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The Returns to Postgraduate Education

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Abstract

This paper aims to estimate the returns to postgraduate education in Japan, taking potential self-selection bias due to the absence of information on academic ability and the business cycle into consideration. The effect of earning a master's degree on wages is estimated using *Japanese Panel Survey of Consumers* (JPSC) data that contains extensive information on individuals' undergraduate subjects and type of university (private or public). The estimates using ordinary least squares (OLS) and Heckman two-step estimation respectively indicate that postgraduate wage premiums in Japan are 25.0% and 26.4% for men and 23.7% and 24.7% for women. The estimation results suggest that workers’ undergraduate subject and type of university (private or public) explain only a small fraction of the postgraduate wage premium. Moreover, in order to account for the self-selection bias, graduate enrollment capacity is employed as an instrumental variable (IV). In the IV regressions, the estimated postgraduate wage premium is not statistically significant. The estimates are not significant even in the regression using *Working Person Survey* (WPS) data, which has a much larger sample size than the JPSC. Although IV regressions of log wage do not provide positive and statistically significant results, the estimated effect of postgraduate education for male workers on job satisfaction is positive and statistically significant. It indicates that Japanese males obtain a master’s degree not for higher wage, but for non-pecuniary benefits.

Keywords: Rate of return, Postgraduate education, Wage premium, LATE
JEL classifications: I21, I23, J24, J31

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All errors that remain are mine.

1. Introduction

The number of graduate students in Japan has increased substantially over the past few decades. Figure 1, which presents the number of students enrolled in master's programs in private and public universities, illustrates this trend: graduate enrollment followed a steady upward trend from the 1970s until the first decade of the 21st century, although this trend has declined to a certain extent in recent years (reflecting overall population trends). If graduate education imparts useful skills and knowledge to students and increases their productivity, the increase in the number of graduate students should boost technological development and guide economic growth. The question then is about the extent by which graduate education raises workers' human capital stock. In order to address this question, this paper attempts to estimate the returns to graduate education in Japan, taking into account the endogeneity of graduate schooling.

Recent studies by Morikawa (2015) and Kakizawa et al. (2014) reveal that the postgraduate wage premium in Japan is positive, significant, and comparable to that in the United States. The study by Morikawa (2015) was the first attempt to estimate the postgraduate wage premium for the nationally representative sample in Japan,[1] and the estimation results indicate that the expansion of graduate education in Japan could affect the wages of workers with a postgraduate degree. However, these studies did not control for the undergraduate majors of the workers and for whether they attended a private or public university. Moreover, they also do not take potential self-selection bias due to the business cycle into consideration.[2]

As highlighted in the education literature on the effect of higher education on wages, it is important not to ignore the possible self-selection bias arising from the association between schooling decisions and unobserved ability: students with higher ability are more likely to go to

[1] Shimizu and Higuchi (2009) estimate the postgraduate wage premium only for MBA holders.
[2] Although the study by Morikawa (2015) takes possible sample selection bias into account by employing the Heckman two-step estimation approach, it does not address potential ability bias and the self-selection bias due to the business cycle.

university and find a high-paying job after they graduate, not only because of what they learned at university, but also because of their inherent ability. Although previous studies on returns to post-secondary education in the U.S. have shown that the ability bias is small, there are at least three major reasons why self-selection biases may cause a serious upward bias in the estimates of the returns to graduate education in Japan. First, as seen in Figure 1, the majority of Japanese graduate students major in science and engineering subjects at public universities, and admission to such subjects at public universities is considerably more selective than admission to humanities and social science subjects at private universities, for instance. Therefore, unless information about individuals' undergraduate subjects and type of university (private or public) is taken into consideration, ordinary least squares (OLS) estimates of the postgraduate wage premium may reflect differences in the inherent abilities of individuals with different majors and from different types of university. Second, the percentage of undergraduate students who continue to graduate study is higher in top universities, and it is possible that the returns to graduate education are higher for those who graduated from a top university. Unless information about a university's ranking or a direct measure of individuals' academic ability such as test scores is taken into consideration, the potential upward bias due to selection reflecting unobserved ability remains even if the undergraduate subjects and type of university are controlled for. Third, students completing their undergraduate studies during a recession have an incentive to pursue graduate education in the hope that the recession will be over by the time they graduate and that they will thus have more chances of getting a high-paying job as their first job, since not finding a first job immediately after graduation in Japan puts job seekers at a disadvantage and tends to have a lingering negative effect on career prospects (see, e.g., Hamaaki et. al., 2013). Therefore, those who can afford to go to graduate school are more likely to find a high-paying job, and the wage differentials between graduates and non-graduates may reflect individuals' financial backgrounds. In order to deal with these potential sources of bias, this study uses data from the *Japanese Panel Survey of Consumers* (JPSC) provided by the Institute for Research on Household Economics and the *Working Person Survey* (WPS) provided by the Recruit Works Institute to estimate the effect of earning a master's degree on wages.

The JPSC has the advantage that it covers a longer period (20 years) than other panel data in Japan and provides more detailed information than surveys published by the government. Utilizing the extensive information provided by the JPSC, the analysis controls for workers' undergraduate major and type of university (private or public) to mitigate the ability bias. Furthermore, in order to deal with any self-selection bias that cannot be eliminated by the control variables and the Heckman two-step estimation procedure, the ratio of the number of student places (capacity) available at graduate schools across Japan to the number of fourth-year undergraduate students for each undergraduate subject and type of university is used as an instrumental variable (IV). The estimated coefficient can be regarded as the local average treatment effect for those whose graduate enrollment decision was potentially affected by the change in graduate enrollment capacity.[3] Although they are only a subgroup of the whole population, the estimate of the effect of postgraduate education on them has significant meaning from a policy analysis point of view, because this motivates the Japanese government to encourage universities to expand/contract the graduate enrollment capacity.

This paper is the first to present estimates of the effect of graduate education in Japan that carefully take the self-selection bias into consideration.[4] The estimation results suggest that the postgraduate wage premium continues to remain positive and significant even if workers'

[3] Figure 1 shows the graduate enrollment rate of undergraduates by undergraduate major and type of university. The figure indicates that the graduate enrollment rate has increased from 20% in the 1970s to 50% in the 2000s. This means that the pool of those who potentially choose to do a graduate degree had increased, and the instrument identifies the effect of graduate education for this pool of potential graduates.

[4] Since the number of workers with a Ph.D. in the dataset used is very small, the analysis focuses only on workers with a bachelor's degree and a master's degree.

undergraduate major and type of university (private or public) are controlled for. Using OLS, the estimated postgraduate wage premium for male workers is 25.0%, while it is 26.4% using the Heckman two-step estimation. The corresponding figures for female workers are 23.7% and 24.7%. However, the IV estimation results reveal that the estimated postgraduate wage premium is not statistically significant.

The biggest concern about our IV estimation result is that the estimate of the effect of earning a master's degree is not significant because of the scarcity of the sample with a postgraduate degree. To overcome this problem, this study uses the WPS data, which contains information about more than one thousand individuals with a postgraduate degree. The OLS estimation results reveal that the estimates of postgraduate wage premium using the WPS data is positive, significant, and not too far from those obtained from the OLS regression with JPSC data and those from previous literature. Similarly, the first-stage regression for the IV regression with the WPS data also gives an F-statistic high enough not to worry about the weak instrument problem. The estimates of the effects of postgraduate education on wages by using the IV, however, were not significant and even negative.

The results of log wage regression with the IV indicate that the estimates of the postgraduate wage premium in the OLS regression may simply reflect sorting based on unobserved ability or screening/signaling effects rather than higher worker productivity due to postgraduate education. However, another possibility needs to be accounted for—students obtain a postgraduate degree in pursuit of the job's non-pecuniary benefits. In order to check if this association is true, we regress the job satisfaction indicator using the same IV. The estimate of the effect of earning a master's degree is positive and significant for male workers, which indicates that Japanese males pursue a graduate degree not for higher wages, but for the non-pecuniary aspects of the job.

The remainder of this paper is organized as follows. Section 2 provides some background about the current study and discusses the related literature. Section 3 describes the dataset used for the estimation. The estimation method and procedure are presented in Section 4, while Section 5 presents and discusses the estimation results. Section 6 describes the conclusions.

2. Background and Related Literature

Numerous studies have discussed the effect of post-secondary education on wages using U.S. data, and some of these include analyses of the effects of postgraduate education. Although there are debates about whether the postgraduate wage premium is attributable to enhanced productivity or signaling/screening effect, most of these studies report positive and significant wage premiums for graduates. For example, early studies in the field such as Ashenfelter and Mooney (1968) and Taubman and Wales (1973) suggest that postgraduate education has a positive effect on wages, although Taubman and Wales (1973) suspect that to a certain extent, the wage premium can be attributed to screening effects. Estimating the so-called sheepskin effect of diplomas using data from the 1991 and 1992 March Current Population Survey, Jaeger and Page (1996) find that white workers with a master's degree earn 5-16% more than those with only a bachelor's degree, even if they have the same years of schooling. Deere and Vesovic (2006) report that the wage gap between those with a graduate degree and those with only an undergraduate degree corresponds to 10.5-42.0% of the average wage of high school graduates. One of the few studies outside the United States is by Walker and Zhu (2011), who estimate a standard wage function for workers in the United Kingdom using data from the Labour Force Survey. They find that workers with a postgraduate degree in science, technology, engineering, or mathematics earn 6.6-16.6% more than those without a postgraduate degree.

All of the above-mentioned studies are similar in that they do not take the endogeneity of schooling into account; that is, the fact that the link between wages and education potentially reflects confounding factors such as self-selection and unobserved ability. However, there is a growing body of literature that explicitly considers such potential endogeneity. A comprehensive survey of such studies focusing on undergraduate education is provided by Card (1999), suggesting that there is indeed evidence of an upward ability bias, but the bias is so small that it can be offset by downward bias due to measurement errors in schooling variables. On the other hand, Song et. al. (2008), examining the postgraduate wage premium, find evidence of a substantial downward bias due to sorting effects, reflecting the fact that students with a higher quantitative graduate records exam (GRE) score are less likely to go to graduate school. While Song et al. (2008) use tuition fees as an IV to deal with the endogeneity of graduate schooling, Hussey (2012) uses the panel data of MBA holders to eliminate the ability bias. The majority of MBA holders in the U.S. have work experience before earning an MBA, and Hussey (2012) estimates a fixed effect model using panel data that contains information on wages before and after individuals obtained an MBA in order to eliminate the upward bias due to unobserved ability, which is assumed not to change over time.

There are very few studies on the postgraduate wage premium in Japan. One of the few exceptions is the study by Shimizu and Higuchi (2009), who examine the effect of obtaining an MBA degree on wages using a dataset from a survey they conducted of MBA degree holders in Japan, in which they asked respondents about their work experience and wage before and after obtaining the MBA and about their current wage. They find that workers who obtained an MBA degree overseas experienced a positive and significant wage increase, while those with a domestic MBA degree did not. The estimation results provided by Shimizu and Higuchi (2009) cast doubt on the effectiveness of MBA postgraduate education in Japan. As mentioned in the previous section, however, the majority of those holding a postgraduate degree are science/engineering majors, and the MBA holders are an exception in Japan.

The study by Morikawa (2015) was the first attempt to estimated postgraduate wage premiums regardless of individuals' majors. Using cross section data from the *Employment Status Survey* (ESS), which is a nationally representative survey, the study by Morikawa (2015) found that workers with a graduate degree earn 15-30% more than those with only a bachelor's degree. Similarly, Kakizawa et. al. (2014) estimated a wage function and found that the internal rate of return to earning a master's degree is around 11-12%. Morikawa (2015) and Kakizawa et. al. (2014) use the Heckman's two-step estimation method in order to deal with the bias arising from the selection into the labor market, but none of the studies on the postgraduate wage premium in Japan take the endogeneity of graduate schooling into account.

As outlined earlier, there are at least three major reasons why it is important to consider possible self-selection biases when assessing the effect of postgraduate education on wages in Japan. These reasons are grounded in certain idiosyncrasies of Japan's education system and labor market practices, and it is useful to consider these in greater detail. The first reason is that the majority of graduate students in Japan are science or engineering majors at public universities and the fact that admission to science and engineering courses at public universities is highly selective. In general, prospective students in Japan have to take entrance examinations for admission to colleges or universities, with public universities requiring applicants to take the National Center Test for University Admission in addition to the university's own entrance examination. Public universities examine examinees in four to six subjects, and those applying for a course in science or engineering have to choose mathematics as one of their exam subjects. On the other hand, private universities require examinees to take only the university's examination in two to four subjects. The stricter entrance requirements for science and engineering degrees at public universities mean that students majoring in these subjects are more likely to have higher ability than other students do. Omitting individuals' subject and type of university can cause a positive bias when estimating the postgraduate wage premium, since most of those with a graduate degree are science/engineering graduates.

Second, even if workers' undergraduate subject and type of university (private or public) are controlled for, it is possible that an ability bias remains. The reason is that the probability that a student will progress to study for a graduate degree appears to be associated with the selectivity or quality of the university attended and his/her own ability. For example, while around 85% of students completing an undergraduate degree in the science and engineering departments at the University of Tokyo and Kyoto University in 2011 enrolled in a graduate degree, the corresponding figure for public universities as a whole is only approximately 50%. Moreover, science and engineering students in Japan typically belong to a research group (called "laboratory") organized by their advisor, and whether students enroll in a graduate program often depends on their relationship with their advisor. It is possible that professors encourage students with superior ability to enroll in a graduate program, which can result in a positive correlation between graduate schooling and unobserved ability. Thus, workers with a graduate degree are likely to have higher academic ability than those with only a bachelor's degree, but test scores to control for academic ability, such as GRE or SAT scores in the U.S., are not available in Japan.

Third, in addition to these ability biases, there may be another type of self-selection bias linked to the timing of entry into the labor market. Figure 3 shows annual growth rates of graduate enrollment from 1972 to 2012. Graduate enrollment increased rapidly following the 1973 oil crisis, in 1990-1993 in the wake of collapse of the bubble economy, and in 2010 following the collapse of Lehman Brothers[5] that triggered the global financial crisis. The pattern suggests that a considerable

[5] The increase in graduate enrollment from 1990 to 1993 may not (only) reflect adverse labor market conditions, since it occurred in tandem with an expansion in graduate enrollment capacity. Moreover, graduate enrollment during this period increased not only in the natural sciences (including engineering), but also in the humanities and social sciences, which differs from the pattern observed

numbers of students decided to enroll in graduate school instead of finding a job during a recession.[6] College students in Japan have an incentive to postpone their entry into the labor market during recession, because those who fail to obtain a job, or a good job, immediately after graduation in Japan's highly standardized recruitment process are at a disadvantage compared to fresh graduates in subsequent years following the recession. Hamaaki et. al. (2013), for example, have shown that in Japan, the first job has a significant lingering effect on future wages, and it takes ten years for the effect of the first job to disappear. Students, therefore, have a strong incentive to avoid graduating during a recession and to go to graduate school instead in order to postpone leaving university. Given that attending graduate school involves substantial costs, if those who are able to attend graduate school to avoid entering the job market during a recession subsequently find higher-paying jobs than those who were not able to attend graduate school, then the difference in wages between those with and without a graduate degree may reflect not only the human capital accumulated through graduate education but also differences in students' financial means reflecting, e.g., their family's wealth.

For the reasons mentioned above, the analysis in this study uses an IV to deal with the endogeneity of graduate schooling. The instrument used is the number of student places (capacity) available at graduate schools across Japan divided by the number of fourth-year undergraduate students for each undergraduate subject and type of university. The rationale for using graduate enrollment capacity as the instrument variable is as follows. The increase in the number of graduate students during the observation period increased in line with the expansion of university capacity for graduate study, and unless the distribution of students' ability and preferences for graduate education has changed substantially, the expansion of graduate enrollment capacity has made it easier for undergraduate students to proceed to graduate study. Therefore, the change in

for 1973 and 2010.

[6] A similar link between graduate enrollment and the business cycle was found for the United States by Bedard and Herman (2008) and Johnson (2013).

graduate enrollment capacity affects the decision of college students to go to graduate school but is not correlated with individuals' unobserved abilities.[7]

3. Data

As mentioned earlier, the two major preceding studies on the returns to graduate education in Japan by Morikawa (2015) and Kakizawa et. al. (2014) employ the ESS data. The ESS is a nationally representative survey consisting of a very large sample. However, the ESS data do not contain information on the subject of workers' undergraduate degree or the type of university (private or public) that they attended, and, as highlighted, omitting these variables can potentially cause serious upward bias. Consequently, this study employs data from the Japanese Panel Study of Consumption (JPSC), even though the sample size is considerably smaller than that of the ESS.

3.1. Japanese Panel Study of Consumer

The JPSC is one of a very limited number of panels available in Japan and offers a host of advantages, including the fact that it is the longest panel of its kind, spanning a period of 20 years. The survey is conducted by the Institute for Research on Household Economics (IRHE) and started in 1992 with 1,500 women aged between 24 and 34. Of the initial sample, 1,002 women were married, while 498 were unmarried. The IRHE added 500 women aged 24 to 27 in 1997, 1,000 women aged 24 to 29 in 2003, and 500 women aged 24 to 28 in 2008. Although the sample size of the JPSC is smaller than that of the ESS, the JPSC data provides more detailed information about the households, including the undergraduate subjects and type of university (private or public) of the respondents and their husbands. Since this paper focuses on the effect of earning a

[7] Since five-year birth year cohort dummies are included as control variables, the instrument is valid unless the change in graduate enrollment capacity within five years is caused by changes in the distribution of students' ability and preferences for graduate education within five years.

master's degree, the analysis focuses on those who have at least a bachelor's degree.[8]

In the JPSC data, 53% of individuals with a master's degree had obtained a bachelor's degree in science or engineering from a public university, while 29% majored in science or engineering at a private school. Thus, more than 80% of those with a master's degree majored in science or engineering.

The analysis below will focus on those with a degree in science, engineering, agriculture, the humanities, social sciences,[9] or education. Those with a degree in medical, pharmaceutical, dental, or veterinary science are excluded, since these degrees require six years of undergraduate study and those intending to obtain a graduate degree in these fields directly enroll in a Ph.D. program after completing their undergraduate degree.

Summary statistics of the sample are provided in Table 1. Since the present study focuses on the postgraduate wage premium, those who do not work and those who work part-time are also excluded. Based on these selection criteria, the sample contains 6,362 observations for men and 1,925 observations for women.[10] Since the sample size is not that large, those with a degree in science, engineering, and agriculture are aggregated into those holding a degree in natural sciences, and those with a degree in the humanities, social sciences, and education are aggregated into those with a degree in humanities and social sciences. Table 2 presents the number of observations for those with a master's degree by degree subject and type of university.

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[8] As mentioned, while survey participants are exclusively women, the panel also includes information on the husbands of married women, in order to include observations about both men and women. Since the analysis focuses on those who work full-time and hold at least a bachelor's degree, the sample used actually contains more men than women.

[9] Social sciences include law, politics, business, and economics.

[10] Because this study uses pooled panel data and individuals are observed four to five times on average, the number of individuals covered by these observations is smaller. This also means that although, as shown in Table 1, the number of observations for individuals with a master's degree is 379, the actual number of individuals covered by this number is smaller (specifically, 60 men and 24 women).

3.2. Working Person Survey

The sample size of the JPSC data is not very large, and single male individuals are not included. The IV regression relies on the response of the average wage to the change in the difficulty of entrance to graduate schools, but only a few percentage of workers are interested in undertaking graduate education in Japan. Thus the sample size can affect the estimation result significantly. In order to deal with this problem, we employ the data from Working Person Survey conducted by the Recruit Works Institute.

The WPS is a biannual cross sectional survey on workers in Japan, starting in 2000. Around 10,000 workers are interviewed at each survey, but information on the year of graduation is available only for the 2006, 2010, 2012, and 2014 data. The WPS data contains information on the undergraduate subjects, but the type of university that workers graduated from are not available.[11]

Summary statistics of the sample are presented in Table 3, and the sample size by major in Table 4. As the table reveals, the sample size is not very different from the JPSC data, but the number of observations with a master's degree is more than three time as large as that of the JPSC.

Unlike the JPSC data, the WPS data lacks information about the type of universities individuals graduated from which can be an important variable to mitigate the ability bias, but the WPS data contains a significantly greater number of individuals with a master's degree than the JPSC data. Moreover, unlike the JPSC data, the WPS data contains single males. In summary, the WPS data has an advantage over the JPSC data in terms of the sample size and sample coverage, while the JPSC data has richer information on individuals' education than the WPS data.

[11] As shown in the later section, the estimated effect of the type of university is positive and significant but not so large. Thus, the WPS data can be helpful for the IV regression, even if information about the type of university is not available.

3.4. Other Datasets

For the IV—the ratio of the first-year graduate enrollment capacity to the number of fourth-year undergraduate students—data for the graduate school capacity are obtained from the *Zenkoku Daigaku Ichiran*, 1972-2012 (List of Universities in Japan, 1972-2012). The number of fourth-year undergraduate students is obtained from the *Basic Survey of Schools* (BSS). The List of Universities in Japan and the BSS are exhaustive surveys respectively covering all universities and all schools, including graduate schools, in Japan.

4. Estimation Method

For the analysis, Mincer's human capital earnings function (see Mincer, 1974) is estimated for workers with a bachelor's degree:

$$\ln W_{it} = \alpha + \beta G_i + \gamma_1 E_{it} + \gamma_2 E_{it}^2 + \zeta X_{it} + \epsilon_{it} \qquad (1)$$

where W_{it} is the wage of individual i at time t, G_i is a dummy variable indicating whether individual i has a master's degree, E_{it} represents individual i's work experience, which is measured in terms of years since graduation, and X_{it} is a vector of other control variables such as year dummies and five-year birth cohort dummies.[12] The subject of individuals' undergraduate degree and type of university (private or public) are included in X_{it}. The coefficient of main interest is that on the master's dummy, G_i, and the null hypothesis $H_0: \beta = 0$ is tested.

For the baseline estimation, Equation (1) is estimated using OLS focusing on individuals working full-time. Taking sample selection bias into account, Equation (1) is also estimated using the Heckman two-step estimation method. The dependent variable of the selection equation is a dummy variable indicating that the individual is working full-time. In addition to the independent

[12] The standard Mincer human capital earnings function contains years of education as an explanatory variable. Since the focus here is on those who have at least a bachelor's degree and the JPSC does not provide the number of years each individual spent at university, years of schooling are omitted.

variables in Equation (1), the selection equation includes the number of children under the age of four, children aged four to six, and children aged seven to eighteen in order for the exclusion restriction to be satisfied. While the parametric Heckman two-step estimation procedure does not require an exclusion restriction, many empirical researchers do not rely on identification using only parametric assumptions. Therefore, the number of children of different ages is added to the selection equation based on the assumption that the number of children of different ages determines labor force participation but does not directly affect the wage.[13] [14]

Since the large majority of those who obtain a master's degree in Japan do so immediately after completing their undergraduate studies, the master's dummy G_i is constant over time for most individuals. Therefore, it is not possible to eliminate the effect of unobserved ability by including individual fixed effects in the regression model. Consequently, in order to account for the self-selection bias, the IV described above is used. Specifically, the variable is calculated as follows. Let τ_i be the year in which individual i completed their undergraduate studies, ϕ_i be the type of university (private or public) where individual i completed their undergraduate studies, and μ_i be individual i's subject of study. The IV Z_i is defined as follows:

$$Z_i = \frac{Graduate\ enrollment\ capacity\ of\ type\ \phi_i\ university\ in\ subject\ \mu_i\ at\ \tau_i + 1}{Number\ of\ fourth-year\ undergraduate\ students\ in\ type\ \phi_i\ university\ studying\ subject\ \mu_i\ at\ \tau_i}.$$

Z_i can be interpreted as a measure of the difficulty of being admitted to a master's program in subject μ_i in a type ϕ_i university at time τ_i. Thus, Z_i affects an individual i's decision of studying for a master's degree, but the graduate enrollment capacity is determined by universities.

[13] Since the annual wage depends on the hours worked, and since, particularly for women, the number of children likely affects the hours worked, the number of children cannot be regarded as exogenous. However, the JPSC does not contain information on the exact hours worked, and the hourly wage is reported only by those who get paid on an hourly basis. Therefore, we cannot use hourly wages instead of annual wages. Consequently, the analysis uses the number of children as an exclusion restriction, based on the assumption that workers can only decide whether to work, while the number of hours worked is determined by the employer.

[14] It is not common in Japan that husbands take childcare leave or quit their job to take care of a child. Thus, the number of children is not likely to affect the husband's labor force participation. However, with regard to male workers, sample selection bias is not a serious problem, because the vast majority of them work full-time.

Consequently, Z_i is not correlated with individuals' unobserved ability. Moreover, it is unlikely that graduate schools expand or contract capacity in response to labor market conditions.[15] Therefore, self-selection bias due to graduate enrollment in response to the business cycle can be eliminated using Z_i as an instrument.[16]

5. Estimation Results

Estimation Results of Wage Regressions

Let us perform the analysis by running a regression excluding the subject that individuals studied and the type of university they attended and compare the results with those obtained by Morikawa (2015). The results are presented in the first three columns in Table 5 and reveal that male workers with a master's degree earn 26.4% more than male workers with only a bachelor's degree, and that female workers with a master's degree earn 26.9% more than female workers with only a bachelor's degree. Although the sample size of the JPSC data is much smaller than that of the ESS data, the estimates of the postgraduate wage premium are very close to the estimation results reported by Morikawa (2015). Moreover, the postgraduate wage premiums are very similar for male and female workers, which is also in line with the results obtained by Morikawa (2015).

The last three columns in Table 5 present the estimation results when the subject of undergraduate study and type of university are included. As mentioned above, omitting these variables potentially exaggerates the postgraduate wage premium, so it is expected that including them will reduce the coefficient on the graduate dummy. However, as can be seen in Table 5, the coefficient estimates continue to be positive and significant, although their size shrinks to some

[15] It is not common for Japanese universities to provide funding to graduate students in a master's program. Thus, universities do not have an incentive to contract capacity during a recession.
[16] If the labor market is segmented such that there are separate labor markets for those with and those without a graduate degree, an increase in the number of workers with a graduate degree can lower the wage of workers with a graduate degree. Even if this is the case, the estimated effect of postgraduate education on wages with the IV will nevertheless be positive as long as obtaining a master's degree increases an individual's human capital more than spending that time working.

extent. Specifically, for males, the estimated postgraduate wage premium drops from 26.4% to 24.9%, while for females, it falls from 26.9% to 23.6%. These results indicate that omitting the subject individuals studied for their undergraduate degree and the type of university they attended results in an overestimation, but these variables explain only a small fraction of the postgraduate wage premium.

Next, Table 6 presents the results of the Heckman two-step estimation. They indicate that the number of children influences the labor force participation decision of women, and that the estimates of the postgraduate wage premium increase by one to three percentage points. The OLS estimates underestimate the effect of postgraduate education, because the opportunity cost of quitting their job to raise a child is lower for those without a master's degree, and they are therefore more likely to quit.

Finally, in order to eliminate the ability bias, the IV is used. To assess the validity of the IV, the master's dummy is regressed on the instrument. The estimation result, shown in Table 7, indicates that the IV is closely related to whether individuals have obtained a master's degree.[17] The results of the IV estimation, presented in Table 8,[18] reveal that none of the estimated coefficients are significant and are even negative in the regressions for the entire sample and for male workers.[19]

How can the IV estimation result be interpreted? The IV estimation relies on the reaction of the average wage to changes in the measure of the difficulty of entering a master's program. However, the share of workers with a graduate degree is at most 10% in Japan. It is therefore possible that even if the return to graduate education is positive, the estimates are not significant

[17] The F statistic is 62.9. According to the Staiger-Stock rule of thumb (Staiger and Stock, 1997), the value of the F statistic is large enough to eliminate the possibility of the weak instrument problem.
[18] The value of adjusted R square for female is not reported, because the model fit is so poor that the value of adjusted R square is negative.
[19] Running the Heckman two-step estimation with the IV did not yield significant coefficients as well.

because of the sample size and the scarcity of "treated" individuals.

In order to check if insignificant estimation results are caused by the small sample, we run the same regression by using the WPS data. Table 9 shows OLS estimates with the WPS data. The estimates of postgraduate education premium are smaller than those obtained from regression with JPSC data, but not too different from the estimates reported by Morikawa (2015).[20] The estimation result of the first stage regression for IV regression is presented in Table 10. The value of F-statistic is 81.35, which is so large that we do not have to wory about the weak instrument problem. Table 11 shows the estimation results of IV regression. The estimates of the effect of postgraduate education are negative, and not significant for all samples and male samples.

Estimation Results of Job Satisfaction Regressions

The negative and insignificant estimates are obtained even for the regression with the WPS data, which contains more than 1,000 individuals with a postgraduate degree. Thus, insignificant estimates may not be caused by a small sample. It is possible, as previous studies such as Taubman and Wales (1973) and Hussey (2012) suggest, that the postgraduate wage premium to a considerable extent reflects signaling/screening effects rather than higher productivity through graduate education. In that case, it is possible that the average wage remains constant when the share of workers with a master's degree increases without a significant increase in workers' productivity.

Another possibility is that there are non-pecuniary returns to postgraduate education. Under Japan's typical employment system, many job seekers do not know what kind of job they will have until they are employed. For instance, it is common in Japan for someone interested in working as a salesman to be forced to work at the personnel division or accounting division.

[20] Since the WPS data contains only worker samples, we skip the Heckman two-step estimation.

However, new graduates are likely to be hired as an engineer and work at the research and development section if they have a master’s degree. To check if this is true, we define job satisfaction variable S_{it}, which takes on the value of one if an individual is satisfied with the current job and zero otherwise. The WPS 2006, 2010, and 2012 data contains a question about the job satisfaction, and an individual is considered satisfied if they report “very satisfied” or “satisfied” with his/her current job.[21] Table 12 shows the estimation results of the job satisfaction regression with the IV.[22] The coefficient on the master’s dummy is positive and significant for males. Therefore, it can be conjectured that earning a master’s degree can help job seekers to find a job, which is not high paying but more desirable than the jobs they could get without a master’s degree.

6. Conclusion

This paper attempted to estimate the returns to graduate education in Japan using data from the JPSC. Unlike previous studies using the ESS data, the present study controls for the subject that individuals studied for their undergraduate degree and the type of university they attended, and employs an IV to deal with the endogeneity of postgraduate schooling. The estimation results of the OLS regression without the undergraduate subject and type of university are close to estimates of the postgraduate wage premiums obtained by Morikawa (2015). Moreover, also in line with Morikawa’s (2015) results, the postgraduate wage premium was found to be very similar for male and female workers. Next, controlling for the undergraduate subject and type of university (private or public), the postgraduate education wage premium shrinks to a certain extent but

[21] For the 2010 and 2012 data, individuals are regarded as being satisfied even if they choose “not satisfied nor dissatisfied,” which is not in the list of options in the 2006 survey. By doing so, the shares of “satisfied” workers are almost the same for 2006, 2010, and 2012 data.

[22] The values of adjusted R square are not reported, because the model fit is so poor that the values of adjusted R square are negative.

continues to remain positive and significant. The results thus confirm that the estimates of the postgraduate wage premium presented in previous studies are likely biased upward due to omitted variables, but also indicate that the subject studied and the type of university attended (private or public) explain only a small portion of the postgraduate wage premium. The estimation results based on the Heckman two-step estimation method indicate that the estimated postgraduate wage premium is biased downward due to sample selection. Taking the labor force participation decision into consideration, the estimates of the postgraduate wage premium increase by one to three percentage points. On average, the estimated postgraduate wage premium ranges from 23-27% and is statistically significant. However, when the IV is used, the estimated effect of postgraduate education is not statistically significant.

If the IV used in this study is valid and the sample size is not too small, the estimation results indicate that graduate education did not have a sizable impact on the wages of those whose graduate enrollment decision was potentially affected by the change in graduate enrollment capacity. The estimation results of the job satisfaction regression with the same IV, on the other hand, indicate that male workers with a master's degree are more likely to be satisfied with their current job. These results suggest that those who obtained a master's degree owing to the expansion of graduate education may not enjoy higher pay than those without a master's degree, but they receive non-pecuniary benefits from the job which they could not get without a master's degree.

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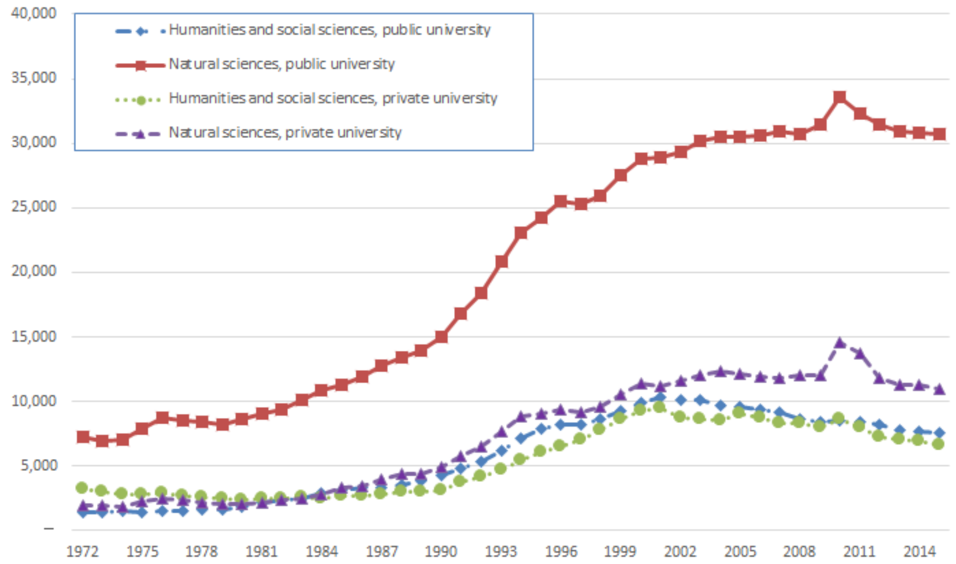

Figure 1: Graduate enrollment by undergraduate major and school type

Data source: *Basic Survey of Schools*

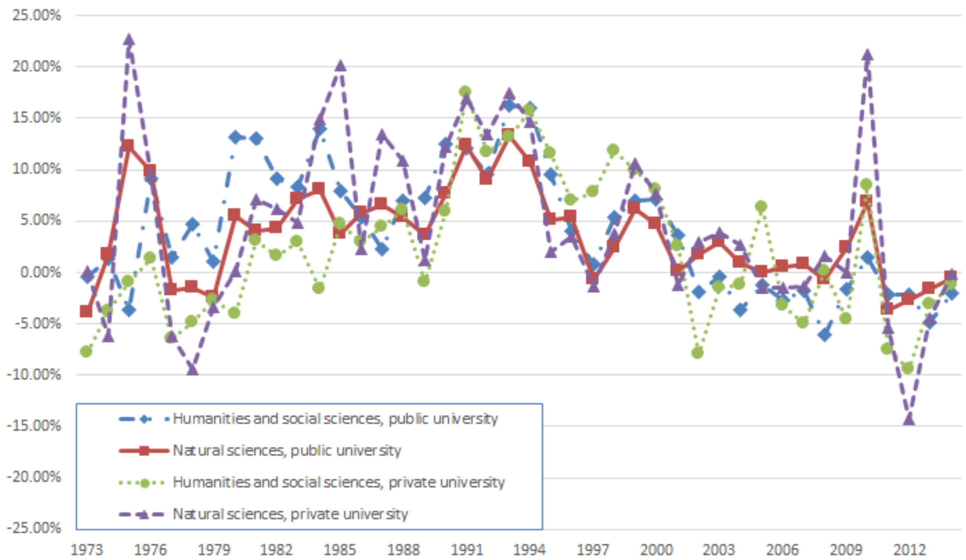

Figure 2: Growth rate of graduate enrollment by undergraduate major and school type

Data source: *Basic Survey of Schools*

Table 1: Summary statistics (JPSC)

	All (college graduates)			Postgraduates		
	All	Male	Female	All	Male	Female
Number of observations	8,287	6,362	1,925	379	284	95
Mean of age	37.0	38.5	31.2	36.3	38.1	30.6
Mean of wages	588.6	636.9	406.0	679.8	739.1	492.9
Std. dev. of wages	259.3	261.9	141.8	281.5	272.8	221.1

Table 2: Number of observations by undergraduate major and school type (public/private) (JPSC)

	Public school			Private school		
	All	Male	Female	All	Male	Female
Natural sciences (B.S.)	200	167	33	126	100	26
Humanities and social sciences (B.A.)	1	0	1	52	17	35
Total	201	167	34	178	117	61

Table 3: Summary Statistics (WPS)

	All (college graduates)			Postgraduates		
	All	Male	Female	All	Male	Female
Number of observations	10,577	8,603	1,974	1408	1,257	151
Mean of age	40.2	41.3	35.3	38.8	39.2	36.0
Mean of wages	639.0	683.3	446.2	702.5	722.5	535.5
Std. dev. of wages	309.7	314.9	190.0	321.0	326.1	210.5

Table 4: Number of observations by undergraduate major and school type (public/private) (WPS)

	All	Male	Female
Natural sciences (B.S.)	1,152	1,062	90
Humanities and social sciences (B.A.)	256	195	61
Total	1408	1,257	151

Table 5: OLS estimation results (JPSC)

	All	Male	Female	All	Male	Female
Master's dummy	0.275***	0.264***	0.269***	0.236***	0.249***	0.236***
	(0.017)	(0.020)	(0.030)	(0.018)	(0.021)	(0.031)
Humanities and social sciences, public university				0.122***	0.136***	0.123***
				(0.010)	(0.012)	(0.016)
Natural sciences, public university				0.114***	0.066***	0.182***
				(0.012)	(0.013)	(0.029)
Natural sciences, private university				0.070***	0.041***	0.029
				(0.009)	(0.010)	(0.023)
Experience	0.064***	0.053***	0.052***	0.064***	0.054***	0.055***
	(0.003)	(0.004)	(0.005)	(0.003)	(0.004)	(0.005)
Experience squared	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment rate	-0.011*	-0.004	-0.033***	-0.007	-0.004	-0.022***
	(0.006)	(0.008)	(0.009)	(0.006)	(0.008)	(0.009)
Constant	5.737***	5.824***	5.950***	5.661***	5.775***	5.871***
	(0.057)	(0.069)	(0.093)	(0.057)	(0.068)	(0.091)
Observations	8287	6362	1925	8287	6362	1925
Adjusted R^2	0.375	0.246	0.282	0.390	0.262	0.314

Notes: Standard errors in parentheses. Year dummies and birth year cohort dummies are included as control variables but not shown for brevity. Experience is defined as the number of years since completing undergraduate or graduate education. The baseline is the humanities and social science majors at private schools.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Heckman two-step estimation results (JPSC)

	All	Male	Female	All	Male	Female
log wage						
Master's dummy	0.240***	0.304***	0.297***	0.214***	0.254***	0.247***
	(0.031)	(0.045)	(0.034)	(0.024)	(0.025)	(0.033)
Humanities and social sciences, public university				0.106***	0.144***	0.125***
				(0.015)	(0.029)	(0.016)
Natural sciences, public university				0.085***	0.074***	0.196***
				(0.024)	(0.029)	(0.032)
Natural sciences, private university				0.056***	0.046**	0.030
				(0.013)	(0.019)	(0.023)
Experience	0.058***	0.055***	0.056***	0.058***	0.055***	0.057***
	(0.006)	(0.005)	(0.006)	(0.005)	(0.004)	(0.005)
Experience squared	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment rate	-0.010	-0.008	-0.035***	-0.006	-0.005	-0.023***
	(0.007)	(0.010)	(0.009)	(0.006)	(0.008)	(0.009)
Constant	5.753***	5.744***	5.760***	5.672***	5.728***	5.629***
	(0.104)	(0.124)	(0.102)	(0.105)	(0.107)	(0.101)
Full-time work dummy						
Master's dummy	0.554***	0.410***	0.689***	0.371***	0.244*	0.599***
	(0.100)	(0.125)	(0.171)	(0.105)	(0.130)	(0.181)
Humanities and social sciences, public university				0.245***	0.438***	0.214***
				(0.049)	(0.071)	(0.078)
Natural sciences, public university				0.504***	0.409***	0.769***
				(0.071)	(0.079)	(0.199)
Natural sciences, private university				0.193***	0.236***	0.011
				(0.045)	(0.053)	(0.107)
Experience	0.091***	0.016	0.130***	0.091***	0.021	0.134***
	(0.014)	(0.021)	(0.024)	(0.014)	(0.021)	(0.024)
Experience squared	-0.001***	0.000	-0.002**	-0.001***	0.001	-0.002**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Unemployment rate	-0.020	-0.035	-0.054	-0.013	-0.032	-0.048
	(0.028)	(0.043)	(0.041)	(0.029)	(0.044)	(0.041)
Number of children aged 1 to 3	0.072*	0.008	-0.689***	0.064*	0.013	-0.717***
	(0.038)	(0.043)	(0.148)	(0.038)	(0.043)	(0.149)
Number of children aged 4 to 6	0.051	0.069	-0.567***	0.051	0.077*	-0.596***
	(0.038)	(0.042)	(0.153)	(0.039)	(0.043)	(0.155)
Number of children aged 7 to 18	-0.058**	-0.010	-0.615***	-0.057**	-0.003	-0.636***
	(0.025)	(0.028)	(0.088)	(0.025)	(0.029)	(0.090)
Constant	0.433	1.483***	0.410	0.272	1.266**	0.269
	(0.316)	(0.498)	(0.456)	(0.320)	(0.503)	(0.462)
lambda	-0.216	0.391	0.107*	-0.204	0.075	0.054
	(0.153)	(0.366)	(0.055)	(0.141)	(0.236)	(0.054)
Observations	9596	7095	2501	9596	7095	2501

Notes: See the footnotes for Table 5.

Table 7: The effect of graduate school capacity on master's dummy (JPSC)

	Master's dummy
Graduate enrollment capacity/number of fourth year undergraduates	0.916***
	(0.145)
Humanities and social sciences, public university	-0.082***
	(0.012)
Natural sciences, public university	-0.030
	(0.038)
Natural sciences, private university	0.043***
	(0.007)
Experience	-0.025***
	(0.002)
Experience squared	0.000**
	(0.000)
Unemployment rate	-0.008**
	(0.004)
Constant	0.497***
	(0.034)
Observations	8287
Adjusted R^2	0.166

Notes: See the footnotes for Table 5.

Table 8: IV estimation results (JPSC)

	All	Male	Female
Master's dummy	-0.093	-0.434	5.448
	(0.266)	(0.291)	(10.747)
Humanities and social sciences, public university	0.117***	0.128***	0.296
	(0.011)	(0.013)	(0.361)
Natural sciences, public university	0.180***	0.197***	-1.190
	(0.055)	(0.057)	(2.831)
Natural sciences, private university	0.092***	0.083***	-0.577
	(0.021)	(0.021)	(1.253)
Experience	0.056***	0.036***	0.223
	(0.008)	(0.009)	(0.348)
Experience squared	-0.001***	-0.001***	-0.000
	(0.000)	(0.000)	(0.001)
Unemployment rate	-0.009	-0.010	-0.010
	(0.007)	(0.009)	(0.043)
Constant	5.832***	6.126***	-0.193
	(0.150)	(0.167)	(11.268)
Observations	8287	6362	1925
Adjusted R^2	0.366	0.135	-

Notes: See the footnotes for Table 5.

Table 9: OLS estimation results (WPS)

	All	Male	Female	All	Male	Female
Master's dummy	0.156***	0.129***	0.170***			
	(0.010)	(0.010)	(0.025)			
M.A. in Humanities and social sciences				0.141***	0.149***	0.124***
				(0.022)	(0.024)	(0.039)
M.A. in Natural Science				0.129***	0.114***	0.165***
				(0.012)	(0.012)	(0.035)
Natural sciences				0.050***	0.020**	0.054***
				(0.007)	(0.008)	(0.017)
Experience	0.005***	0.005***	0.003	0.004***	0.005***	0.003
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)
Experience squared	-0.000**	-0.000***	0.000***	-0.000*	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
UnempRate	0.003	-0.013	0.001	0.003	-0.012	-0.001
	(0.007)	(0.008)	(0.015)	(0.007)	(0.008)	(0.015)
Constant	28.702***	23.550**	-1.769	28.754***	23.833**	-2.150
	(9.474)	(9.378)	(16.182)	(9.453)	(9.376)	(16.134)
Observations	9975	8014	1961	9975	8014	1961
Adjusted R^2	0.364	0.339	0.317	0.367	0.340	0.322

Notes: Standard errors in parentheses. Year dummies and birth year cohort dummies are included as control variables but not shown for brevity. Experience is defined as the number of years since completing undergraduate or graduate education. The baseline is the Humanities and Social Science majors.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: The effect of graduate school capacity on master's dummy (WPS)

	Master's dummy
Graduate enrollment capacity/number of fourth year undergraduates	1.336***
	(0.143)
Natural sciences	0.076***
	(0.019)
Experience	-0.004***
	(0.001)
Experience squared	0.000
	(0.000)
UnempRate	-0.012
	(0.007)
Constant	13.361
	(9.256)
Observations	9975
Adjusted R^2	0.145

Notes: See the footnotes for Table 9.

Table 11: IV estimation results of log wage regression (WPS)

	All	Male	Female
Master's dummy	-0.254**	-0.229**	-1.454
	(0.117)	(0.107)	(0.961)
Natural sciences	0.142***	0.104***	0.316**
	(0.029)	(0.028)	(0.157)
Experience	0.003*	0.004**	-0.007
	(0.001)	(0.001)	(0.008)
Experience squared	-0.000	-0.000***	0.001***
	(0.000)	(0.000)	(0.000)
UnempRate	-0.001	-0.014*	-0.047
	(0.008)	(0.009)	(0.038)
Constant	32.421***	26.678***	-19.510
	(10.170)	(10.032)	(29.855)
Observations	9975	8014	1961
Adjusted R^2	0.276	0.251	-

Notes: See the footnotes for Table 9.

Table 12: IV estimation results of job satisfaction regression (WPS)

	All	Male	Female
Master's dummy	0.326*	0.392**	-0.655
	(0.197)	(0.180)	(1.441)
Natural sciences	-0.068	-0.078*	0.068
	(0.043)	(0.042)	(0.186)
Experience	0.003	0.004*	-0.009
	(0.002)	(0.002)	(0.012)
Experience squared	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
UnempRate	0.024**	0.024*	0.024
	(0.012)	(0.013)	(0.043)
Annual wage	0.159***	0.186***	0.359
	(0.047)	(0.046)	(0.385)
Constant	16.216	9.909	25.744
	(10.628)	(11.718)	(22.443)
Observations	7125	5724	1401

Notes: See the footnotes for Table 9.