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Gender salary and promotion gaps in Japanese academia: Results from science and engineering[1]

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Abstract

Using original survey data on Japanese academics in science and engineering, we examined the gender salary and promotion gaps. We found a 6% gender salary gap after controlling for ranks. This gap was unaffected when quality and quantity of publications were controlled for. In contrast, promotion gap disappeared when publication variables were controlled for. We failed to find negative effects of marriage and children on women's salary and promotion, though a positive sorting into motherhood could conceal such negative effects, and we provided suggestive evidence for this. Men and women are equally likely to move to other universities voluntarily, and the salary premiums from these job changes are the same for both genders, suggesting that outside job offers are not responsible for the gender salary gap. Finally, there are substantial gender differences in academic labor market dropout rates, which could lead to underestimation of the gender salary and promotion gaps.

JEL Classification: J7

1. Introduction

Economic literature on discrimination began to document the gender salary and promotion gaps in US academia in the 1970s with the works of Katz (1973), Johnson and Stafford (1974), Gordon et al. (1974), and Hoffman (1976). Despite significant progress made by women in academia since then, research has continued to find gender salary and promotion gaps. Long et al. (1993) found that women in biochemistry are 10% less likely than men to be promoted to tenure, while Kahn (1993) found similar results in economics and management. Broder (1993) found a 5-8% salary gap in economics departments in the US, while Ward (2001) found a 9.4% gender salary gap in economics departments in the UK, although this salary gap completely disappears when ranks are controlled for.

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McDowell et al. (2001) showed that women were promoted more slowly than men in economics departments in the US until the end of the 1980s, but that the promotion gap disappeared afterward. However, Ginther and Hayes (2003) found that the gender promotion gap persisted over time, although the gender salary gap within ranks disappeared by 1985. Ginther and Kahn (2009) found a 8% gender promotion gap in the probability of receiving tenure in life sciences, but no promotion gap in engineering and physical sciences. Blackaby et al. (2005) documented a 9% gender salary gap among British economists, but this gap reduced to 3.5% when ranks were controlled for.

Japan has been noted for its large gender pay gap in the general labor market. Blau and Kahn (2003) showed that the gender pay gap in Japan was one of the largest among the OECD countries, with the female-male wage ratio being 0.65 in the late 1990s. Daly et al. (2006) also found a gender salary gap of a similar magnitude in Japan, although the gap has been steadily declining over time. Kato et al. (2013) showed, by using a personnel data set for a single firm, that there is a substantial gender salary gap, but this gap is explained away by the gender differences in hours worked.

Although the overall Japanese labor market shows substantial gender inequality in salary, one may expect that academia is an exception. In Japanese academia salary is mostly determined based on rigid salary tables where experience and educational qualifications are the primary determinants of the location on the salary scale. Such rigid salary tables may ensure gender equality in salary. Moreover, Japan is known for its seniority based promotion system where experience largely determines promotion in the majority of industries. Given the near absence of the up-or-out promotion system in Japanese academia, it is reasonable to expect that the seniority promotion system is used in academia as well. If so, then the seniority based promotion system would shield Japanese academia from a gender promotion gap.

However, whether or not there are gender salary and promotion gaps in Japanese academia is still an open empirical question, since these gaps have not been investigated with a similar scrutiny as for the US or UK. Takahashi and Takahashi (2011) is the only study that documents gender salary gaps in Japanese academia. By using a survey sample of 337 academic economists, they concluded that there exists a 7% gender salary gap, after controlling for ranks, the quantity of publications, and various demographic, institutional and job characteristics. Takahashi and Takahashi (2014) used the same sample to investigate gender promotion gaps. They found a statistically significant gender promotion gap for the first promotion spell (from the initial hiring to associate professor). The gender salary gap for the second promotion spell (from associate professor to full professor) was more complex. They found that single childless women are promoted *more quickly* than comparable men. However, they also found that this 'reverse' gender gap disappears after a first child is born, and women's time to promotion becomes significantly longer than men's if they have a second child.

The goal of this study is to investigate if there exist gender salary and promotion gaps in Japanese academia, and if they exist, to explore the possible reasons for the gaps. We improve on Takahashi and Takahashi (2011, 2014) by using a much larger data set, and by controlling for both the quantity and quality of research output. Our data come from a survey of academics in science- and engineering-related departments in Japan that we conducted in 2011. This data set contains 1517 usable observations, and to our knowledge, this is the largest and most detailed microeconomic data set of Japanese academics that currently exists.

To motivate our study, let us provide an initial look at the gender salary and promotion gaps that can be observed in our data set. Figures 1A and 1B show the average salary by experience in public universities (national, prefectural, or city universities) and private universities, respectively. There are visible gender salary gaps in all the experience categories. Figure 2 shows the Kaplan-Meier survival curves for the duration from the initial appointment in academia to the full professor position. Here as well, we observe a gender promotion gap. What could have caused these gaps? This paper will examine the following three possible causes that have been shown to be important sources of gender salary and promotion gaps in US and UK academia: (1) gender differences in academic productivity; (2) gender differences in household responsibilities, especially due to child rearing; and (3) gender differences in outside job offers.

Gender differences in publication productivity are perhaps the first potential cause that one might suspect. In the US and UK, many studies including McDowell et al. (2001), Ward, (2001), and Ginther and Hayes (2003) have found that female academics have a lower rate of publication than males, and that publications are significant determinants of salary and promotion. Regarding Japanese academia, few studies have examined the extent of productivity differences between genders and how much of the observed gender salary and promotion gaps can be attributed to such productivity differences. By using information on both the quantity and quality of academic publications, we examine the effect of publications on the gender salary and promotion gaps. To preview our results, the gender promotion gap for the latter career spell (duration from the end of lecturer to full professor) disappeared after controlling for publications. However, the promotion gap for the early career spell (the duration of lecturer or postdoc) persisted. The gender salary gaps are almost unaffected by the inclusion of quality and quantity of publication controls.

Gender differences in household responsibilities, especially due to child rearing, are another potential cause that one might suspect. As Becker (1985) theorized, females may focus more on the family role relative to their male counterparts, which in turn would reduce the effort allocated to paid work. Although household responsibilities have been shown to cause the gender salary gap in the general labor market (Goldin and Polachek, 1987; Korenman and Neumark, 1992), there are only a few studies that examine whether household responsibilities contribute to the observed gender salary and promotion gaps in academia. Johnson and Stafford (1974) argued that the depreciation of human capital during the time out of work might explain a substantial part of the gender salary gap in academia. Ginther (2004) did not find a substantial marriage and motherhood wage penalty for women in US academia, while Kelly and Grant (2012) did find a motherhood wage penalty, although it was caused by reduced publication due to motherhood.

In this study, we first demonstrate that there is a large difference in the amount of household work performed by each gender, and that marriage and young children are *the* cause of this difference. Thus, to examine if household responsibilities are causing gender salary and promotion gaps, we examine whether these gaps are concentrated among the following three groups: single childless academics, married academics without children, and married academics with children. To preview our results, we failed to show that gender salary gap is different among these three groups. We only found weak evidence of the negative household duty effects on women's promotion, but only for the latter career spell. We argue that there may be a positive sorting into motherhood that conceals the negative household duty effects, and we provide suggestive evidence for this.

Gender differences in outside job offers can also cause the gender salary gap, as Booth et al. (2003) theorized in their sticky floor model. Academics can use outside offers to negotiate their salaries at their current universities, or they can take the offers to increase salary. In fact, Blackaby et al. (2005) showed that the driving force of the gender salary gap in UK academia is the gender difference in the number of outside job offers.

Although our data do not have outside job offer information, we have the entire history of each respondent's job moves, and the reasons for each job move. This can be used to test the above mentioned possibility, since Booth et al.'s sticky floor model provides two testable predictions based on actual job moves. In their model, a firm offers a guaranteed minimum wage to a worker provided that he or she acquires the required specific human capital. However, if the worker receives an outside offer that exceeds the guaranteed minimum wage, the firm matches this offer as long as the offer does not exceed his or her productivity at the firm. This explains why gender differences in the values of outside offers can cause a gender salary gap among equally productive workers.

If an outside offer exceeds the worker's productivity at the firm, the firm cannot match the offer so that the worker moves to another firm. This means that if the values of outside offers are higher for men than women on average, (1) men are more likely than equally productive women to change jobs, and (2) the salary premium for a job move will be higher for men than for equally productive women. These predictions can be tested. To preview our results, we found that women are as likely as men to move to another job for positive reasons such as salary increases, and that the wage premium for moving to another university for a positive reason is the same for men and women. Thus, gender differences in outside job offers do not appear to be the primary reason for the observed gender salary differences.

2. Background

Japan's four-year university system includes: public universities (national, prefectural, and city universities), and private universities. National universities are established and funded by the central government. Prefectural and city universities are established by local governments, but funded by both the local and the central governments. Private universities are established by private entities, and although they receive public funds to some extent, they are largely financially self-supporting.

In 2004, the *National University Corporatization Law* was passed, and it took effect in April 2006. This law brought significant changes to public universities as the 'corporatization' eliminated the public employee status of academics at national universities, and thus allowed these universities greater freedom in various personnel decisions, including salary and promotion determination.[1] For example, before corporatization, the experience and age necessary to be promoted from an assistant professor to an associate professor in public universities were set by civil service laws. In addition, according to these laws, national university employees were considered civil servants and therefore had job security until they reached retirement age, although it has been possible to hire academics on fixed term contracts since 1997.[2] Lifetime employment requirements no longer applied to faculty at national universities after the corporatization took effect. The *Prefectural and City University Corporatization Law* was passed and took effect at the same time. This law, however, did not force these institutions to corporatize, and instead provided them with the option to corporatize if they wished to do so.

Corporatization was supposed to facilitate the adoption of new hiring and promotion systems, such as the 'up-or-out' tenure track system that could increase the competitiveness of universities. In fact, in 2006, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) began to encourage public and private universities to adopt the up-or-out tenure system by providing financial support for introducing and maintaining this system. However, this tenure system has not spread widely yet. According to the MEXT website[3], only 117 departments in 54 universities received the grant, and these departments employ only 315 tenure track faculty as of 2014. Therefore, it is not clear how much promotion practices have changed since 2006.[4]

[1]For the details of the *National University Corporatization Law*, see Yamamoto (2004).

[2]In 1997, the *Law Regarding the Duration of the Contract of University Employees* passed, and allowed universities to hire academics under fixed term contracts.

[3]www.jst.go.jp/tenure

[4]Departments can introduce a tenure track system without receiving MEXT financial support. Certainly,

There are four academic ranks in Japanese academia. They are, from the highest to the lowest rank, full professor (*kyouju*), associate professor (*jun-kyouju*), assistant professor (*koushi*), and lecturer (*jokyo*). Although many universities have these four ranks, according to Japanese education laws, the only 'official ranks' are full professors, associate professor and lecturer. It is up to each university to add assistant professor as an extra rank.

As will be detailed later, academics typically start their career as a lecturer, though some academics start as postdocs, or start directly as assistant professors or associate professors. In addition, there are faculty who start their academic career directly as full professors after a long non-academic career, often in various ministries.

The total annual salary of academics includes: monthly salary for 12 months, bonuses, and allowances (i.e., for children less than 20, spouse with income less than a threshold, cost of living, teaching at graduate level). In most universities, salary is determined based on a rigid pay scale called the salary table. Although currently all universities have the freedom to set their own salary table, public universities typically follow the guideline salary table provided by the National Personnel Authority (NPA).[5] Most private universities set their own salary tables.

A salary table stipulates how salaries should progress depending on academic rank. Each rank contains a number of divisions (pay scales). The initial division at hiring is determined based on age, previous experience, and educational attainment. Before the corporatization, an academic in public universities used to move up one division annually. After the reforms, the NPA divided one division into four smaller divisions, so that universities can fine-tune the salary among different individuals. Who decides how many divisions

more than 117 departments could have introduced tenure track system. For example, one of the authors' university introduced the tenure track system without this support. However, the paucity of departments accessing MEXT support indicates that the tenure track system is not widespread yet.

[5]NPA (Jinjiin) is a neutral, third-party organization dealing with public employee management. Since MEXT determines the subsidies to public universities assuming that universities follow the NPA guideline table, setting salary greater than the NPA's guideline table is difficult due to budget constraints.

a faculty member should move up annually and the criteria used for the decision are in a black box, presumably depending on each university's regulations.

Japanese academics typically receive a bonus twice a year. In a few universities, the amount of bonus is set as $(\textit{Monthly salary including allowances}) \times K$, where K is a predetermined constant set by the university.[6] We do not know whether discretionary bonuses are possible in other universities, or how common they are. If discretionary bonuses are possible in many universities, a gender salary gap might arise despite the rigid salary tables.

Promotion decisions within Japanese universities are made at the department level, usually by faculty personnel committees, considering various criteria such as experience, research output and education. However, it is commonly believed that 'a larger factor than the research output in determining promotions is the years of experience (OECD 2006, p.78)'.

3. Data

Data were obtained from a survey we administered via a postal questionnaire in 2011. Our survey method follows. First, from MEXT's web page, we obtained an official list of all four-year universities in Japan: 86 national, 95 public and 599 private universities. Second, by checking each university's website, we collected the names of all faculty in sciences- and engineering-related departments: 29,114 names (17,567 from national, 1,487 from prefectural, and 10,060 from private universities).

We sent out 4800 questionnaires. In order to increase the number of female observations, we first selected all the female sounding names (1,122 names). Then, we randomly selected the rest of the names (3,678). We sent questionnaires to each faculty's work address, and a reminder was sent two weeks later. As an incentive, we offered 1000 yen (either cash or

[6] In one of the authors' university, K is set equal to 1.375, and there is no room for discretion based on productivity.

a special cash card) to about 500 respondents by lottery. About half of the respondents participated in the lottery.

We received 1,636 responses for a response rate of 34%. The response rates by gender are 35% and 28% for males and females, respectively, assuming that all female-sounding names were in fact females. From the 1636 responses, we dropped 46 observations due to missing salary information. We dropped observations whose annual salary is less than 1.5 million yen (7 observations), since respondents with such low salary are unlikely to be fulltime faculty. We also dropped respondents whose age exceeds 65 (42 observations), since they are likely to be retired academics who were rehired, and since we want to focus on the gender gaps among primary working age academics. Further eliminating observations with missing variables (20 observations), and observations with clearly inconsistent answers (4 observations), we have the usable sample of 1517 observations.

The percentage of females in our final sample is 19.6%. Based on the MEXT Statistics of School Education, the percentage of females in the sciences and engineering related departments is 6.7%. Our successful oversampling of females will increase the precision of the estimates.

3.1 Choice of Variables

Table 1 contains all the variables used for our salary regressions and their summary statistics. Promotion analyses will use a subset of these variables. The dependent variable in the salary equation is the logarithm of the total annual salary which includes the 12-month salary plus bonuses and allowances from the current institution. It does not include income from other universities. We have a number of control variables for personal, job, institutional and human capital characteristics. Let us explain the variables that are not self-explanatory.

Quantity of research output is measured by the number of refereed career articles without distinguishing between single authored and co-authored articles. Quality of research output is measured by the variable *Field top 20 article share*. Each respondent reported the names of the journals in which their top three articles were published. *Field top 20 article share* indicates the share of field top 20 articles among the three reported articles.[7]

If female academics are over-represented in low paying universities, the female dummy will pick up the difference in university characteristics. To minimize this possibility, we control for several university characteristics. Universities differ in many dimensions, such as reputation, research orientation, location, or public or private status. To control for reputation, the ideal variable would be the departmental ranking. Due to the anonymous nature of our survey, this is not possible. However, reputation is likely to be correlated with research orientation, a characteristic we are able to control for. Our survey asked each respondent to indicate the weights that their departments place on research, teaching and administrative duties in promotion decisions.[8] We use the weights on research to control for research orientation. In addition, research orientation is controlled for by including a dummy for Ph.D. offering institutions.

Location is also an important determinant of salary, since universities adjust for the cost of living. For example, public universities provide 'cost of living adjustment allowances' based on the NPA's university location classifications. Private universities do not have explicit cost of living adjustment allowances, but their salaries could reflect the cost of living. Thus, we include five large city dummies, Class 1 Cities to Class 5 Cities, based on NPA's university location classifications.[9]

[7] Journal rankings are based on the citation counts, and are derived from journalranking.com.

[8] When such weights are not formally set by the department, we ask respondents to approximate the weights.

[9] According to NPA classifications, Tokyo Metropolitan area is classified as a Class 1 city, and Osaka is classified as a Class 2 city, and so on with decreasingly large cities denoted by class number. At the time of writing this paper, public universities in class 1 cities provided a cost of living adjustment allowance equivalent to 18% of the base monthly salary. The survey questionnaire lists all the cities in each location classification, and the respondents were asked to tick their location classification.

Japanese universities pay allowance for those who have a dependent spouse. This allowance is paid when the spouse's annual income is less than 1.3 million yen for public universities, and less than 1.03 million yen for private universities. Thus, we include a dummy for those who are eligible for dependent spouse allowance.

Job mobility variables are created as follows. Our survey asked each respondent to report their entire history of job moves and the reasons for each move: for a salary increase; for a better job environment; due to contract expiration; for family reasons; or for 'other reasons'. When a respondent chose 'other reasons', the survey asked them to write down the actual reasons. The most common 'other reasons' were to obtain promotion, and because they were offered a job.

Respondents were allowed to choose multiple answers. Thus, we reclassified the moves into five categories. A type 1 move is any move that entails a salary increase. A type 2 move is any move that is due to other positive reasons, but that *does not entail a salary increase*, namely for a better job environment, for promotion, or because they are offered a job. A type 3 move is a move that is the result of contract expiration, and *that does not entail any positive reasons.* A type 4 move is a job move that is purely a result of family reasons. A type 5 is a job move that cannot be classified in any of the first four types. Regressions will control for the total number of each type of moves.

Table 1 shows that female academics have lower salary, have fewer years of experience, have fewer publications, are less likely to have managerial positions, are more likely to be employed under fixed term contracts, and are over-represented in the two lowest ranks. Female academics are slightly under-represented in research oriented universities. The number of positive job changes (type 1 moves and type 2 moves) is lower for women, while the number of negative job moves (type 3 moves and type 4 moves) is greater for women.

4. Gender differences in key characteristics

In this section, we provide a detailed look at the gender differences in the key characteristics used to examine the reasons for the gender salary and promotion gaps. First, let us examine the gender differences in productivity. Figure 3A shows the average number of career articles by experience categories. At any experience, women publish less than men. Figure 3B presents the average of *Field top 20 article share* by experience categories. Interestingly, there seem to be no significant gender differences in research quality up to 25 years of experience. In fact, women's research quality seems to be higher for some experience categories.

Another indicator of research productivity is the amount of competitive grants. Our survey contains information on the two most important grants at the time of the survey: their duration in years, the total amount of each grant, and in case of a joint grant, the respondent's contribution to the grant project in percentage. *Annual grant amount* is computed as the total amount of grant multiplied by the respondent's percentage contribution divided by the duration of the grant project. Figure 4 shows the average *Annual grant amount* by experience categories. We observe visible gender differences.

Second, let us look at gender differences in household responsibility. Our survey asked information on the percentage of total household work the respondent performs at home, and the household size (the number of people in the household including the respondent). We can thus construct a proxy for the amount of household work performed by each respondent as follows: $\textit{Household work} = (\textit{Household size}) \times (\textit{Percentage of household work performed})$. This variable shows the approximate number of family members (including the respondent) that the respondent takes care of. Thus, if this variable is greater than 1 the respondent is a net care giver, and if less than 1 the respondent is a net care receiver.

Figure 5A shows the average *Household work* by experience categories. Men's *Household work* hovers between 0.5 and 0.6, and thus they are net care receivers. In contrast, women's *Household work* ranges between 1.2 and 1.7, and thus, they are net care givers. For women, *Household work* is increasing up to experience 25, and then declines. This increasing trend at the beginning of their careers is likely to capture the increasing household burden due to marriage and parenting.

A greater amount of household work performed by women would affect their number of hours worked. Thus, we further examine gender differences in hours worked. Our survey contains information on the weekly hours worked during a typical work week, including hours worked at home and in weekends. Figure 5B presents the average weekly hours worked by experience categories. For the first 15 years of experience, men work longer hours than females, with the difference being about 3 hours per week. Gender differences in hours worked disappear after 20 years of experience.

What causes the gender differences in the amount of household work and weekly hours worked? In Appendix A, we present regression results for *Household work* and *Weekly hours worked*. We found that the gender differences in *household work* are present only among (1) married academics with young children, and to a lesser extent in (2) married academics without young children. Similarly, the gender difference in the *weekly hours worked* is found only among married academics with young children. These results indicate that children and marriage are the cause of the gender differences in household responsibility. Thus, if the household responsibility is the primary source of the the gender salary and promotion gaps, these gaps should be concentrated among married academics with children, and among childless married academics. We test this in the empirical section.

Finally, we examine gender differences in job mobility patterns. Table 2 provides Tobit regressions of the job moves. Column 1 shows the results for *#Type 1 moves*. *Female* coefficient is negative, though it is insignificant. More importantly, the magnitude of the coefficient is small, with the marginal effect of *Female* being only -0.013. Column 2 presents the results for *#Type 2 moves*. The coefficient for *Female* is positive, though the estimated marginal effect of female is again very small (0.029). Women are more likely than men to move purely for contract expiration (Column 3), though the female coefficient is not statistically significant, and the marginal effect is very small (0.017). In sum, there are no economically and statistically meaningful gender differences in the job mobility patterns.

5. Gender salary differences

Table 3 shows our salary regressions. Model 1 is the most parsimonious model that does not control for ranks. Results show a gender salary gap of about 8.7%. Model 2 adds the rank variables. This reduces the salary gap to 6.5%, although it remains statistically significant. The relatively small decrease in the estimated gender salary gap implies that the salary gap that stems from the gender promotion gap is not large. This contrasts with the findings of Ward (2000) and Ginther and Hayes (2003) that much of the gender salary gap in the UK and the US academia stems from the gender promotion gap.

As mentioned previously, Japanese universities decide salary based on rigid salary tables. This payment setting method is expected to shield academics from a gender salary gap. Nevertheless, a gap exists in our sample. One interpretation of the result is that the estimated salary gap might capture pay scale differences among universities, and that there may be no gender salary gap within each university.

Although we cannot estimate the gender gap for any specific university, we can examine if this possibility is true. As public universities mostly follow the guideline salary table set by the NPA while private universities traditionally set their own salary table, if the estimated gender salary gap merely reflects pay-scale differences among universities, the gender salary gap is likely to be concentrated among private universities. Model 3 and 4 in Table 3 separately estimate the salary regression for public and private universities. The gender gap is 6.7% in public universities and 6.2% in private universities. Thus, the gender salary gaps are almost equal, which is inconsistent with the aforementioned interpretation.

Now, let us examine if gender differences in research productivity are responsible for the gender salary gap. Model 5 in Table 3 adds research quantity and research quality variables.[10] *Career articles* and its squared term are statistically significant. *Field top 20 article share* does not have a statistically significant effect. This does not mean that research quality is not rewarded in Japanese academia. When we excluded rank variables in an unreported regression, we found statistically significant effects of research quality on salary. It will also be shown later that research quality is positively associated with the probability of promotion. *Annual research grant* has no significant effects. The most important finding in Model 5 is that the inclusion of productivity variables has little impact on the estimated gender salary gap. Thus, we can conclude that gender differences in productivity are not responsible for the observed gender salary gap.

Next, let us investigate if gender differences in household responsibility are responsible for the observed gender salary gaps. Since *Household work* is the current household responsibility while it is perhaps the cumulative household responsibility that affects salary, simply controlling for *Household work* in the regression will not answer the question (i.e., current *Household work* might be low because a child has grown up, but there may be lasting impacts from household work undertaken when the child was young). However, we have already shown that marriage and children are *the* causes of the gender differences in household responsibility. Thus, children and marriage can capture the negative effects of

[10] As for our research quality variable *Field top 20 article share*, if this variable is indicative of the quality of the rest of the publications, it is better to use it as a discount factor to compute the quality-adjusted career publications. However, if it is not indicative of the rest of the publications, it may be better to include this variable in an additive fashion. We experimented with both methods and we found that additively incorporating this variable achieves the greatest statistical significance. Thus, we use the second method.

household responsibilities on salary that were inflicted in the past, but that persist over time. To investigate the effects of cumulative household responsibility on the observed gender salary gap, we investigate if the gender salary gap is concentrated among childless married academics, and married academics with children.

Model 6 in Table 3 includes the $Female \times Married$ interaction as well as the $Female \times Total\#Children$ interaction. We use the *total* number of children instead of the number of *young* children since children may have long term effects. Note that the model includes rank variables, so that it does not capture indirect effects of household responsibility through delayed promotion. The estimation results show that marriage is associated with a 3.1% increase in salary for men, while it is associated with a 2.5% increase for women. An increase in the total number of children by one is associated with a 0.9% increase in salary for men while it is associated with 0.4 % increase in salary for women. The estimated gender salary gaps for (1) single childless academics, (2) married childless academics, and (3) married academics with one child are 5.1%, 5.7%, and 6.2%, respectively.

Thus, the differences in the gender salary gaps among the three groups are minor in magnitude. Moreover, the differences are statistically insignificant. Thus, we failed to find evidence that household responsibility is a cause of the gender salary gap. This is a puzzling result since the marriage and motherhood wage penalties for women are widely documented in the labor economics literature.[11] Should we conclude that there is no marriage and children wage penalty for women in Japanese academia?

One interpretation of this result is that this is indeed evidence of the absence of household duty wage penalty for women. Academia is often viewed as a flexible work place, where faculty have considerable discretion over the setting of their work schedules. This flexibility might translate into the absence of the household duty wage penalty for women. In addition,

[11] For example, see Korenman and Neumark, 1992; Goldin, 1997 and Waldfogel, 1998.

a slightly higher gender salary gap for the academics with children may reflect the dependent children allowances that universities pay to their employees.[12] This allowance is more likely to be received by men than women, since universities usually have no-double-recipient policy–when the husband receives the dependent children allowance from his employer (regardless of whether or not his employer is a university), the wife is not qualified for the dependent children allowance.

The second interpretation is that there is a household duty wage penalty for women, but there also is a positive sorting into motherhood–the most productive women self-select into motherhood, and this positive sorting might have cancelled out the negative household duty effects. In fact, Krapf et al. (2014) report such positive sorting effects on academic publication productivity. Despite the perception that academia is a flexible workplace, Mason et al. (2013) provided case evidence that women often struggle to balance work and life, especially in the US where there is a pressure to obtain tenure. Even in Japan where the tenure track system is rare, many early career positions (postdocs and lecturers in particular) are fixed term positions, which put a similar stress on female academics. In addition, in science fields, experiments are often done in a team, and thus flexibility is not always guaranteed.

Which interpretation is more likely? If there is a positive sorting into motherhood, it is likely that more productive women decide to have a child at an early stage of their career because they are perhaps more confident in their ability to combine children and work, while less productive women wait longer to have a child perhaps because they see a larger risk in childbearing or because they may have more tenuous appointments.

Thus, the early child-bearers are likely to have a higher ability and thus a higher salary

[12] In fact, the estimated child wage premium for men roughly corresponds to the amount of the allowance. In one of the authors' university, the annual amount of dependent children allowance is 60 thousand yen, while 0.9% salary premium is equivalent to 76 thousand yen at the male average in our sample.

than late child-bearers. In Appendix B we examined this possibility. More specifically, we divided academics with at least one child into: (A) those who had their first child within one year prior to the beginning of their academic career; (B) those who had their first child within three years of academic career; and (C) those who had their first child after three years of academic career. Having the first child one year prior to the academic career could indicate that they might have successfully negotiated and delayed the start of the job after receiving a job offer. This may indicate high productivity. Having the first child within three years of academic experience would also indicate high productivity.[13]

Thus, we compared the salary of the early child-bearers (group A and B) with the the late child-bearers (group C). As Table B.2 in Appendix B indicates, for female academics, group A has a salary premium of 14.8%, and group B has a salary premium of 5.2% as compared to the group C. Such large salary premiums for having children early may partly reflect university differences–more productive women are hired by better paying universities, and at the same time they are likely to give birth at early stage. We found no such pattern for men. The salary premium for female early child-bearers is consistent with the hypothesis that there exists a positive sorting into motherhood. Thus, we are inclined to support the hypothesis that the negative household duty effects is concealed by the positive motherhood sorting.

Finally, we examine if the observed gender salary differences may stem from the gender differences in the values of outside job offers. If this is the case, then the wage premium from positive job moves must be higher for men than women. Model 7 in Table 3 includes the job mobility variables as well as the interactions between these variables and *Female*. *#Type 1 moves* (moves due to salary increases) has a positive coefficient but it is insignificant. *#Type*

[13] Some academics gave birth earlier than one year prior to the beginning of their career. They are likely to be the ones who worked in the non-academic sector first, and then moved to academia. Thus, we do not include them in the 'early child-bearers' groups.

2 moves (other positive moves) has a negative but small and insignificant coefficient. Not surprisingly, *#Type 3 moves* (contract expiration only) has a negative coefficient. Our interest is the interaction term between *Female* and *#Type 1 moves.* If the gender gap stems from the gender differences in outside job offers, this interaction term should have a negative coefficient. However, the interaction coefficient is *positive*, though it is not statistically significant. Thus, the above hypothesis was not supported by the data. Let us also look at the result for other positive moves, *#Type 2 moves.* The coefficient for *#Type 2 moves*×*Female* interaction is negative, but it is small and insignificant.

In sum, we did not find evidence that salary premium for a positive job move is higher for men. Combining this result with the earlier finding that there are no differences in the number of 'positive' job moves, we can conclude that gender differences in outside job offers are not responsible for the gender salary gap in Japanese academia.

6. Gender promotion gaps

6.1 Typical patterns of academic career

Now, we turn our attention to the gender promotion gap. First, it is worth describing the typical patterns of academic careers in our sample. Table 4 tabulates the rank at initial hiring in academia. 70.1% of academics started their career from the lowest instructor rank (lecturer), but a few academics start their career from even a lower position (postdoc). A few respondents started their career directly as assistant professors or associate professors. 5.3% of respondents started their career directly as full professors, and they are excluded from our promotion analysis since for them the duration to promotion is zero.

The bottom half of Table 4 tabulates what rank respondents received immediately after their early career positions (lecturer or postdoc). About one third of the respondents became assistant professors and about one third skipped assistant professorship and became associate professors. The rest were still lecturers at the time of survey. Thus, a considerable percentage of respondents have skipped the assistant professor position.[14]

In this study, we analyze the following two separate promotion spells: *the early career spell*, which is the duration of being either a lecturer or a postdoc; and *the latter career spell*, which is the duration from the end of early career spell to the promotion to full professor. Note that the latter career spell can start either in an assistant professor or in an associate professor position (since some respondents skipped the assistant professor positions). When a respondent started their career directly as an assistant professor or associate professor, the year of initial hire is set as the start of the latter career spell.

There are two reasons for why we separated the promotion spells in this way. First, Takahashi and Takahashi (2014) indicated in their analysis of promotion in economics departments in Japan that the gender promotion gap is concentrated in the very early career. Thus, we suspect that the gender promotion gap may be more problematic for the early career spell in our data as well. Second, both of the early career positions (lecturer and postdoc) are often unstable fixed term positions, and thus getting out of these positions is one of the most important milestones of a career in academia in Japan.

Graph 6A shows the Kaplan Meier survival function estimation of the duration of the early career spell. We observe visible gender differences in the survival probability. Graph 6B shows the Kaplan Meier survival function of the duration of the latter career spell. For this spell, gender differences in the probability of promotion are much less pronounced.

In the following hazard function analyses, we split the data in one year increments to accommodate time-varying variables. As we know the exact timing of each job change and the type of university the respondent worked for in the past, the private university dummy is now time-varying taking the value 1 only for the time the respondent is working at a

[14]This could be because the assistant professor rank is optional according to education law in Japan, and thus, the distinction between assistant and associate professor becomes blurred.

private university. We converted the number of career articles into a yearly publication rate. This construction assumes that publication rate is constant over time. This is likely erroneous, but since promotion is decided in the past, converting it into an annual rate is necessary.

As described already, there is a considerable variation in the initial academic rank. Thus, before presenting our hazard function analyses, it is useful to investigate whether there are gender differences in the initial rank assignment. We ran a probit model that predicts the probability of whether an academic's initial appointment is as a lecturer or a postdoc as opposed to an assistant professor or an associate professor. Results are in Table 5. We do not observe a gender gap in the probability that one starts their career as a lecturer or postdoc.

6.2 Hazard function estimations

Now, we present our hazard function analyses. To allow possible duration dependence, we employ a Weibull baseline hazard. Table 6 presents the results. Column 1 includes our baseline results for the early career spell. The female coefficient is negative and significant at the 5% level. Column 2 presents our baseline results for the latter career spell. The female coefficient is negative and statistically significant.

Column 3 and 4 include controls for annual publication rate and the publication quality. Let us first look at the results for the early career spell (Column 3). The publication rate and its squared term have statistically significant coefficients. *Field top 20 article share* does not have a significant effect for this spell. The inclusion of these productivity controls slightly reduced the female coefficient, though the coefficient remains negative and highly significant.

Now, let us add publication rate and publication quality to our analysis of the latter career spell (Column 4). The publication rate and its squared term have statistically significant coefficients. *Field top 20 article share* now has a statistically significant coefficient. Most importantly, the female coefficient is reduced substantially, and it is no longer statistically significant. Thus, gender differences in publication seem to be the primary source of the gender promotion gap for the latter career spell.

We now proceed to examine if the gender promotion gap simply reflects gender differences in household responsibility. If this is the case, then the gender promotion gap should be concentrated among married childless academics and among married academics with children. To test this, we include *Female*×*Married* interaction as well the interactions between *Female* and the number of young children. The number of young children is separated in two age categories (age 0 to 5 and age 6 to 18). In addition, children variables are time-varying.[15]

Let us first look at the results for the early career spell (Column 5). Inclusion of these interaction variables does not change the female coefficient much, though the statistical significance is reduced, and now it is only marginally significant (pval=0.156). The coefficients for all the interaction terms are negative, although none of them are statistically significant.

Most importantly, based on the results in Column 5, the magnitude of the gender promotion gaps within different marriage×children cells are not different for this spell. Graphs 7A to 7C show the estimated survival probabilities for single childless academics, married childless academics, and married academics with one child. We observe visible gender promotion gaps for all the three groups. These gender promotion gaps are not appreciably different among these three groups.

Now, we take a look at the latter career spell (Column 6). None of the coefficients for the interaction terms are statistically significant. However, the estimated magnitudes of

[15]The questionnaire asked the age of each child at the time of survey. Based on this information, we are able to compute the number of children that falls into a particular age category at a particular point in time.

gender promotion gaps among different marriage-children cells are meaningfully different. Graph 8A to 8C show the estimated survival probability for single childless academics, married childless academics, and married academics with one child. Graph 8A shows a sizable promotion 'advantage' for single childless women over single childless men. The expected duration to promotion is 14.3 years for men while it is only 11.8 years for women. Graph 8B and 8C shows, however, that this 'reverse promotion gap' completely vanishes for married academics with or without children, and it seems that men and women are promoted at a fairly equal rate.

As a robustness check, we re-estimated the hazard function for the latter career spell, separately for single childless academics, married childless academics, and married academics with young children in unreported regressions.[16] Although the estimated female coefficients were not statistically significant, the pattern of the gender gap confirms our analysis in the previous paragraph: there is a reverse promotion gap among single childless academics, but that the reverse promotion gap vanishes for married academics with or without a child.

Thus, we have only weak evidence of the negative effects of household duties on female promotion–the disappearance of the 'reverse gender promotion gap' for married academics with and without a child in the latter career spell. However, as we discussed in the salary analysis, a positive sorting into motherhood might be concealing such negative effects.

The above analyses presented us with a puzzling pattern of the gender promotion gap: a gender promotion gap exists in the early career spell, but not in the latter career spell. Furthermore, we even found a 'reverse promotion gap' in the latter career spell among single childless academics. We note that the same pattern, including the existence of a reverse

[16]In these regressions, single academics are defined as those who were never married during the latter career spell. Childless married academics were defined as those who were married at least one period during the spell, but never had a child during the period. Married academics with young children are defined as those who were married at least one year during the spell, and had at least one child aged between 0 to 18 during that spell.

promotion gap, was found in Takahashi and Takahashi (2014), who studied the gender promotion gaps in economics departments in Japan. Given this, we are inclined to believe that such a pattern is not merely due to statistical noise.

Then, what could explain such a pattern? One possible explanation is that women might have higher academic labor market dropout rates as compared to men during the early career spell, and only the most productive women survive into the later career spell. Such a 'survivor bias' could lead to an underestimation of the gender promotion gap in the latter career spell, and even make women appear to promote faster than men. Note again that the early career positions are often fixed term positions, and thus, a promotion is often equivalent to receiving a permanent position elsewhere after the contract expires. Thus, a greater dropout rate for women could occur if there is gender discrimination in hiring into a permanent academic position.

Let us examine if there are gender differences in academic labor market dropout rates. For this purpose, we obtained the 2010 MEXT statistics of university faculty (*Kyoin Kojin Chosa*), which contain information, although fairly basic, about the entire faculty in Japan, such as age, experience, the name of universities, departments they belong to, whether they quit the university within one year prior to the survey, and the reason for the quit. Based on this data set, we computed the annual academic labor market dropout rates in science and engineering fields.[17]

Figure 9A shows the overall annual academic labor market dropout rates; the male dropout rate is 1.4 % while the female dropout rate is as much as 3.8%. Figure 9B shows the breakdown by ranks. The dropout rates are higher for the lower academic positions both for men and women, but women's dropout rates are significantly higher than those

[17]Reasons for quit are classified as follows: (1) retirement, (2) mental sickness, (3) other sickness, (4) death, (5) move to a research institute, (6) move to a non-academic job, (7) move to another university, (8) entered a university as a student, (9) family reasons, and (10) other reasons. Academic labor market dropouts are defined as quits due to reasons (2), (3), (6), (8), (9), and (10).

of men for all the positions, and especially for the lower academic ranks. Note that these are annual dropout rates, so over the course of several years, a considerable number of women would drop out of the academic labor market. Given this, we cannot rule out the possibility that gender differences in the academic labor market dropout rates are causing the promotion patterns we observe.

Nevertheless, we admit that this is just one possible explanation. Another possible explanation is employer learning. For example, employers might be more uncertain about women's productivity than men's upon hiring, which might make women's promotion slower in their early career. However, as the employers learn the ability of women more precisely over time, women's speed of promotion would catch up with that of men's, eliminating the gender promotion gap for the latter career spell.

7. Discussion and Conclusion

Despite the growing interest in gender equality in Japanese academia, there have been very few studies that analyzed the gender salary and promotion gaps. This study contributes to the literature by providing detailed analyses of gender salary and promotion gaps in Japanese academia using original survey data.

We found that there is a gender salary gap of 6% after controlling for ranks and various other characteristics. When quality and quantity of publication are additionally controlled, this gender salary gap was almost unchanged, indicating that gender differences in publication productivity are not responsible for the gender salary gap.

The results for the promotion analyses were quite different, however. The gender promotion gap for the latter career spell disappeared when quality and quantity of publication were controlled for. Thus, the gender differences in publication productivity appear to be the main source of the gender promotion gap for this spell. This result also indicates that publications affect wage mainly through promotion. We note however that, for the early career spell, a sizable gender promotion gap remained even after controlling for publications.

This raises the question of why gender promotion gap is present only in the early career spell. We provided two possible explanations. One of these explanations suggests that women's greater academic labor market dropout rates in the early career spell, which might be a result of discriminatory hiring into permanent positions, and the resulting 'survivor bias' might be concealing a gender promotion gap in the latter career spell. If there is such a survivor bias, we are also underestimating the gender salary gap. We admit however, that other explanations can be possible, such as employer learning.

As for the analysis of the effects of household duties on the gender salary gap, the estimated gap was not appreciably different among different marriage×children cells, thus failing to show evidence that household duties are responsible for the gender salary gap. We only found weak evidence of negative household duty effects for promotion in the latter career spell. One possible explanation for the lack of evidence is that there may be a positive sorting into motherhood that is concealing the negative household duty effects.

Finally, we found no evidence that gender differences in the value of outside job offers are responsible for the estimated gender salary gap, despite the fact that there are significant university-to-university job changes for both male and female academics. Perhaps, Japanese academics are not using outside job offers to negotiate salary.

There are a number of limitations in this study. The most important limitation is that we failed to control for university fixed effects. Thus, we are not able to eliminate the possibility that the estimated gender salary and promotion gaps reflect the situation where women are disproportionately appointed in low-paying and slow-promoting universities. The incompleteness in our publication variables should be acknowledged as well. These limitations could result in our overstating the gender salary and promotion gaps.

It is fair to say, however, that the results of this study are a reminder that gender equality in salary and promotion in Japanese academia cannot be assumed simply because of the existence of rigid salary tables and the possible existence of a seniority based promotion. While more studies are definitely needed to firmly establish the existence or the absence of gender salary and promotion gaps, we believe that this study have substantially contributed to the understanding of the state of gender inequality in Japanese academia.

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Figure 1: Experience-salary profiles

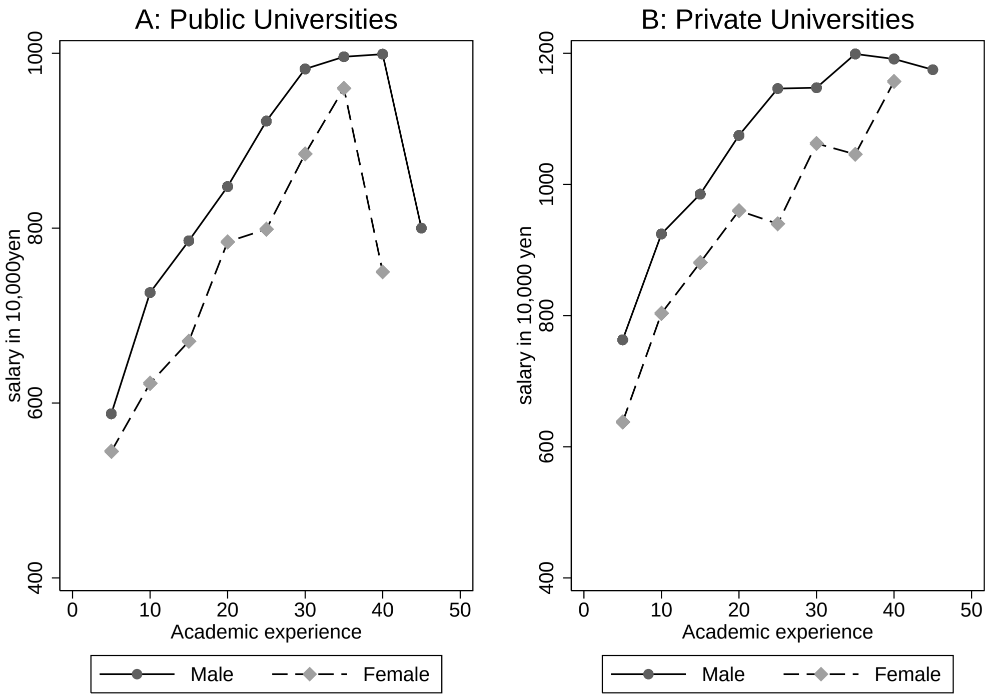


Figure 2: Duration from the initial appointment to the full professor position.

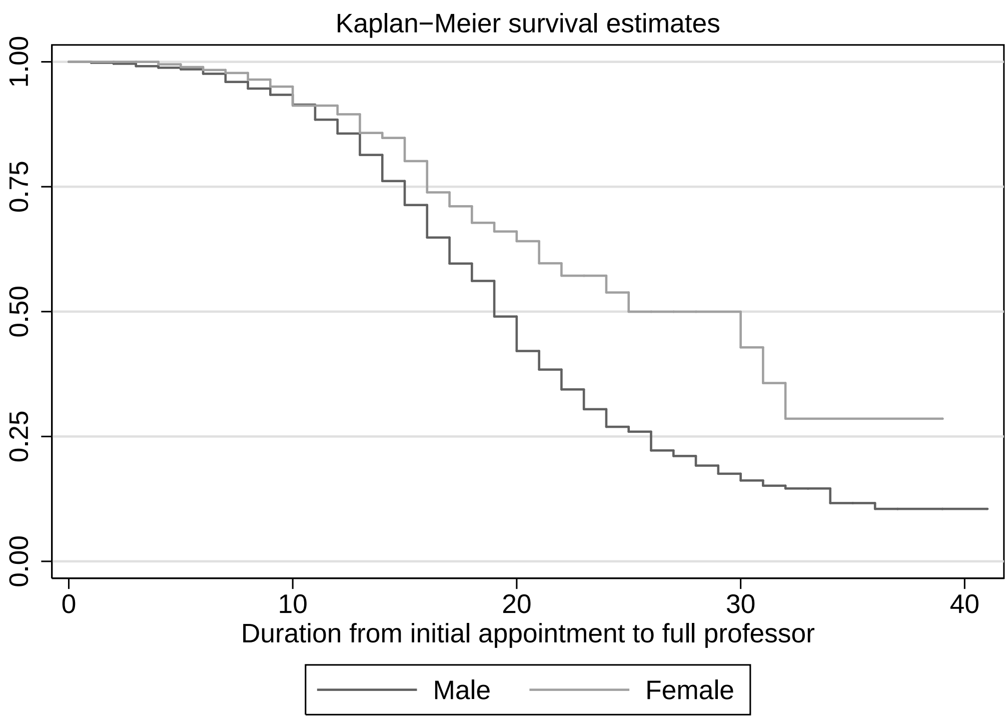


Table 1: Summary statistics for salary regressions

# Obs	Males =1221	Females =296		Males	Females
Annual salary (10,000 yen)	859.5	719.6	#Subjects taught/year=0	0.106	0.199
	(239.6)	(221.9)		(0.308)	(0.400)
Female	0	1	#Subjects taught/year=1-3	0.347	0.375
			(will be excluded category)	(0.476)	(0.485)
Full professor	0.430	0.179	#Subjects taught/year=4-6	0.442	0.294
	(0.495)	(0.384)		(0.497)	(0.456)
Associate professor	0.313	0.301	#Subjects taught/year$\geq$7	0.105	0.132
	(0.464)	(0.459)		(0.306)	(0.339)
Assistant professor	0.0385	0.115	#Sessions taught/week	2.305	2.330
	(0.192)	(0.319)		(1.469)	(1.737)
Lecturer	0.219	0.405	Eligible for spousal allowance	0.258	0.0169
(will be the excluded category)	(0.414)	(0.492)		(0.438)	(0.129)
Academic experience	16.30	11.85	Fixed term contract	0.153	0.253
	(10.94)	(9.674)		(0.360)	(0.436)
Non academic experience	3.368	2.567	Have a managerial position	0.120	0.0372
	(7.003)	(5.305)		(0.325)	(0.189)
Private University	0.274	0.389	Initial rank=Full professor	0.0590	0.0270
	(0.446)	(0.488)		(0.236)	(0.162)
Department offers PhD	0.906	0.861	Married	0.843	0.669
	(0.292)	(0.346)		(0.364)	(0.471)
# Career articles	60.070	32.128	Total#Kids	1.314	0.649
	(64.792)	(35.543)		(1.097)	(0.908)
Field top 20 article share	0.422	0.413	#Type 1 moves	0.0753	0.0574
	(0.397)	(0.389)		(0.302)	(0.261)
Annual amount of grant	281.616	145.681	#Type 2 moves	0.295	0.253
(in 10,000 yen)	(1531.654)	(465.615)		(0.598)	(0.487)
Educ=MA and below	0.075	0.088	#Type 3 moves	0.0852	0.145
(will be excluded category)	(0.263)	(0.284)		(0.328)	(0.431)
Educ= PhD from Japan	0.906	0.892	#Type 4 moves	0.0205	0.0439
	(0.292)	(0.311)		(0.153)	(0.236)
Educ= PhD from abroad	0.0197	0.0203	#Type 5 moves	0.00573	0.0135
	(0.139)	(0.141)		(0.0857)	(0.116)
Weight on research	53.11	48.05	Class 1 cities	0.0958	0.145
for promotion decision	(22.68)	(22.55)		(0.294)	(0.353)
Teach graduate classes	0.744	0.568	Class 2 cities	0.0663	0.0811
	(0.436)	(0.496)		(0.249)	(0.273)
#MA supervisees	3.627	2.260	Class 3 cities	0.138	0.132
	(3.719)	(2.713)		(0.345)	(0.339)
#PhD supervisees	0.771	0.446	Class 4 cities	0.184	0.223
	(1.616)	(0.990)		(0.388)	(0.417)
			Class 5 cities	0.130	0.132
				(0.337)	(0.339)
			Smaller cities	0.516	0.419
			(will be the excluded category)	(0.500)	(0.494)
			Department field dummies	Yes	Yes

Inside the brackets are standard deviations. Department field dummies are: mechanical engineering, material engineering, bio-engineering, electronics, civil engineering, engineering in business field, engineering in other social science, physics and mathematics, chemistry, bioscience, astronomy, and 'other' field.

Figure 3: Experience-research productivity profile

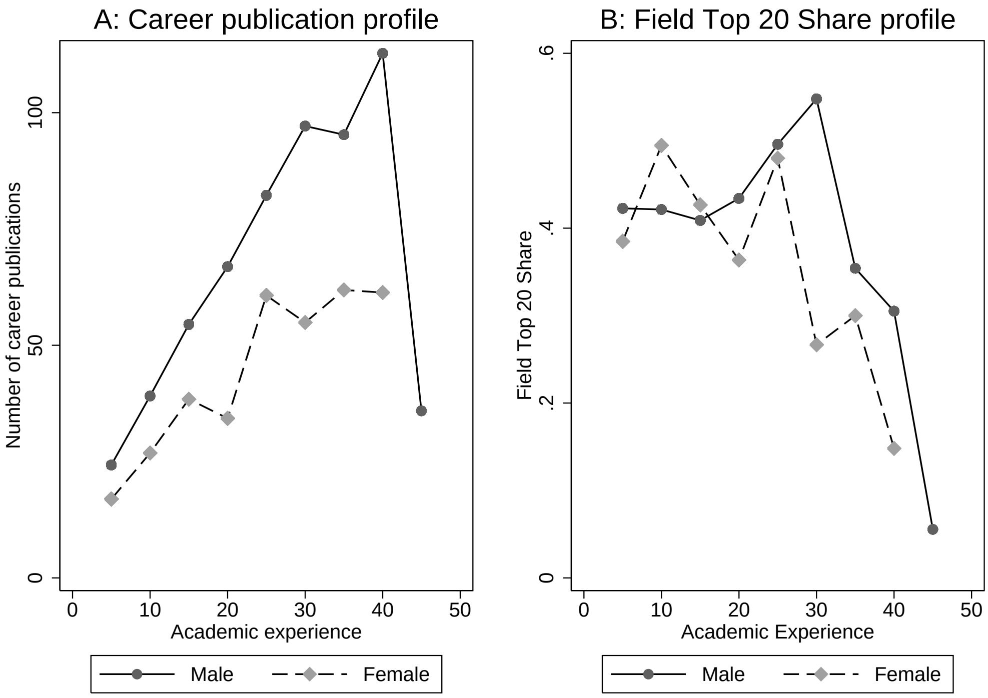


Figure 4: Experience-annual amount of grant profile

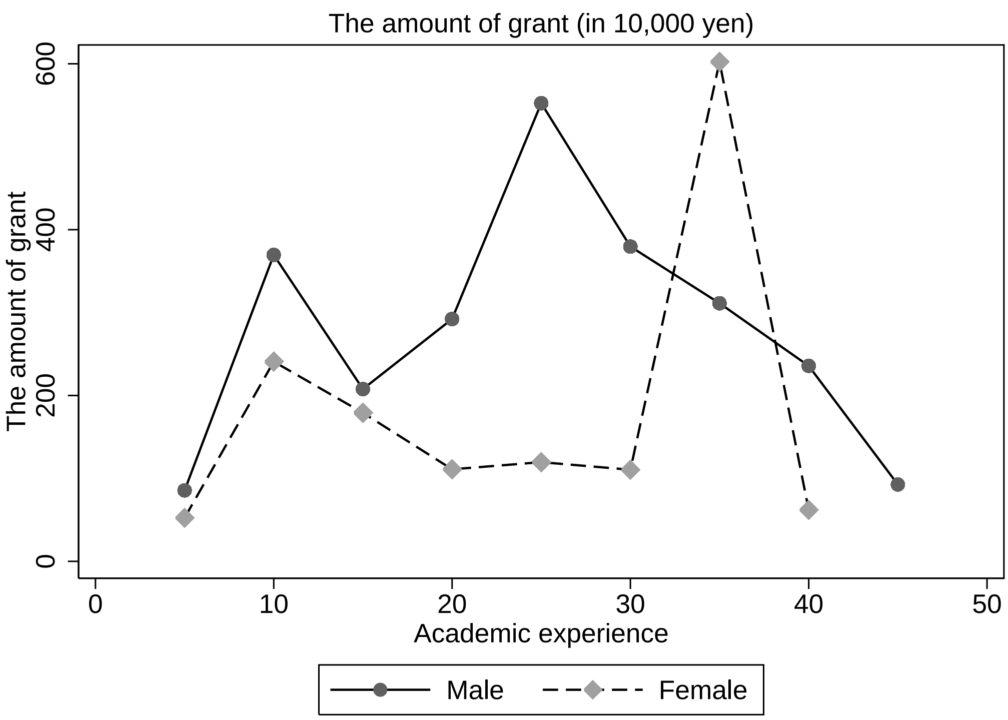


Figure 5: Household work and hours worked

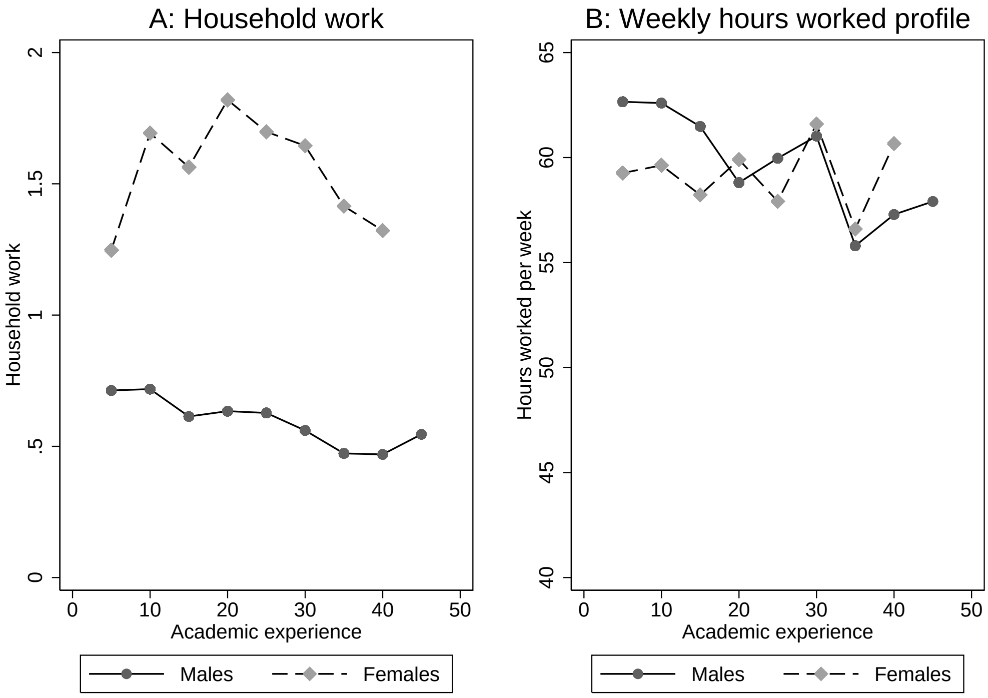


Table 2: Determinants of job mobility (Tobit regressions)

Dept var=	#Type 1 moves (Salary increase)	#Type 2 moves (Other positive moves)	#Type 3 moves (Contract expiration only)
Female	-0.335	0.128	0.212
	(0.328)	(0.159)	(0.252)
Married	-0.115	0.156	0.012
	(0.328)	(0.175)	(0.279)
Academic experience	0.045	0.158***	-0.002
	(0.045)	(0.024)	(0.041)
(Academic experience)^2	-0.001	-0.004***	-0.001
	(0.001)	(0.001)	(0.001)
Non academic experience	-0.042*	-0.057***	-0.013
	(0.025)	(0.013)	(0.021)
Have Phd from Japan	0.554	0.507**	0.317
	(0.533)	(0.254)	(0.447)
Have PhD from abroad	-10.574	0.654	0.709
	(0.000)	(0.468)	(0.821)
Annual publication rate	-0.034	-0.006	-0.155***
	(0.031)	(0.014)	(0.042)
Field top 20 article share	0.207	0.409**	0.669**
	(0.338)	(0.169)	(0.301)
Cons	-4.057***	-2.883***	-2.711***
	(0.793)	(0.380)	(0.633)
Dept field dummies	Yes	Yes	Yes
# Obs	1,517	1,517	1,517
Marginal effect of Female	-0.013	0.029	0.013
	(0.0120)	(0.038)	(0.0169)

Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Table 3: Salary regression

	Model 1	Model 2	Model 3 Pub univ	Model 4 Priv univ	Model 5	Model 6	Model 7
Female	-0.087***	-0.064***	-0.067***	-0.064***	-0.061***	-0.051**	-0.059***
	(0.012)	(0.011)	(0.011)	(0.022)	(0.011)	(0.020)	(0.012)
Full Professor		0.304***	0.294***	0.364***	0.282***	0.279***	0.277***
		(0.020)	(0.019)	(0.050)	(0.020)	(0.020)	(0.021)
Associate Professor		0.179***	0.175***	0.214***	0.170***	0.169***	0.167***
		(0.017)	(0.016)	(0.046)	(0.017)	(0.017)	(0.017)
Assistant Professor		0.084***	0.067***	0.133***	0.081***	0.079***	0.078***
		(0.022)	(0.023)	(0.046)	(0.022)	(0.022)	(0.022)
Academic experience	0.025***	0.018***	0.018***	0.017***	0.017***	0.017***	0.017***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Academic experience^2	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Non academic experience	0.007***	0.004***	0.006***	0.000	0.004***	0.003***	0.004***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
#Career articles/100					0.072***	0.071***	0.070***
					(0.016)	(0.016)	(0.016)
(#Career articles/100)^2					-0.013***	-0.013***	-0.013***
					(0.004)	(0.004)	(0.004)
Field top 20 article share					0.014	0.014	0.016
					(0.011)	(0.011)	(0.011)
Annual grant amount/1000					-0.002	-0.002	-0.002
					(0.002)	(0.002)	(0.002)
Married	0.055***	0.038***	0.047***	0.010	0.037***	0.031**	0.030**
	(0.013)	(0.011)	(0.011)	(0.027)	(0.011)	(0.013)	(0.012)
Married×Female						-0.006	
						(0.026)	
Total#Kids						0.009**	0.007*
						(0.004)	(0.004)
Total#Kids×Female						-0.005	
						(0.012)	
#Type 1 moves							0.016
(salary increase)							(0.012)
#Type 1 moves×Female							0.021
							(0.032)
#Type 2 moves							-0.001
(other positive reasons)							(0.006)
#Type 2 moves×Female							-0.003
							(0.018)
#Type 3 moves							-0.037***
(contract expiration only)							(0.014)
#Type 3 moves×Female							-0.009
							(0.032)
#Type 4 moves							-0.015
(family reasons only)							(0.027)
#Type 4 moves×Female							0.021
							(0.044)
#Type 5 moves							0.008
(other reasons)							(0.052)
#Type 5 moves×Female							0.066
							(0.076)

Table continues to next page

Table 3 continued

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Private university	0.155***	0.144***			0.152***	0.151***	0.152***
	(0.012)	(0.011)			(0.011)	(0.011)	(0.011)
Department offers PhD	0.049***	0.042***	0.026	0.046*	0.041***	0.042***	0.040***
	(0.016)	(0.015)	(0.016)	(0.026)	(0.015)	(0.015)	(0.015)
Have PhD from Japan	0.046***	0.019	0.027	-0.008	0.014	0.015	0.016
	(0.018)	(0.016)	(0.018)	(0.030)	(0.016)	(0.016)	(0.016)
Have PhD from abroad	0.031	-0.009	0.005	-0.083	-0.017	-0.014	-0.010
(Excluded=MA and below)	(0.030)	(0.026)	(0.027)	(0.062)	(0.026)	(0.026)	(0.026)
Weight on research	0.0003	0.001***	0.000*	0.001**	0.001***	0.001***	0.001***
for promotion (%)	(0.0002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fixed term position	-0.066***	-0.054***	-0.033**	-0.095***	-0.054***	-0.055***	-0.053***
	(0.014)	(0.014)	(0.013)	(0.034)	(0.014)	(0.014)	(0.014)
Have a managerial position	0.088***	0.047***	0.047***	0.039	0.046***	0.045***	0.046***
	(0.013)	(0.012)	(0.013)	(0.025)	(0.012)	(0.012)	(0.012)
Teach graduate classes	0.095***	0.016	-0.001	0.018	0.013	0.012	0.013
	(0.013)	(0.014)	(0.013)	(0.032)	(0.014)	(0.014)	(0.014)
#MA supervisees	0.005***	0.004***	-0.000	0.012***	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
#PhD supervisees	0.010***	0.005*	0.007**	0.010	0.004*	0.005*	0.004*
	(0.004)	(0.003)	(0.003)	(0.012)	(0.002)	(0.002)	(0.002)
#Subjects taught/year=0	-0.052***	-0.030**	-0.043***	0.001	-0.028**	-0.029**	-0.028**
	(0.015)	(0.014)	(0.015)	(0.047)	(0.014)	(0.014)	(0.014)
#Subjects taught/year=4-6	0.021**	0.003	0.009	-0.014	0.007	0.007	0.006
	(0.010)	(0.010)	(0.009)	(0.026)	(0.010)	(0.010)	(0.010)
#Subjects taught/year≥7	0.002	-0.019	0.008	-0.050	-0.016	-0.015	-0.018
(Excluded=#subject=1-3)	(0.017)	(0.016)	(0.015)	(0.031)	(0.016)	(0.016)	(0.016)
#Sessions taught/week	0.008**	0.002	0.003	-0.002	0.003	0.003	0.004
	(0.004)	(0.003)	(0.004)	(0.006)	(0.003)	(0.003)	(0.003)
Eligible for spousal allowance	-0.027***	-0.019**	-0.023***	-0.004	-0.019**	-0.022**	-0.021**
	(0.010)	(0.010)	(0.009)	(0.025)	(0.010)	(0.010)	(0.010)
Initial rank =Full Prof	0.157***	0.102***	0.046	0.157***	0.105***	0.105***	0.104***
	(0.035)	(0.031)	(0.032)	(0.049)	(0.031)	(0.031)	(0.031)
Class 1 cities	0.103***	0.098***	0.122***	0.064**	0.097***	0.099***	0.098***
	(0.015)	(0.014)	(0.016)	(0.027)	(0.014)	(0.014)	(0.014)
Class 2 cities	0.110***	0.103***	0.094***	0.102***	0.099***	0.100***	0.101***
	(0.017)	(0.016)	(0.019)	(0.031)	(0.016)	(0.016)	(0.016)
Class 3 cities	0.096***	0.093***	0.078***	0.104***	0.090***	0.091***	0.088***
	(0.012)	(0.011)	(0.011)	(0.028)	(0.011)	(0.011)	(0.011)
Class 4 cities	0.074***	0.078***	0.084***	0.067**	0.073***	0.073***	0.074***
	(0.012)	(0.011)	(0.010)	(0.034)	(0.011)	(0.011)	(0.011)
Class 5 cities	0.047***	0.040***	0.021*	0.081**	0.034***	0.034***	0.032***
(Excluded=smaller cities)	(0.013)	(0.011)	(0.011)	(0.032)	(0.011)	(0.011)	(0.011)
Cons	6.027***	6.070***	6.112***	6.207***	6.061***	6.058***	6.062***
	(0.032)	(0.030)	(0.031)	(0.061)	(0.030)	(0.030)	(0.030)
Dept field dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
#Obs	1,517	1,517	1,068	449	1,517	1,517	1,517
R squared	0.753	0.795	0.828	0.727	0.799	0.799	0.801

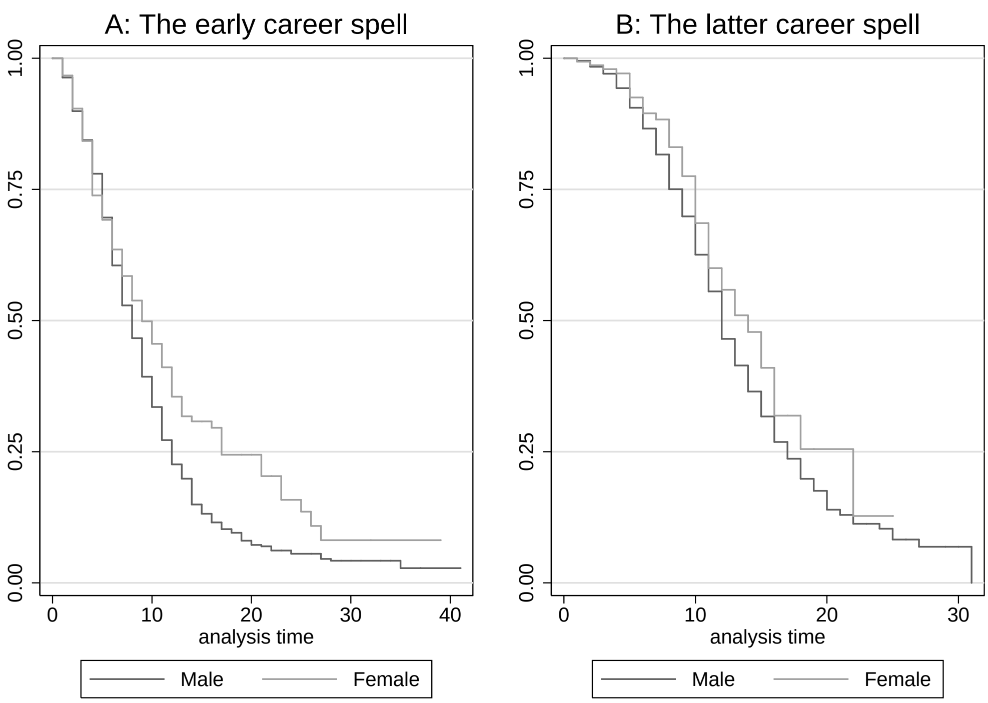
Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Table 4: Promotion patterns

Rank at initial hiring in academia	# Obs	%	Included in promotion regressions
Full professor	80	5.3%	NO
Associate professor	140	9.2%	YES
Assistant professor	122	8.0%	YES
Lecturer	1063	70.1%	YES
Postdoc	99	6.5%	YES
Promotion history missing	13	0.9%	NO
Total	1517	100%	
Next rank after the early career positions (i.e., lecturer or postdoc)			
Associate professor	390	33.6%	
Assistant professor	381	32.8%	
Still a lecturer at the time of survey	391	33.7%	
Total	1,162	100%	

Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Figure 6: Kaplan Meier survival curves



The early career spell is the duration of lecturer and postdoc. The latter career spell is the duration from the end of the early career spell to full professor.

Table 5: The rank at initial hiring = lecturer or postdoc (probit regression)

Variables	Coefficients
Female	0.017
	(0.107)
Non academic career	-0.117***
	(0.009)
Educ=Phd from abroad	-0.648**
	(0.309)
Educ=Phd from Japan	-0.222
	(0.171)
Cons	1.278***
	(0.187)
Department specialization dummies	Yes
#Obs	1,424
Marginal effect of female	0.004
	(0.0258)

Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Table 6: Hazard function analysis of promotions

	Baseline		Productivity		Household responsibility	
	Early career (1)	Latter career (2)	Early career (3)	Latter career (4)	Early career (5)	Latter career (6)
Female	-0.475***	-0.351*	-0.373***	-0.172	-0.300	0.435
	(0.145)	(0.189)	(0.136)	(0.191)	(0.210)	(0.330)
Non academic experience	0.006	0.056***	0.002	0.047***	0.002	0.045***
	(0.015)	(0.012)	(0.016)	(0.011)	(0.016)	(0.011)
Educ=PhD from Japan	1.281***	0.176	1.108***	-0.049	1.112***	0.007
	(0.178)	(0.200)	(0.174)	(0.176)	(0.175)	(0.173)
Educ=PhD from abroad	2.290***	0.005	2.123***	-0.164	2.103***	-0.098
(Excluded=MA and below)	(0.344)	(0.308)	(0.339)	(0.274)	(0.345)	(0.276)
Private university	0.645***	0.390***	0.739***	0.622***	0.748***	0.625***
	(0.109)	(0.103)	(0.109)	(0.103)	(0.109)	(0.102)
Annual publication rate			0.177***	0.194***	0.174***	0.183***
			(0.039)	(0.042)	(0.038)	(0.043)
Annual publication rate^2			-0.008***	-0.006**	-0.007***	-0.006**
			(0.003)	(0.003)	(0.002)	(0.003)
Field top 20 article share			0.010	0.482***	0.018	0.493***
			(0.119)	(0.136)	(0.120)	(0.138)
Married	0.213**	0.438*	0.148	0.396**	0.104	0.454*
	(0.096)	(0.224)	(0.094)	(0.194)	(0.113)	(0.249)
Married×Female					0.063	-0.590
					(0.285)	(0.464)
#Kids age 0-5					0.050	-0.261**
					(0.055)	(0.103)
#Kids age 0-5×Female					-0.199	-0.658
					(0.191)	(0.528)
#Kids age 6-18					0.076	0.171***
					(0.061)	(0.050)
#Kids age 6-18×Female					-0.168	0.092
					(0.194)	(0.236)
Cons	-4.888***	-7.042***	-5.300***	-7.932***	-5.290***	-7.813***
	(0.243)	(0.364)	(0.250)	(0.373)	(0.248)	(0.399)
Log(α)	0.431***	0.828***	0.474***	0.898***	0.464***	0.855***
	(0.030)	(0.036)	(0.030)	(0.036)	(0.031)	(0.038)
#Subjects	1118	978	1118	978	1118	978
#Failures	767	479	767	479	767	479

Inside brackets are cluster robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Figure 7: Early career spell: Estimated survival probabilities

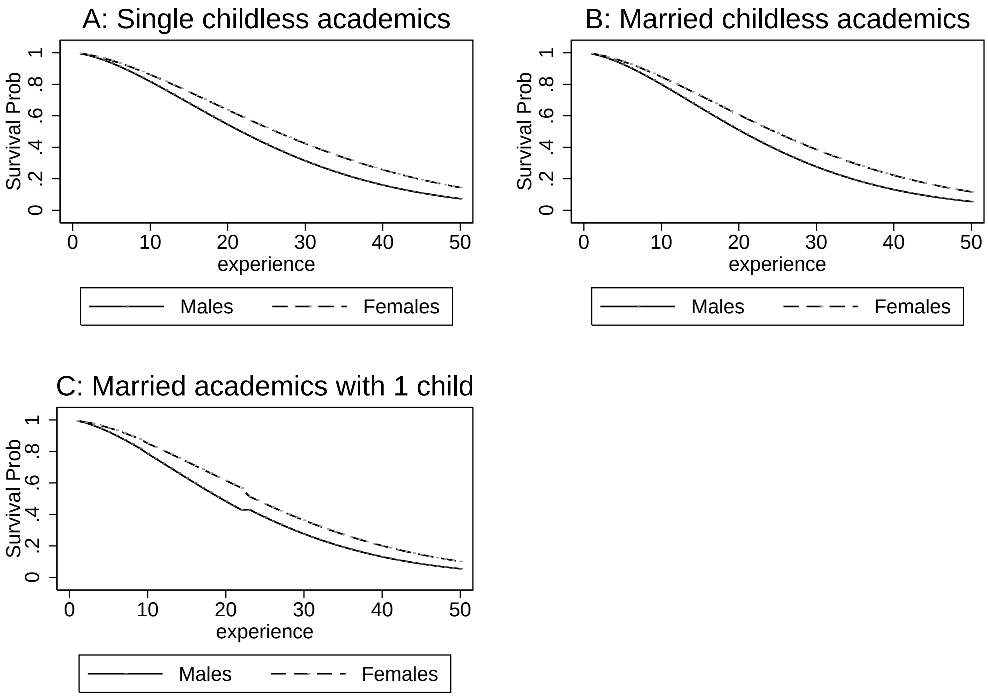


Figure 8: Latter career spell: Estimated survival probabilities

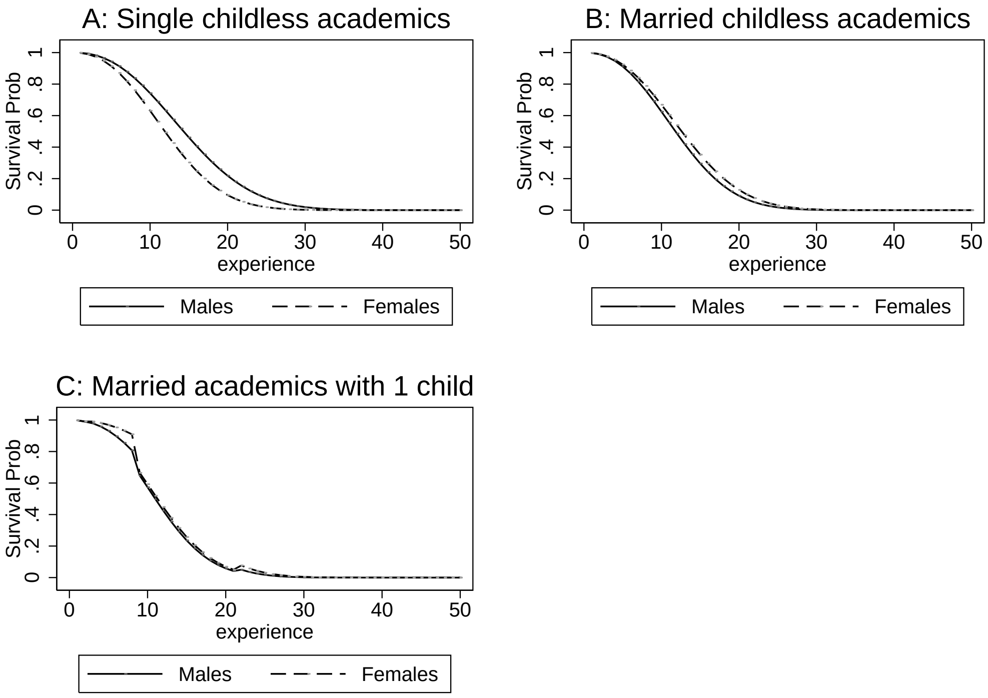
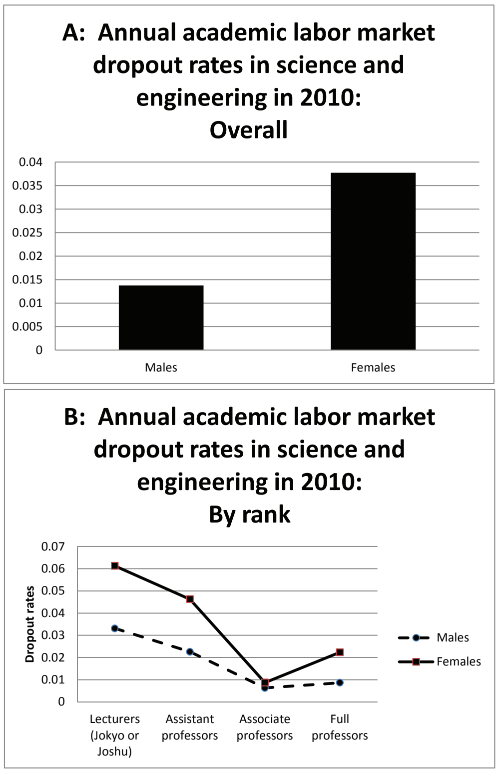


Figure 9: Academic labor market dropout rates in science and engineering fields in 2010



Statistics are based on 2010 MEXT Kyouin Kojin Chousa.

Appendix A: Determinants of household responsibility and weekly hours worked.

Table A.1 Columns 1 and 2 show *Household work* regression results.[18] Column 1 is the simplest model that does not control for gender differentiated effects of marriage and young children. *Household work* is greater for female by 0.8. Column 2 includes the interaction between *Female* and *Married*, as well as the interactions between Female and young children variables. Gender differences in household responsibility are present only among: (1) married childless academics, and to a greater extent (2) married academics with young children. Thus, it is the presence of young children and the husband that cause gender differences in household responsibility.

Table A.1 Columns 3 and 4 show *Weekly hours worked* regression results.[19] Column 3 does not control for gender differentiated effects of marriage and young children. Women work 1.48 hours less than men per week, but this difference is statistically insignificant. Column 4 includes the interaction between *Female* and *Married*, as well as the interactions between *Female* and young children variables. Gender difference in weekly hours worked are present only among married academics with children aged 0 to 5. We observe no gender differences in weekly hours worked among single childless academics, among married childless academics, and among married academics with children aged 6 years and older. This results indicate that it is younger children that cause gender differences in weekly hours worked. Combining all the results, it is reasonable to conclude that it is marriage and young children that cause gender differences in household responsibility.

[18]The number of observations is smaller than that for the salary regression due to missing *Household Work* information.

[19]The number of observations is smaller than that for the salary regression due to missing *Weekly hours worked* information.

Table A.1: Determinants of *Household responsibility* and *Weekly hours worked.*

Dept var=	*Household work*		*Weekly hours worked*	
	(1)	(2)	(3)	(4)
Female	0.835***	-0.032	-1.475	1.083
	(0.037)	(0.057)	(1.087)	(1.951)
Married	-0.061	-0.415***	-2.249*	-1.514
	(0.046)	(0.047)	(1.358)	(1.616)
Married×Female		0.831***		-1.026
		(0.073)		(2.518)
#Kids age 0-5	0.241***	0.151***	0.602	1.791*
	(0.035)	(0.031)	(1.034)	(1.080)
#Kids age 0-5×Female		0.570***		-8.504***
		(0.068)		(2.354)
#Kids age 6-18	0.135***	0.037*	0.850	1.098
	(0.025)	(0.022)	(0.741)	(0.764)
#Kids age 6-18×Female		0.696***		-1.488
		(0.050)		(1.734)
#People in the household	-0.000	0.031**	-0.125	-0.182
including respondent	(0.018)	(0.016)	(0.530)	(0.532)
Academic experience	0.001	0.000	-0.147**	-0.144**
	(0.002)	(0.002)	(0.059)	(0.059)
Non academic experience	-0.002	-0.002	-0.008	-0.010
	(0.003)	(0.002)	(0.075)	(0.075)
Full professor	-0.074	-0.012	-1.838	-1.780
	(0.067)	(0.057)	(1.986)	(1.984)
Associate professor	-0.007	0.013	-2.305	-2.355
	(0.056)	(0.047)	(1.644)	(1.640)
Assistant professor	0.012	-0.007	-1.887	-1.933
	(0.071)	(0.061)	(2.092)	(2.086)
Have a managerial position	-0.032	-0.032	0.041	0.054
	(0.050)	(0.042)	(1.465)	(1.459)
Educ=Phd from Japan	-0.131**	-0.128***	0.689	0.709
	(0.055)	(0.047)	(1.615)	(1.609)
Educ=Phd from abroad	0.005	-0.024	-2.048	-2.120
	(0.111)	(0.094)	(3.295)	(3.283)
#Subject taught/year =0	0.021	-0.023	-1.706	-1.547
	(0.053)	(0.045)	(1.549)	(1.543)
#Subject taught/year =4-6	-0.035	-0.043	0.973	1.054
	(0.036)	(0.030)	(1.052)	(1.048)
#Subject taught /year≥7	-0.129**	-0.167***	2.021	2.270
(Excluded=#subject=3)	(0.055)	(0.046)	(1.594)	(1.588)
#Sessions taught per week	0.015	0.013	0.391	0.368
	(0.011)	(0.010)	(0.328)	(0.327)
Weight on research	0.000	0.000	-0.012	-0.011
for promotion (%)	(0.001)	(0.001)	(0.018)	(0.018)
Eligible for spousal allowance	-0.205***	-0.136***	0.431	0.246
	(0.036)	(0.031)	(1.054)	(1.056)
Teach graduate classes	-0.009	-0.011	-0.748	-0.888
	(0.045)	(0.038)	(1.338)	(1.334)
# MA supervisees	0.009**	0.009**	0.437***	0.443***
	(0.004)	(0.004)	(0.125)	(0.125)
#PhD supervisees	0.003	0.002	0.969***	0.986***
	(0.010)	(0.008)	(0.288)	(0.286)
Fixed term position	-0.009	0.006	-0.389	-0.382
	(0.040)	(0.034)	(1.177)	(1.172)
Constant	0.716***	0.986***	63.073***	62.214***
	(0.084)	(0.072)	(2.445)	(2.475)
#Obs	1,495	1,495	1,488	1,488
R-squared	0.352	0.534	0.043	0.054

Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Appendix B: Timing of the birth of the first child and salary.

If more productive women self-select into motherhood, there should be a productivity difference in salary between women who gave birth at an early stage of their career and women who gave birth at a late stage of their career. Figure B.1 shows the histogram of the timing of birth relative to the start of one's career. Time zero indicates the start of one's career. Minus one indicates one year prior to the start of one's career. For both male and female academics, the histograms appear to peak at three years of academic experience, then decline. Child birth before the start of academic career is much less common for both male and female academics.

We divided academics with at least one child into: (A) those who had their first child within one year prior to the beginning of their academic career; (B) those who had their first child within three years of academic career; and (C) those who had their first child after three years of academic career. Having a child one year prior to the academic career (Group A) could indicate that they might have successfully negotiated and delayed the start of the job after receiving a job offer. This may indicate high productivity. Having the first child in the first three years of career would also indicate high productivity (Group B). Group C is the late child-bearer group. In addition, we added a dummy for those who had their first child more than one year prior to the beginning of their career. They are likely to be the ones who initially worked in the non-academic sector. Thus, we do not include them in the 'early child-bearer' groups.

We added dummy variables for these categories, as well as the interactions between *Female* and these dummies to the salary regression. Table B.1 shows the regression results. Note that the excluded category is those who do not have a child. However, what we are interested to see is if the salary for early child-bearers is higher than that of late child-bearers. In the case of men in Group A, the wage premium is computed as the coefficient for the Group A dummy minus the coefficient for the Group C dummy. For women, the interaction terms are taken into account.

Table B.2 shows the early child-bearers wage premiums. For women, Group A has a 14.8% higher salary than Group C, and Group B has a 5.2% higher salary than Group C. Wage premium for having a child early is consistent with the hypothesis that there is a positive sorting into motherhood. Having said so, the large salary premium for having children early would in part reflect the university differences–more productive women are hired by better paying universities, and at the same time, are likely to give birth at an early stage of their career. In contrast, we observe no such wage premium for men.

Figure B.1: The timing of birth relative to the start of the academic career

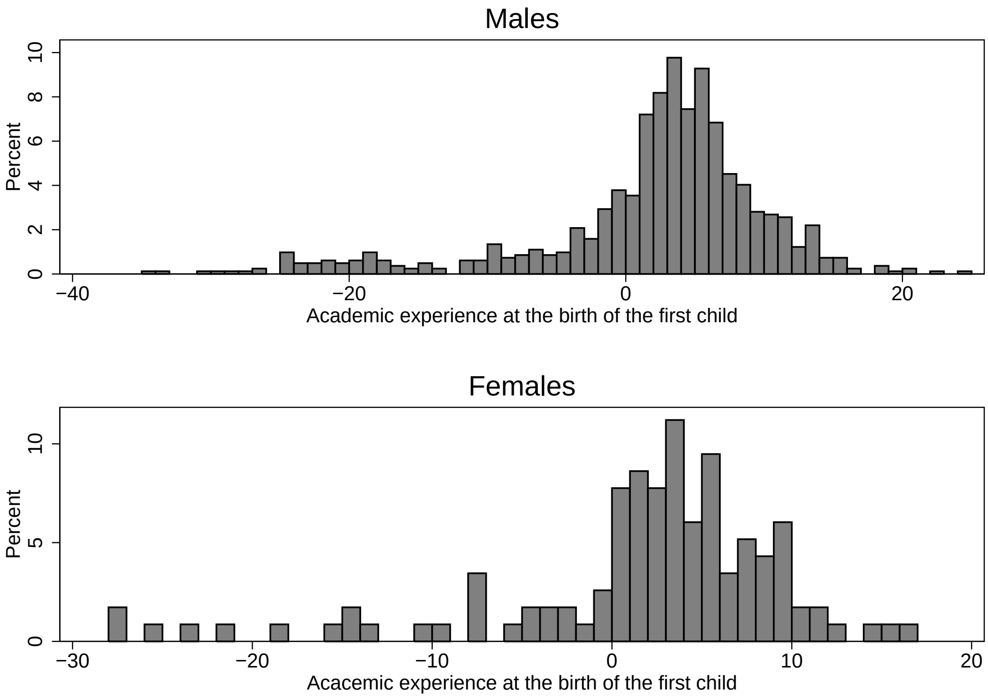


Table B.1: Salary and the timing of the birth of the first child: Dept var=Log(Annual salary)

Female	-0.051**	Fixed term position	-0.054***
	(0.020)		(0.013)
Full Professor	0.272***	Have a managerial position	0.044***
	(0.020)		(0.012)
Associate Professor	0.168***	Private university	0.149***
	(0.016)		(0.011)
Assitant Professor	0.081***	Department offers PhD	0.042***
	(0.022)		(0.014)
Academic experience	0.017***	Educ=PhD from Japan	0.014
	(0.002)		(0.016)
Academic experience^2	-0.000***	Educ=PhD from Abroad	-0.013
	(0.000)		(0.026)
Non academic experience	0.002*	Weight on research	0.000***
	(0.001)	for promotion (%)	(0.000)
#Career publication/100	0.069***	Teach graduate classes	0.011
	(0.016)		(0.014)
(#Career publication/100)^2	-0.013***	# MA supervisees	0.003**
	(0.004)		(0.001)
Field top 20 article share	0.015	#PhD supervisees	0.004*
	(0.011)		(0.002)
Annual grant amount	-0.002	#Subject taught/year =0	-0.029**
(in 10 million yen)	(0.002)		(0.014)
Married	0.034**	#Subject taught/year =4-6	0.007
	(0.014)		(0.009)
Female×Married	-0.020	#Subject taught /year≥7	-0.017
	(0.028)	(Excluded=#subject=3)	(0.016)
Total#Kids	0.008	#Sessions taught per week	0.004
	(0.006)		(0.003)
Total#Kids×Female	-0.053***	Eligible for spousal allowance	-0.022**
	(0.020)		(0.010)
Timing of first birth relative to		Initial rank =Full Prof	0.100***
the beginning of the academic career			(0.031)
Group A: Within 1 year prior to	-0.032	Class 1 cities	0.097***
the beginning	(0.028)		(0.014)
Above×Female	0.262***	Class 2 cities	0.098***
	(0.091)		(0.016)
Group B: Within 3 years of	-0.015	Class 3 cities	0.089***
academic career	(0.019)		(0.011)
Above×Female	0.149***	Class 4 cities	0.074***
	(0.044)		(0.011)
Group C: More than 3 years of	-0.013	Class 4 cities	0.034***
academic career	(0.016)		(0.011)
Above×Female	0.095**	Cons	6.062***
	(0.041)		(0.030)
More than 1 year prior the beginning	0.056***	#Obs	1,517
	(0.021)	R squared	0.804
Above×Female	0.029		
	(0.061)		

Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.

Table B.2: Salary premium for having a child early: Comparison group= Group C (academics who had their first child *after* 3 years of academic experience)

Timing of the birth of the first child relative to the beginning of academic career	Males	Females
Group A: Within 1 year prior to the beginning	-0.019	0.148**
Group B: Within 3 years of academic career	-0.002	0.052**

Inside brackets are robust standard errors. *,**,***= significant at 10%, 5%, and 1% levels.