deere and Vesovic, 2006; Walker and Zhu, 2011; Lindley and Machin, 2011, among others). The return to postgraduate education is interpreted as evidence of a skill biased technical change. However, studies from other countries have been scarce. Long-term employment and seniority-based wage structure are distinct characteristics of the Japanese labor market. The evidence from Japan offers an important contribution that the return to postgraduate education is high regardless of the differences in labor market structure.

Based upon these backgrounds, this paper investigates the effects of postgraduate education on labor participation and wages in Japan. Specifically, we estimate employment probability and wage functions using micro data from the 2007 Employment Status Survey, and we calculate the rate of return on the investment in postgraduate education. The contribution of this paper is its focus on the effect of postgraduate education not only on the wages of people in the workforce but also its effect on labor participation. In addition, we calculate the rate of return by incorporating both wages and employment-population rates. Further, there is a special focus on labor participation and on the wages of highly educated females and elderly people.

The major findings of this paper can be summarized as follows. First, the employment-population rates of females and elderly people with a postgraduate education are higher than the rates for those with an undergraduate education. The negative effect of marriage

on labor participation is small for postgraduate females. Second, the wage premium for postgraduates relative to undergraduates is approximately 30%, which is comparable to the upper figures found in studies of the U.S. and UK. The postgraduate wage premium is similar in magnitude for male and female workers. Third, the wage reduction after age 60 is less for workers with a postgraduate education. In other words, people with postgraduate educations earn higher wages and remain in the labor market longer. Finally, the private rate of return on postgraduate education exceeds 10%.

The rest of this paper is structured as follows. Section 2 briefly reviews the relevant studies investigating the labor market outcomes of postgraduate education. Section 3 explains the method of analysis and the data used in this paper. Section 4 reports and interprets the results, and Section 5 concludes with policy implications.

2. Literature Review

There have been numerous studies on the returns of education. In advanced countries, the average estimate of the gross rate of return of a year of additional education ranges between 5% and 10% (see survey articles such as Card 1999, 2001; Blundell et al. 1999; Meghir and Rivkin 2011). In Japan, Kawaguchi (2011), for example, conducted a comprehensive analysis of the wage structure and found that the rate of return for an additional year of education for educated workers was approximately 10% when their tenure was relatively short, but the rates monotonically increased as the tenure increased. However, most previous studies have not distinguished between undergraduate and postgraduate education.

While studies on the effect of postgraduate education on wages have been limited, there are several exceptions in the U.S. and the UK. Jaeger and Page (1996), using the U.S. Current Population Survey (CPS) data, find that postgraduate degrees are valued by the labor market. Specifically, MA degree holders earn 5.5% to 15.5% more and Ph.D. degree holders earn 8.3% to 10.3% more than holders of a bachelor's degree. By gender, the wage premium of a postgraduate degree is greater for females than for males. Card’s (1999) representative survey on the relationship between education and wages indicates that the wages of workers with MA and Ph.D.

degrees were approximately 20% and 30% higher, respectively, than were those of workers with undergraduate educations. Deere and Vesovic (2006) use data from the U.S. Census and find that the hourly wage for workers with postgraduate educations is approximately 30% higher than the wage for workers with college educations in 2000. Song et al. (2008) use the U.S. scientist and engineer statistics data system, collected by the NSF for 1993, and find that the sorting effect produces a substantial downward bias in estimated returns on postgraduate education. Furthermore, these authors find that correcting for the sorting effect raises estimated annualized returns on a master's or doctoral degree from approximately 5% to 7.3% and 12.8%, respectively. Hussey (2012) estimates the economic returns on an MBA degree using panel data about MBA graduates in the U.S. The estimated returns on an MBA range around 20% to 30%, but the majority of the returns are derived from the signaling role of the degree.

In the UK, Walker and Zhu (2011) use data from the Labour Force Surveys to demonstrate that males (females) with MA degrees earn 12% (17%) more than their counterparts with undergraduate degrees and that those males (females) with Ph.D. degrees earn 4% (7%) more than their counterparts with MA degrees. It is interesting to note that the postgraduate wage premium is greater for females than for males.

Lindley and Machin (2011) analyze the change in the number of workers with postgraduate qualifications and their relative wages in the U.S. and the UK. They find that in the U.S. the postgraduate/undergraduate wage differential increased from zero in 1963 to a gap of 0.28 log points by 2009, whereas in the UK, the postgraduate/undergraduate wage gap increased from 0.05 log points in 1996 to 0.12 log points in 2009. These authors argue that postgraduate and undergraduate workers are imperfect substitutes in production and that the principal beneficiaries of technological change (the computer revolution) have been skilled workers with postgraduate qualifications rather than all graduates.

In Japan, to the best of our knowledge, the postgraduate wage premium has not been studied empirically. An exception is the study of Shimizu and Higuchi (2008), which analyzes MBA qualifications and wages using an original survey of MBA holders in Japan. According to their analysis, the acquisition of an MBA in foreign countries increases wages by more than 50%, but an MBA acquisition in Japan does not have a significant effect on wages.

To summarize, in the U.S. and the UK, significant effects on wages attributable to postgraduate education have been identified, and these effects have increased over time. These recent studies

suggest that it is important to distinguish between undergraduate and postgraduate education in empirical analyses of the relationship between education and labor market outcomes.

3. Data and Methodology

3-1. Data: Employment Status Survey in 2007

As described in the introduction, the 2007 Employment Status Survey adopted a revised questionnaire that distinguished postgraduates from undergraduates. The aim of the Employment Status Survey is to obtain basic data about the employment structure at both national and regional levels by surveying the labor force in Japan. The survey was conducted every three years from 1956 to 1982 and every five years since 1982. The 2007 survey was conducted on October 1, 2007 and included household members 15 years or older, thus resulting in approximately 450,000 households and one million people participating in the survey. Survey items include gender, age, education, employment status, type of employment, industry, occupation, tenure, working hours per week, and annual income earned. Employee income is defined as the gross earnings, inclusive of tax, gained during the previous year from wages, salaries, various allowances, and bonuses. The income of self-employed workers is defined as revenue gained during the previous year from their business, namely, gross sales less necessary expenses. Income from financial assets and earnings from side jobs are not included in the annual income for the survey. In this paper, we use "annual income" and "wages" interchangeably.

Most of the survey items are categorical variables. For example, age groups are categorized in 5-year intervals: 15 to 19, 20 to 4, 25 to 29...75 to 79, 80 to 84, and 85 or older. Educational attainment is grouped into six classes: 1) primary school or junior high school, 2) senior high school, 3) vocational school, 4) junior college, 5) college or university, and 6) graduate school. Unfortunately, MA degrees and Ph.D. degrees are not treated separately. Annual income is categorized into 15 classes: 1) less than 500,000 yen, 2) 500,000 to 999,000 yen, 3) 1 to 1.49 million yen, 4) 1.5 to 1.99 million yen, 5) 2.0 to 2.49 million yen... 13) 9 to 9.99 million yen, 14) 10 to 14.99 million yen, and 15) 15 million yen or more. Weekly working hours are categorized into

11 classes: 1) less than 15 hours, 2) 15 to 19 hours, 3) 20 to 21 hours, 4) 22 to 29 hours... 10) 60 to 64 hours, 11) 65 hours or more.

3-2. Method of analysis

First, we observe the employment-population rates of people with postgraduate educations by gender and age groups in comparison with people with only undergraduate educations. In this calculation, we do not include individuals still attending school, and the sample weights of the survey are taken into account. Next, we estimate a simple probit model to explain the working status of the individual where gender (female dummy), education, and age groups are used as explanatory variables.

$$Pr\ (work=1) = F\ (ß_0 + ß_1\ female\ dummy + ß_2\ education\ dummies + ß_3\ age\ dummies) + \varepsilon \quad (1)$$

Undergraduate education is used as the reference group because the focus of this paper is the postgraduate education relative to the undergraduate education. With respect to age classes, individuals aged 25 years or over are used in the analysis, and the 25 to 29 age class is used as the reference group. We conduct sample-weighted estimations to control sampling differences due to individual characteristics. In addition to the overall working probability, we also estimate the probability to work as regular (standard) employees. We include the “executive of a company or corporation” as a regular employee.

Separate estimations for males and females are also presented. In addition, we analyze the effects of marriage and children on the labor participation of women. In Japan, women of childbearing age tend to exit from the labor force. Therefore, family policies, such as the extension of maternity leave and the improvement in the availability of nursery schools, to encourage labor participation of women have been adopted in recent years. However, we do not know much about the effects of higher education on the compatibility of jobs with marriage or childbearing. To better understand this issue, we estimate the working probability of females with undergraduate and postgraduate educations where dummies for having a spouse and children under the age of six are used as

additional explanatory variables.

In the latter part of this paper, we analyze the effect of postgraduate education on wages. Specifically, we estimate standard wage functions to explain the log annual income of those who engage in work.[1] As previously mentioned, annual income is categorized into 15 classes in the 2007 Employment Status Survey. The central values of the annual income classes are converted to logarithmic form and used in the analysis. In the estimations, "less than 500 thousand yen" and "15 million yen or more" are treated as 250 thousand yen and 17.5 million yen, respectively. In addition to the education dummies, gender (female dummy), age group dummies, tenure and its square, and weekly working hours are used as explanatory variables. Because the focus of this study is the differences between workers with postgraduate and undergraduate educations, undergraduate education is used as the reference group. As a result, the estimated coefficient for the postgraduate education dummy is the postgraduate wage premium relative to the undergraduate wage. Technically, educational attainment can be converted into years of education, and age can be converted into a continuous variable by using the central value of the age classes. However, in Japan, Kawaguchi's (2011) comprehensive study of the Japanese wage structure noted that educational attainment should be included as discrete dummy variables rather than as a single index of the years of education. Furthermore, his study suggests that the discontinuity in the wage profile at age 60 due to mandatory retirement should be considered when choosing model specifications. With respect to age classes, ages 25 to 29 through ages 70 and over are used as dummy variables in the analysis, and the 25 to 29 age group is used as the reference group. For working hours, it is possible to calculate hourly wages by using the central values of the weekly working hours. However, to avoid introducing additional measurement errors, we use weekly working hours as explanatory dummy variables, and we use "35 to 42 hours" as the reference. Concerning tenure, we include tenure and its square as dependent variables because the continuous value of tenure is available in the 2007 Employment Status Survey. To summarize, the baseline equation to be estimated is as expressed below.[2]

[1] Persons engaged in work include the "executive of company or corporation," "self-employed," and "family workers."

[2] To remove a possible bias caused by the uneven spatial distribution of workers by education, we conduct regressions that include region (prefecture) dummies as additional explanatory variables. However, as the results are essentially unchanged, we report results without region dummies.

$$ln(w) = ß_0 + ß_1\ female\ dummy + ß_2\ education\ dummies + ß_3\ age\ dummies + ß_4\ tenure + ß_5\ tenure^2 + ß_6\ hours\ dummies + \varepsilon \quad (2)$$

We estimate the above equation for all workers and for the restricted sample of regular (standard) employees. In the 2007 Employment Status Survey, "regular employees" are defined as "persons who are called 'regular employees' at their workplace." We include the "executive of the company or corporation" as regular employees. Separate estimation results for male and female are also presented. However, in this case, the gender dummy is dropped from the right-hand variables.

One possible concern is that the estimated postgraduate wage premium may understate the true premium because the share of workers whose annual income is "15 million yen or more" is relatively large among postgraduate workers. To control for this top-coding bias, we estimate using the Tobit model with upper limits for censoring to check the robustness of the OLS results.[3]

Another concern regards the estimation of female wages. In estimating wage functions for female workers, sample selection bias caused by their choice to work is considered an important issue in the literature. To remove this possible selection bias, we conduct the Heckman two-step estimation for females to verify the robustness of the OLS results.

Finally, with some assumptions, we calculate the private rate of return on investment in postgraduate education by accounting both for the wages and the employment-population rates by gender and age group.

4. Results

4-1. Labor participation

Table 5 shows the employment-population rates by genders and age groups. In this calculation, we do not include individuals still attending school. The employment-population rate of older people with postgraduate educations is more than 10 percentage points higher than the rate for both

[3] "The Paretian distribution of the right tail of empirical wage distributions is a well-known stylized fact" (Teulings, 1995). We estimate Pareto parameters for our data, but the Pareto index is estimated to be less than unity and the mean value cannot be derived.

males and females with only undergraduate educations: average retirement age of people with postgraduate educations is relatively high.[4] In the case of typical individuals with MA degrees, while they enter the labor market two years later than the undergraduates, their age of retirement is more than two years later. Therefore, the lifetime working years are longer for postgraduate workers than for those with only undergraduate degrees. This fact suggests that the intellectual skills and knowledge of postgraduate workers depreciate slowly.[5] The employment-population rates by age classes are unstable for female postgraduates because the number of female postgraduates is relatively small. In fact, the female share to total postgraduates is 17.2% in this data set. However, we should emphasize that the decline in labor participation for those in their 30's, when marriage and childbearing negatively affect female engagement in workforce, is relatively small for females with postgraduate education (Table 5, column (2)).

Next, we estimate equation (1) using the probit model. Table 6 indicates the marginal effects of postgraduate education on working probability relative to undergraduates. Working probability of postgraduates is 8% greater for males and 18% greater for females than it is for their undergraduate counterparts. The probability to work as a regular (standard) worker is approximately 9% higher both for male and female postgraduates than for undergraduates.

Table 7 shows the estimation results for females with an undergraduate education or more, where marriage and preschool children are included as additional explanatory variables. The interaction terms of postgraduate with marriage and preschool children are also included. The coefficients for postgraduate education and its interaction term with marriage are both positive and statistically significant, indicating that the exit from the labor market due to marriage is small among women with a postgraduate education. While highly skilled females continue working after their marriage, the coefficient for the interaction term with children is small and insignificant, thus indicating that the effect of the existence of preschool children on labor participation of mothers is indifferent between undergraduates and postgraduates. This result suggests that to employ highly skilled women, it is

[4] Shimizutani and Oshio (2010) indicate that, in Japan, the likelihood of exiting the labor force is lower for highly educated older males, but educational attainment is not related to the work status of females. However, the data used in their study does not distinguish between postgraduate and undergraduate education.

[5] Another possibility of late retirement is the better health status of highly educated people. The strong positive relationship between education and health is a stylized empirical regularity (see, for example, Eide and Showalter 2011;Cutler and Lleras-Muney 2012). In Japan, an analysis using the Japanese Study of Aging and Retirement (JSTAR) indicates a positive relationship between education and health among older people (Ichimura et al. 2009).

important to expand childcare support policies.

In relation to this result, Table 8 shows the relationship between higher education and marriage outcomes for age groups under the age 60. Marriage rates are calculated based on the existence of a spouse at the time of the survey, that is, those who divorced or widowed are classified as unmarried in this calculation. In the case of males, the marriage rates are somewhat higher for postgraduates than for undergraduates after age 30 (column (2)). On the other hand, although the rates for married females with an undergraduate education are not much different from the rates of the education total, the rate for married females is significantly lower among postgraduates. The total marriage rate for females between age 30 and age 59 with a postgraduate education is 13.5 percentage points lower than the rate of undergraduates. When we estimate a simple probit model to explain the married status by education and age classes (not reported in the table), the probability of being married is 0.4% higher for postgraduate males but 10.0% lower for postgraduate females compared to undergraduates. A postgraduate education has a relatively large negative relationship with the probability to marry among women. In the U.S., Lefgren and McIntyre (2006), using the 2000 Census data, indicate that additional education beyond undergraduate completion is associated with fewer marriages. The above result in Japan is similar to the pattern observed among highly educated women in the U.S. Although investigation of the reason behind the marriage outcome is beyond the scope of this paper, the results suggest that female postgraduates may choose not to get married if the marriage prevents her from continuing in the labor market.

4-2. Postgraduate wage premium

Table 9 presents the estimation results of the wage functions (equation (2)) where gender, age, education, tenure, tenure squared, and weekly working hours are used as the set of covariates. The baseline results indicate that the postgraduate wage premium is approximately 30% (log points), on average (column (1)). [6] This figure is comparable to the high side of figures found in

[6] As shown in Table 2, the majority of postgraduates study natural sciences, including science, engineering, agriculture, and medical science. The estimated wage premium for postgraduate education may include the effects of studying natural sciences. In advanced countries, the rates of return to college majors are higher for engineering and management (see Altonji et al., 2012 for a survey).

the U.S. and the UK. When we limit the sample to the regular employees (including executives), the estimated postgraduate wage premium is also approximately 30% (Table 9, panel B), similar to the size obtained from the regression results for all workers.

Columns (2) and (3) of Table 9 show the results of separate estimations for male and female workers. The estimated postgraduate wage premium is 33.8% for male and 31.9% for female workers. That is, the postgraduate wage premium does not differ much by gender. [7] Several studies in the U.S. and the UK report that the postgraduate wage premium is greater for females than for males, or alternatively, that the gender wage gap is smaller for postgraduates than for undergraduates (Jaeger and Page, 1996; Montgomery and Powell, 2003; Mulligan and Rubinstein, 2008; Walker and Zhu, 2011). However, in Japan, the postgraduate wage premium is similar in magnitude for both genders.[8]

When estimating the wage function of female workers, selection bias caused by the choice of labor participation has been extensively studied. In considering this possibility, we conduct a Heckman's two-step estimation to control possible selection bias. In the first-stage probit model, we use age, marriage, and preschool children as explanatory variables. In the second-stage wage function estimation, all of the covariates used in the above OLS estimations as well as the inverse Mills ratio are included as the right-hand variables. According to the first-stage result, the coefficient for marriage and preschool children are both negative and highly significant. The inverse Mills ratio is statistically significant, indicating the existence of sample selection bias. However, the estimated postgraduate wage premium is 31.3%, which is very close to the results obtained from the OLS (Table 10). That is, the wage premium of approximately 30% for female postgraduates relative to undergraduates is robust to the correction for the selection bias.

To control for the possible top-coding bias in annual income, Table 11 presents the results of the Tobit model with upper limits for censoring. While the estimated postgraduate wage premium is somewhat larger than the OLS results, the differences are less than 1%, indicating that top-coding bias is not serious in our data set. [9]

[7] Beaudry and Lewis (2012) indicate the co-movement in the declining male-female wage gap and the increasing returns to education in the U.S. as a result of skill-biased technological change.

[8] However, according to the separate regressions for undergraduates and postgraduates, the coefficients for the female dummy are -33.8% for undergraduate and 29.5% for postgraduates. That is, the gender wage gap is somewhat smaller for postgraduate females.

[9] As education is a dummy variable, the estimated coefficient for postgraduate education in the Tobit

Next, we compare the age-wage profile of male workers by educational attainment based on the separate regressions for all educational categories, for undergraduates, and for postgraduates. The specification of the regression is the same with equation (1), as previously described. Figures 1 and 2 plot the age-wage profiles of all workers and regular employees, respectively. The age patterns of the two figures are essentially the same. The first observation from these figures is that the wage profile is steeper for postgraduates than it is for undergraduates. This result suggests the effect of learning by experience on productivity is stronger for postgraduates, thus possibly reflecting their superior learning skills. The second observation is regarding the different developments after age 60. Undergraduate degree workers' wages drop abruptly after age 60 (typical mandatory retirement age), which is a well-known phenomenon in the Japanese labor market. In contrast, it is interesting that the drop in wages after age 60 for workers with postgraduate educations is relatively small. It may be argued that the slow decline in the wages of postgraduates after age 60 may be a result of the selection in which relatively low-wage workers tend to retire, thereby leaving only high-wage earners in the labor market. However, as noted in the previous subsection, the retirement age of people with postgraduate educations is relatively high. Despite policy efforts to extend the mandatory retirement age, most Japanese firms have not extended the formal retirement age though they re-employ elderly workers at significantly reduced wages. However, the productivity level of employees with postgraduate educations seems to be maintained even during their old age. This may be because they actively engage in specialized jobs, and their high skills do not depreciate rapidly.

4-3. Rate of return on investment in postgraduate education

In this subsection, we calculate the rate of return on the investment in postgraduate education. In calculating the discounted present value of lifetime income, some assumptions should be made. First, postgraduate education is assumed to be an MA as our data does not distinguish between an MA and a Ph.D. This is a rather strong assumption, but the ratio of MA degrees to the total number of new postgraduates obtaining jobs has been approximately 84% in recent years (see Table 1).

model indicates the marginal effect.

Second, we assume the discount rate to be 3% per year. Third, we assume annual schooling and related expenses as described below.

Additional lifetime earnings produced by postgraduate education depend on both wage levels and employment-population rates throughout one's life. Therefore, we first calculate annual income multiplied by employment-population rates by age groups to obtain the discounted present value of the lifetime income. In these calculations, the opportunity cost is set as the average of the first two years of income earned by new undergraduate workers (1.83 million yen and 1.67 million yen per year for men and women, respectively). With the assumption that annual school expenses and living expenses are 3 million yen, the rate of return on investment in postgraduate education is approximately 15.7% for males and 13.1% for females (Table 12). If we do not consider higher employment rates of postgraduates later in life, the calculated rate of return is 13.5% and 8.2%, respectively (Table 12, figures in parentheses). These figures are hypothetical calculations based on assuming that the postgraduate employment rate after the age 40 is the same as that of the undergraduates. It is obvious that the effect of accounting for the higher labor participation on the profitability of investment in postgraduate education is especially large for females (column (2)). These figures are rather conservative because the assumption of 3 million yen for annual schooling expenses may be somewhat higher than the actual costs. In Japan, the annual cost of a private university for postgraduate education (science and engineering courses) is approximately 1.2 to 1.8 million yen in the first year and approximately 0.9 to 1.5 million yen in the second year. In the case of national universities, the figures are approximately 0.8 million yen in the first year and approximately 0.5 million yen in the second year. If we assume these annual expenses to be 1.5 million yen, the estimated rate of return will be greater: 22.8% for males and 18.8% for females (Table 12, row B). These figures are the private rates of return on investment. The social rate of return may be much higher because knowledge and innovations generated by high-level human capital have positive spillover effects on the economy (see, for example, Moretti, 2004 and Falck et al., 2011).[10]

If the private rate of return to postgraduate education is so high, why do more students not go to postgraduate school? One possibility is that the rate of return found in this study may be overestimated due to positive sorting. That is, students with high unobservable ability tend to go to postgraduate school. We cannot exclude this possible sorting bias because the analysis of this

[10] On the other hand, accounting for financial support for postgraduate education by the government decreases the social rate of return relative to private returns.

paper uses cross-section data, and accordingly, good control variables are difficult to find in our data set. However, past studies on the effects of education when employing instrumental variables or using data for twins generally report similar or somewhat large effects compared with the OLS results (see, for example, Card, 1999; Oreopoulos and Petronijevic, 2013, for surveys on this issue). Although studies on postgraduate education are limited, Song et al. (2008), for example, estimate wage premiums for MA and Ph.D. degrees in the U.S. and report that the premium correcting for sorting bias is larger than the OLS results.

Apart from overestimation, there are three possibilities. 1) Postgraduate schools have a limited capacity. 2) Some students choose not to go to postgraduate school due to credit/financial constraints. [11] 3) Undergraduate students do not recognize the large positive effects of postgraduate education on labor participation and wages. Although detecting the true reason among these explanations is beyond the scope of this paper, expansion of the supply capacity is the solution to the first possibility. An increase in financial aid (scholarship) is the appropriate policy to address the financial constraints, and providing information about the effects of postgraduate education on labor market outcomes is the solution to the undergraduates' lack of information concerning the impact of postgraduate degrees on labor participation and wages.

5. Conclusions

Given the trend toward advanced technology and the growing demand for highly skilled human resources, postgraduate education is important in the revitalization of the economy. Using micro data from the 2007 Employment Status Survey, this paper analyzes the relationship between postgraduate education and labor market outcomes.

The major results of the analysis can be summarized as follows. First, the employment-population rates for females and elderly people with postgraduate educations are higher than they are for those who have only an undergraduate education. In particular, the negative effect of marriage on labor participation is small for postgraduate females. Second, the wage premium for postgraduates relative to undergraduates is approximately 30%, which is

[11] Numerous studies have been conducted on the credit constraints in education, but the results are diverse and inconclusive (see Lochner and Monge-Naranjo, 2012, for a survey). Although the target is not higher education, Akabayashi and Araki (2011) indicate the existence of credit constraints in senior high school in Japan.

comparable to the upper figures found in U.S. and the UK studies. The postgraduate wage premium is similar in magnitude for males and females. Third, wage reduction after age 60 is less for workers with postgraduate educations. In other words, people with postgraduate educations earn higher wages and remain in the labor market longer. Finally, the private rate of return on postgraduate education exceeds 10%. Stronger labor market attachment significantly contributes to the high pay-off of postgraduate education.

Implications based on the analysis of this paper are as follows. First, when analyzing the effects of education or when comparing wage levels among firms or institutions, it is desirable to distinguish between undergraduate and postgraduate education. Second, the expansion of postgraduate education may contribute to increasing the labor participation of women and elderly people in the long term.

The future of the postgraduate wage premium depends on both the supply of postgraduates and the demand for high-skilled labor. Because the trend toward advanced technology is expected to continue, the postgraduate wage premium may increase further if the increase in the supply of postgraduate degrees does not catch up to the increase in demand for postgraduate workers.

Several reservations should be noted in the analysis of this paper. First, because the analysis of this paper uses cross-sectional data for the single year of 2007, the existence of a postgraduate wage premium does not necessarily imply a causal relationship.[12] The observed wage premium may result from 1) the effects of postgraduate education on human capital upgrading, 2) the signal effect, and/or 3) the selection effect. While the analysis in this paper does not try to disentangle these competing explanations, the data used in this paper are notably large and suitable for presenting new empirical observations about the Japanese labor market. Second, although the 2007 Employment Status Survey is useful in distinguishing between postgraduate and undergraduate educational attainment, the differences between MA and Ph.D. degrees are not delineated. Third, as the majority of postgraduates study natural sciences, including science, engineering, agriculture, and medical science, we cannot eliminate the possibility that the estimated wage premium for and the rate of return on postgraduate education may include the effects of studying natural sciences. Finally, as indicated by Cameiro and Lee (2011) in their study of the U.S., due to the increase in the ratio of students admitted to universities, the quality of average undergraduate students may be

[12] The Employment Status Survey has been conducted every five years, but it is not designed to construct an individual-level longitudinal data set.

declining. As a result, the estimated postgraduate wage premium may reflect the relative decline in the quality of workers with only undergraduate educations.

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Table 1

The number of new postgraduates who obtained jobs

	MA	Ph.D.
2001	39,496	7,454
2002	43,137	7,697
2003	43,301	7,896
2004	45,217	8,531
2005	48,200	8,723
2006	50,618	9,149
2007	53,437	9,872
2008	55,264	10,239
2009	55,024	10,537
2010	52,052	9,772
2011	54,004	10,150
Annual Growth	3.2%	3.1%

Source: The School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology (MEXT)).

Table 2

The distribution of the fields of study (MA and Ph.D.)

(1) MA

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Humanities	4,404	4,603	4,836	4,856	4,955	5,157	5,337	5,134	5,048	5,016	4,953
Social science	8,082	9,382	9,830	9,365	9,280	8,679	8,714	8,181	7,891	7,796	7,842
Science	5,633	5,741	5,722	5,998	6,194	6,281	6,367	6,266	6,224	6,047	6,115
Engineering	26,957	28,538	28,498	28,921	30,145	30,617	30,995	30,641	30,710	30,362	31,456
Agriculture	3,362	3,515	3,471	3,676	3,678	3,825	3,797	4,113	4,185	4,078	4,179
Medical science, pharmacy	2,815	3,116	3,733	4,146	4,629	4,862	5,191	5,299	5,680	6,047	6,197
Education	4,591	4,737	5,036	5,044	4,915	4,847	5,001	5,082	5,024	4,686	4,366
Art	1,271	1,358	1,431	1,553	1,666	1,775	1,980	1,976	1,959	1,888	1,930
Others	3,520	4,285	4,855	5,514	5,978	6,488	6,611	7,189	7,090	7,300	7,642
Natural sciences	63.9%	62.7%	61.4%	61.9%	62.5%	62.8%	62.6%	62.7%	63.4%	63.6%	64.2%

(2) Ph.D.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Humanities	1,190	1,174	1,383	1,283	1,371	1,298	1,271	1,358	1,370	1,393	1,441
Social science	1,026	1,026	1,162	1,254	1,282	1,302	1,272	1,238	1,285	1,225	1,234
Science	1,510	1,607	1,500	1,558	1,421	1,522	1,687	1,610	1,483	1,350	1,255
Engineering	3,048	3,073	3,212	3,355	3,341	3,679	3,719	3,636	3,714	3,569	3,370
Agriculture	953	1,042	1,093	1,129	1,104	1,056	1,121	1,065	1,114	1,073	1,001
Medical science, pharmacy	4,173	4,310	4,561	4,728	4,730	4,920	5,389	5,074	5,026	4,744	5,068
Education	335	288	362	337	339	334	362	356	333	375	379
Art	56	74	96	96	119	140	154	150	172	172	189
Others	888	1,048	1,143	1,420	1,579	1,722	1,826	1,794	1,966	1,941	1,955
Natural sciences	73.5%	73.5%	71.4%	71.0%	69.3%	70.0%	70.9%	69.9%	68.9%	67.8%	67.3%

Note: The ratios of natural sciences in the last rows of these tables are the sum of science, engineering, agriculture, and medical science and pharmacy.

Table 3

The number of new postgraduates by industry, 2011

	MA	Ph.D.
Total	54,186	10,160
Agriculture & Forestry	181	21
Fishery	16	3
Mining	100	3
Construction	2,257	87
Manufacturing	22,710	1,392
Electricity, Gas & Water Supply	1,144	30
Information & Communication	5,408	246
Transportation	1,026	18
Wholesale & Retail	1,687	65
Finance & Insurance	987	44
Real Estate	250	15
Professional & Techinical Services	3,317	1,211
Accomodations & Restaurants	161	3
Personal Services & Amusement Services	272	4
Education	5,026	3,657
Health Care & Welfare	3,680	2,674
Compound Services	261	16
Services N.E.C.	1,563	141
Government	3,125	319
Industries Unable to Classify	1,015	211

Source: The School Basic Survey in 2011 (MEXT).

Table 4

The share of workers with postgraduate degrees by age groups

Age Groups	(1) Engaged in Work (thousands)	(2) BA	(3) MA, Ph.D.	(4) (3)/(1)	(5) (3)/[(2)+(3)]
25-29	6,196	2,052	236	3.8%	10.3%
30-34	7,221	1,995	248	3.4%	11.1%
35-39	7,379	1,816	211	2.9%	10.4%
40-44	6,711	1,682	152	2.3%	8.3%
45-49	6,442	1,704	130	2.0%	7.1%
50-54	6,495	1,563	97	1.5%	5.8%
55-59	7,736	1,373	84	1.1%	5.8%
60-64	4,762	713	51	1.1%	6.7%
65-69	2,934	324	24	0.8%	6.8%
70-	3,031	287	18	0.6%	5.8%
Total	58,907	14,399	1,273	2.2%	8.1%

Source: The 2007 Employment Status Survey (Ministry of Internal Affairs and Communications).

Table 5

Employment-population rates by age and education

Age Groups	(1) Male			(2) Female		
	All	Undergraduates	Postgraduates	All	Undergraduates	Postgraduates
25-29	91.8%	93.4%	97.8%	74.3%	83.0%	92.2%
30-34	93.9%	96.1%	97.8%	63.6%	67.4%	84.7%
35-39	94.6%	96.9%	98.0%	64.6%	64.4%	79.7%
40-44	94.8%	97.0%	98.6%	71.2%	70.3%	73.2%
45-49	94.7%	96.8%	98.5%	74.7%	72.6%	89.3%
50-54	93.4%	96.0%	97.9%	71.0%	71.8%	75.1%
55-59	90.6%	93.2%	96.6%	61.4%	59.8%	91.2%
60-64	73.0%	74.7%	84.7%	43.1%	40.3%	76.2%
65-69	49.9%	47.2%	65.0%	28.0%	32.3%	43.8%
70-	24.2%	26.3%	40.1%	10.3%	16.9%	17.1%

Note: The figures are calculated from the micro data of the 2007 Employment Status Survey. Individuals still attending school are not included in these figures. The figures in "all" are calculated for all education categories, including high school graduates.

Table 6

Postgraduates' probability of being engaged in work (marginal effect relative to undergraduates)

	(1) Male & female		(2) Male		(3) Female	
A. All workers	0.1368	***	0.0777	***	0.1777	***
	(0.0005)		(0.0004)		(0.0012)	
B. Regular employees	0.0969	***	0.0910	***	0.0896	***
	(0.0005)		(0.0006)		(0.0008)	

Note: Probit estimates with standard errors in parentheses. *** Significant at 1% level. Gender, education, and age dummies are used as explanatory variables. Undergraduate is used as the reference group. Regular employees include executives of companies or corporations.

Table 7

Effects of marriage and preschool children on the probability to work

	(1) Engaged in work		(2) Regular employment	
Postgraduate	0.0834	***	0.0405	***
	(0.0017)		(0.0016)	
Married	−0.2363	***	−0.2416	***
	(0.0005)		(0.0006)	
Preschool children	−0.2640	***	−0.1165	***
	(0.007)		(0.0007)	
Postgraduate*Married	0.0625	***	0.1104	***
	(0.0023)		(0.0024)	
Postgraduate*child	0.0099		0.0043	
	(0.0099)		(0.0030)	

Note: Probit estimates with standard errors in parentheses. *** Significant at 1% level. The figures indicate marginal effects. The sample is restricted to undergraduate and postgraduate females only. Age dummies are included as explanatory variables.

Table 8

Higher education and marriage effects by age groups

Age Groups	(1) Male			(2) Female		
	All	Undergraduates	Postgraduates	All	Undergraduates	Postgraduates
25–29	26.8%	22.2%	17.2%	36.1%	24.4%	21.1%
30–34	51.4%	52.4%	55.1%	62.8%	60.1%	51.3%
35–39	63.6%	69.6%	70.3%	72.7%	71.1%	61.4%
40–44	71.3%	77.5%	81.1%	77.9%	78.9%	62.5%
45–49	76.2%	81.8%	85.6%	81.1%	83.1%	68.1%
50–54	79.3%	86.0%	88.5%	82.3%	82.4%	76.4%
55–59	82.1%	89.0%	94.5%	81.2%	82.4%	65.3%

Note: The figures are calculated from the micro data of the 2007 Employment Status Survey.

Table 9

Postgraduate wage premiums

	(1) Male & female		(2) Male		(3) Female	
A. All workers	0.3135	***	0.3372	***	0.3132	***
	(0.0080)		(0.0082)		(0.0214)	
Number of obs.	457,670		264,362		193,308	
Adjusted R-squared	0.5164		0.3763		0.4136	
B. Regular employees	0.2836	***	0.2998	***	0.2799	***
	(0.0066)		(0.0067)		(0.0208)	
Number of obs.	277,648		193,883		83,765	
Adjusted R-squared	0.3854		0.3203		0.2834	

Notes: OLS estimates with standard errors in parentheses. *** Significant at 1% level. The dependent variable is log annual income. Explanatory variables include gender, education, age, tenure, tenure squared, and weekly working hours. Undergraduate is used as the reference group.

Table 10

Heckman's two-step estimation results

Postgraduate	0.3130	***
	(0.0216)	
Selection equation		
Married	−0.1871	***
	(0.0053)	
Preschool children	−0.5209	***
	(0.0074)	
Inverse Mill's ratio	−0.4456	***
	(0.0149)	
Number of observations	416,739	
Censored observations	223,431	

Notes: Heckman's two-step estimation results with standard errors in parentheses. *** Significant at 1% level. The first stage selection equation includes age dummies as explanatory variables. The dependent variable is log annual income. The second stage regression includes gender, education, age, tenure, tenure squared, and weekly working hours as explanatory variable. Undergraduate is used as the reference group.

Table 11

Tobit estimation results

	(1) Male & female		(2) Male		(3) Female	
A. All workers	0.3230	***	0.3471	***	0.3158	***
	(0.0081)		(0.0083)		(0.0215)	
	457,670		264,362		193,308	
B. Regular employees	0.2895	***	0.3057	***	0.2822	***
	(0.0067)		(0.0068)		(0.0208)	
	277,648		193,883		83,765	

Notes: Tobit estimates with standard errors in parentheses. *** Significant at 1% level. The dependent variable is log annual income. Explanatory variables include gender, education, age, tenure, tenure squared, and weekly working hours. Undergraduate is used as the reference group.

Table 12

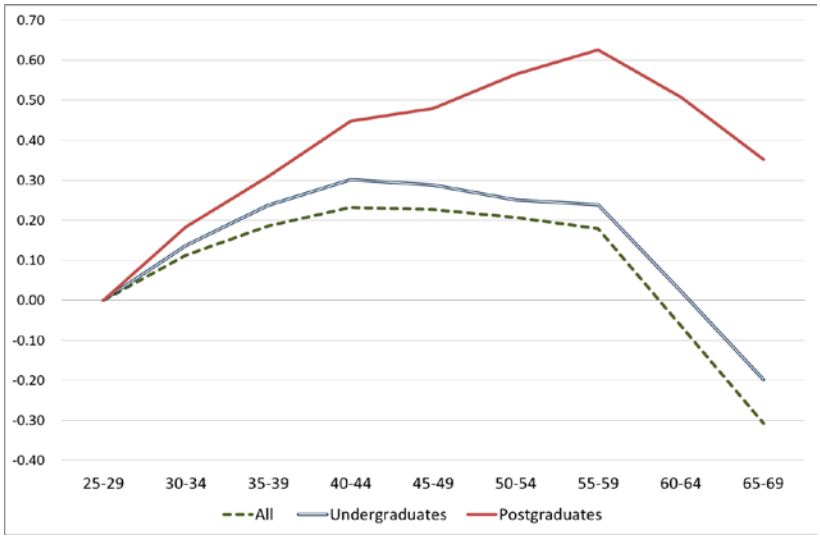
Rates of return on investment in postgraduate education

	(1) Male	(2) Female
Rate of return (a)	15.7%	13.1%
	(13.5%)	(8.2%)
Rate of return (b)	22.8%	18.8%
	(19.6%)	(11.9%)

Notes: The figures are calculated using the micro data from the 2007 Employment Status Survey. The employment-population rates by gender and age classes are accounted for. The discount rate is assumed to be 3% per annum. The rates of return (a) and (b) assume annual school and living expenses to be 3 million yen and 1.5 million yen, respectively. The figures in parentheses are the hypothetical calculations assuming that the postgraduate employment rate after the age 40 is the same as that of the undergraduates.

Figure 1

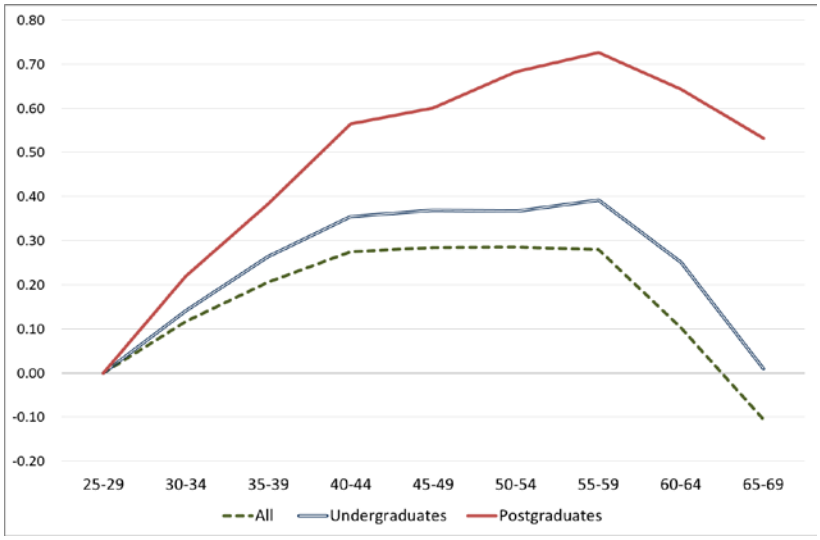
Age-wage profiles of males by levels of education



Note: Estimated from the 2007 Employment Status Survey. The vertical axis indicates the coefficients for education dummies (log annual income).

Figure 2

Age-wage profiles of male regular workers by education



Note: Estimated from the 2007 Employment Status Survey. The vertical axis indicates the coefficients for education dummies (log annual income).