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An empirical analysis of the effect of increasing male wage inequality on female marriage behavior in Japan*

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ABSTRACT

This paper examines the effect of the greater inequality in the lower than in the upper tail of the male wage distribution on female marriage behavior in Japan, using a new analysis framework. I first formulated the analytical model applying the "median-preserving spread" method to a marriage search model and then analyzed the theoretical hypothesis empirically, using extensive individual Japanese data from the Employment Status Survey, which examined a large sample. The theoretical and empirical results show that the higher male wage inequality in the lower tail, which is due to an increase in the male non-regular employment rate, has a significant effect on the rising single-female rate. Furthermore, the increase in the "non-regular employment" rate, regardless of the employment contract period, also has a significant effect on the rising single-female rate, even where the increasing male wage in the lower tail is controlled for. These results suggest that policies to improve the income security of the low-income male and to promote a shift from non-regular to regular employment are needed to raise the female marriage rate.

Key words: higher male wage inequality in the lower tail, non-regular employment, female marriage behavior, search model, median-preserving spread

JEL classification: J120; J310; D310

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1. Introduction

This paper examines the effect of the greater inequality in the lower tail of the male wage distribution than in the upper tail on female marriage behavior in Japan, using an analysis framework different from previous methods.

In recent years, the declining birthrate has become a serious problem in Japan. The tendency among the young generation to remain single or delay marriage attracts social interest as the main cause of this phenomenon. Several studies have argued the possibility that the tendency among young females to remain single or delay marriage is related to the increasing male non-regular employment rate or the lower-tail male wage inequality (Sakai and Higuchi, 2005; Nagase, 2002; Ohta, 2007), because these phenomena appear at almost the same period.

In fact, after the 1990s, the singlehood rate among Japanese women aged 25–44 years and the non-regular employment rate among Japanese men of the same age group rise simultaneously over the years, as shown in Figure 1. This suggests some kind of relationship between these phenomena. In addition, Figure 2 shows that the single-female rate and the greater male wage inequality in the lower tail follow the same trends.

Therefore, it would be useful to examine the relationship between the rising single-female rate and the increasing lower-tail male wage inequality to clarify the tendency among young women to remain single or delay marriage.

Conventionally, the mainstream economic approach to the predominant female behavior of remaining single or delaying marriage is founded on Becker (1973). Becker performed a cost-benefit analysis based on factors such as the declining benefits of marriage or the rising opportunity cost of marriage for women with the popularization of female higher education and the reduction of the wage gap between men and women.[1] Specifically, most studies examine the influence of individual attributes such as age, education qualification, income, and employment form as factors influencing the single-female probability.[2]

However, recent studies in the United States and Europe have examined macroeconomic factors such as the increasing non-regular employment rate and male wage inequality in the lower tail with the decline in the male labor market. However, similar Japanese studies are limited. This is because statistical data suitable for such

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[1] Oppenheimer (1997) suggests that the specialization model based on marriage gain is essentially an argument for *nonmarriage*, not *delayed* marriage.

[2] Stevenson and Wolfers (2007) outline another hypothesis on the determinants of the female marriage rate, such as cohabitation, birth control technology, household technology, change in the legal structure of marriage, and shock to the matching function of the marriage market.

analyses are difficult to obtain in Japan.

In the first place, most US and European studies on the relationship between the single-female rate and macroeconomic factors are divided into two types, independent of each other. The first type focuses on the decreasing number of males who can marry, because of the decline in the labor market, while the second concerns the increasing male wage inequality.

Both these issues can probably be analyzed by the integrated analysis framework because they are closely related to each other. Therefore, I first modeled the relationship between the greater lower-tail male wage inequality and female marriage behavior on the "median-preserving spread." I then applied this analysis framework, which allows asymmetric distributional moves between the upper and lower tails, to search the marriage model in order to analyze the theoretical hypothesis. The study is based on Japanese individual data obtained from the Employment Status Survey, conducted among a large sample.

The outline of this paper is as follows. Section 2 provides a review of the literature. Section 3 presents the theoretical hypothesis and the estimation model. The data are then described in Section 4. Section 5 reports the estimation results, and Section 6 concludes the paper.

2. Literature survey

Some studies have examined the relationship between the male labor market and female marriage behavior. Recent works that examine why females increasingly remain single or delay marriage are divided into two types. The first type is built on the concept that the number of desirable men who can marry (the so-called marriageable men) is decreasing with the growing number of low-income-earning men due to the decline in the male labor market. The second type is based on the notion that increasing male wage inequality raises the expected value for women to remain unmarried and continue the search for a partner.

Wood (1995), an example of the first type, suggests that the decreasing number of regular male employees indicates an increasing number of low-income earners and a simultaneous decrease in the number of marriageable men. Thus, these phenomena lead to higher single-female rates.

Wood (1995) examines Wilson's (1987) hypothesis that with fewer marriageable black men, due to the labor market decline in urban areas, female marriage rates have dropped. Lichter et al. (1992), Brien (1997), and Blau et al. (2000) also find that worse male labor market conditions affect the female marriage rate negatively.

Oppenheimer et al. (1997) argue that career-entry uncertainties lead to delayed marriage. In other words, those employed in stopgap jobs are less likely to marry than are career workers because the stopgap arrangement is a sign of career immaturity, uncertainty about the young person's long-term prospects, and a low current labor-market position. Sakai and Higuchi (2005), Nagase (2002), and Ohta (2007) find that in Japan the marriage rate of persons who have worked as part-time employees (e.g., non-regular employees) in their first employment or have been unemployed is lower than that of regular employees, and their marriage is delayed.

The second type of studies include Loughran (2002), Gould and Paserman (2003), Kuo (2008), and Coughlin and Drewianka (2011). They examine the search model hypothesis that varying the dispersion of the male wage distribution raises the marriage reservation wage for men and women postpone marriage. Thus, they indicate a decrease in the female marriage rate.

Loughran (2002) analyzes these issues for the 22-30 female age group, using the 90%/50% and 50%/10% tile ratios of the male hourly wage for the 21–45 age group as income inequality indices based on U.S. census data for 1970, 1980, and 1990. He found that higher male wage inequality in the upper tail, but not in the lower tail, indicates significantly delayed female marriage.

Gould and Paserman (2003) examine the same issues for the 21–30 female age group, using the standard deviation of weekly wages of full-time male workers of the 16–64-age group. They used the same data that Loughran had employed as the main inequality indexes, controlling for city fixed effects. Gould and Paserman argue that 25% of the 20-year decline in the female marriage rate, from 1970 through 1990, can be explained by increasing male wage inequality.

In Taiwan, where the singlehood rate is rising rapidly, Kuo (2008) examined the Manpower Utilization Survey data on women in the 22–30 age group for the 1980–2005 period, controlling for geographic and linear-time fixed effects. Kuo concludes that whereas the increasing male wage inequality has a negative effect on the female marriage rate, the effect is neither large nor significant. Kuo also shows, by estimating the 90%/50% and 50%/10% ratios simultaneously without controlling for geographic and linear-time fixed effects, that higher male inequality has a greater marginal effect in the lower tail than in the upper tail. This result is different from findings based on US data.

Coughlin and Drewianka (2011) estimate the effect of rising male wage inequality on the female marriage hazard and conclude that inequality continues to encourage young women to delay marriage.

Researchers have rarely employed individual data to conduct country-level analysis in Japan because such data are difficult to obtain. Tachibanaki and Kimura (2008), among others, have used aggregate data based on official government statistics instead of individual data, but they performed simple empirical analysis without controlling for various factors.

Recently, Yugami and Sasaki (2011) conducted an analysis based on the Japanese General Social Surveys, which provide individual data. However, their estimation neither uses the 90%/50% and 50%/10% ratios, because of data limitations, nor provides a clear result on the effect of the increasing non-regular employment rate.

However, not all previous studies have employed the analysis framework that connects both types of study. Besides, the mechanisms of the rising single-female rate differ according to the cause—fewer marriageable men or increasing male wage inequality. The first focuses on female behavioral responses to the lower tail of the male wage distribution, while the second considers the upper tail. Furthermore, the first mechanism has not been clarified in detail because of the absence of a micro-foundation analysis such as the search model.

Overcoming the limitations of previous methods, the present analysis framework helps explain how the female reservation wage and marriage probability respond to the asymmetric male wage distribution in Japan. This phenomenon—higher inequality in the lower tail than in the upper tail—is due to the rise in the male non-regular employment rate with the decline in the male labor market.

I first formulate an integrated analysis framework by applying the "median-preserving spread," instead of the "mean-preserving spread," to the marriage search model. The theoretical hypothesis thus derived is based on more realistic wage inequality changes in Japan than in previous studies. This analysis framework has an advantage in that it explains phenomena that consistently happen in the youth labor and marriage markets.

I also analyze the theoretical hypothesis empirically, using anonymous Japanese individual data from the Employment Status Survey, conducted among a large sample.

3. Theoretical hypothesis and estimation model

This paper constructs a theoretical model based on Loughran (2002), Gould and Paserman (2003), and Kuo (2008). However, it differs from previous work on one point: the single-female rate in Japan. I apply a relatively new analysis concept, the median-preserving spread, to a marriage search model to examine the effect of the recent increase in lower-tail male wage inequality. The asymmetry between the lower

and upper tails is due to the rise in the male non-regular employment rate. The theoretical hypothesis derived is consistent with the increase in the male non-regular employment rate and the higher male inequality in the lower tail.

3.1. Search model

I outline a simplified form of the previous analytical framework: the Loughran (2002) model. The marriage market is supposedly characterized by imperfect information. Women do not know the income level of each individual from whom they receive a marriage proposal, but they know the characteristics of the whole male income distribution. In such a marriage market, women consider the reservation male wage, that is, the lowest wage level at which they would be willing to accept a marriage proposal. Each female receives a marriage proposal with a certain offer rate and makes a dichotomous decision, to marry or not. Women reject a proposal if the man's wage is less than the reservation level and continue to search for a marriage partner. They stop the search when they accept someone's marriage proposal.

Therefore, females marry when the present value of the marriage is equal to the present value of continuing to search for their marriage partner. This condition is formulated as follows:

$$w^* = b - c + \frac{\lambda}{r}\int_{w^*}^{\infty}(w - w^*)\,dF(w) \tag{1}$$

where F is the distribution function of male wage W with mean μ and variance σ, which are conditional on individual attributes such as age and education. λ is the offer rate that each female receives, which depends on marriage market conditions, such as the sex ratio. b_t is the utility that a woman gains when she remains single, c_t is the cost of searching for a marriage partner, w_t is the present value of the offer of marriage at time t (considering the probability of divorce),[3] w^* represents the female reservation wage for men, and r is the discount rate.

The probability of accepting an offer of marriage (hazard rate of the marriage), p, which is inversely proportional to the reservation wage, is defined as follows:

$$p = q[1 - F(w^*)] \tag{2}$$

In this situation, the average search duration for women is $1/p$ (inverse of the hazard rate of marriage). In other words, the higher the reservation level, the lower the probability p that a woman will accept the marriage offer. Likewise, the longer the

[3] I omit the additional character t, representing time, to simplify the expression.

duration of search, the higher the female first-marriage age and singlehood rate.

Based on equation (1), let us consider how a change in the male mean wage would influence the female reservation wage for men. Here, from Mortensen (1986), the following relationship holds.

$$0 \leq \frac{\partial w^*}{\partial \mu} = \frac{p}{r+p} \leq 1 \tag{3}$$

Thus, an increase in the mean of the male wage distribution raises the female reservation wage by an amount less than the increase in the mean.

Moreover, a higher mean of the male wage distribution affects the probability of accepting an offer of marriage as follows:

$$\frac{\partial p}{\partial \mu} = \lambda F'(w^*)\left[1 - \frac{p}{p+r}\right] > 0 \tag{4}$$

In other words, the higher the acceptance probability for an offer of marriage, the lower the single-female rate will be.

Furthermore, Mortensen (1986) applies to the search model the concept of the mean-preserving spread, which Rothschild and Stiglitz (1970) introduce to analyze the marginal effect of a risk increase. Mortensen derives the marginal effect of an increase in the variance σ with the mean μ of male wage remaining unchanged. With the assumption of risk-neutral agents, the following relationship holds:

$$\frac{\partial w^*}{\partial \sigma} = \frac{\lambda \int_0^{w^*} F_\sigma(w^*, \sigma)}{r+p} > 0 \tag{5}$$

where $F_\sigma(w^*, \sigma)$ represents the partial differentiation of the distribution function about the variance σ and, from the definition of the mean-preserving spread, $\int_0^{w^*} F_\sigma(w^*, \sigma)\, dw > 0$ holds. Thus, an increase in the dispersion of male wages indicates a higher female reservation wage for men.

Then, a change in the acceptance probability for the marriage proposal and termination of search by varying the dispersion of the male wage distribution is described as follows:

$$\frac{\partial p}{\partial \sigma} = -\lambda F'(w^*)\frac{\partial w^*}{\partial \sigma} - \lambda F_\sigma(w^*, \sigma) < 0 \tag{6}$$

Therefore, varying the dispersion of the reservation wage in the upper tail raises the reservation wage per se and results in a lower acceptance probability for the marriage

proposal. However, the actual movement of the increasing wage inequality is commonly more asymmetric than symmetric around the mean wage. In that case, the acceptance probability of the marriage proposal will not be captured strictly according to (6) (Loughran, 2002).

3.2. Implication of a rise in the non-regular employment rate

I will now explain, using the search model, how increasing male wage inequality affects the single-female rate. This interpretation differs from that of previous studies. Non-regular employees are generally low-wage earners. Therefore, the larger the number of such employees, the lower the mean male wage in the marriage market, and the greater the dispersion of the wage distribution in the lower tail. Thus, the change in the male wage distribution is asymmetric between the upper and lower tails. However, the mean-preserving spread applies only when the wage distribution spreads symmetrically around the mean wage, because it holds the mean constant. Actually, Loughran (2002) mentions that equation (5) does not hold for non-mean-preserving spreads, for example, a higher inequality in the lower than the upper tail.

To avoid this problem, this study developed the median-preserving spread as an analysis framework to allow for asymmetric distribution changes between the upper and lower tails.[4] Aldashev (2010) applies the median-preserving spread to the job search model.

Here, I apply this method for the first time to a marriage search model[5] and derive a theoretical hypothesis on the effect on the female reservation wage for men in the case of median changes and increasing inequality in the upper or lower tails.

3.2.1. Deriving the effect of median change

First, I derive the effect of a median change on the reservation wage. The reservation wage is the same as previously described (1).

$$w^* = b - c + \frac{\lambda}{r}\int_{w^*}^{\infty}(w - w^*)\,dF(w) \tag{7}$$

For an increase in the median of the wage distribution, $F(x)$, to just θ, the

[4] Labor economic studies using the median-preserving spread in a search model include Möller and Aldashev (2007) and Aldashev (2010).

[5] As far as I know, no previous studies have applied the median-preserving spread to a marriage search model.

reservation wage w^* can be described as follows:

$$w^*(\theta) = b - c + \frac{\lambda}{r}\int_{w^*(\theta)}^{\infty} [w - w^*(\theta)]\, dF(w-\theta) \tag{8}$$

Subtracting (1) from (8) yields

$$(w^*(\theta) - w^*) = \frac{\lambda}{r}\left[\int_{w^*(\theta)}^{\infty} \big(w - w^*(\theta)\big) dF(w-\theta) - \int_{w^*}^{\infty} (w - w^*) dF(w)\right] \tag{9}$$

Integrating the first and second term on the right side of (9) respectively gives

$$\int_{w^*(\theta)}^{\infty} \big(w - w^*(\theta)\big) dF(w-\theta) = E(w) + \theta - w^*(\theta) + \int_{0}^{w^*(\theta)} F(w-\theta) dw \tag{10}$$

$$\int_{w^*}^{\infty} (w - w^*) dF(w) = E(w) - w^*(\theta) + \int_{0}^{w^*} F(w-\theta) dw \tag{11}$$

Partially differentiating (8) with θ using (10) and (11),

$$\frac{\partial w^*}{\partial \theta} = \frac{\lambda}{r}\left[1 - \frac{\partial w^*(\theta)}{\partial \theta}\big(1 - F(w^*)\big) - F(w^*)\right] \tag{12}$$

Therefore, the following inequality holds:

$$0 \leq \frac{\partial w^*}{\partial \theta} = \frac{\lambda\big(1-F(w^*)\big)}{r+\lambda\big(1-F(w^*)\big)} = \frac{p}{r+P} \leq 1 \tag{13}$$

Thus, a higher male median wage increases the female reservation wage by an amount less than the increase in the median.

Moreover, how the increase in the median of the male wage distribution affects the acceptance probability of a marriage offer is described as follows:

$$\frac{\partial p}{\partial \theta} = \frac{F'}{w^*}\left[1 - \frac{p}{p+r}\right] > 0 \tag{14}$$

In other words, the higher the acceptance probability of a marriage offer, the lower the single-female rate will be.

3.2.2. The effect of a greater wage inequality in the upper or lower tail

When the female reservation wage is higher than the median of the male wage distribution, a greater wage inequality in the lower tail does not affect the reservation wage for women who adopt suitable search strategies. Therefore, the reservation wage is assumed to be lower than the median, and the expected value of accepting an offer of marriage above the reservation wage male wage is described as follows:

$$\Lambda = \int_{w^*}^{\infty} (\overline{w} - w^*) dF(w) \tag{15}$$

where $\overline{w}$ is the median, and w^* is the reservation wage, σ_L is the dispersion in the lower tail, and σ_U is the dispersion in the upper tail.

It is possible to rewrite (15) as

$$\Lambda = \int_{w^*}^{\overline{w}} (w - w^*) dF(w) + \int_{\overline{w}}^{\infty} (w - w^*) dF(w) \tag{16}$$

where the first bracket in the left-hand side is

$$\int_{w^*}^{\overline{w}} (w - w^*) dF(w) = (\overline{w} - w^*) F(\overline{w}) - \int_{w^*}^{\overline{w}} F(w) dw = \frac{\overline{w} - w^*}{2} - \int_{w^*}^{\overline{w}} F(w) dw$$

and the second bracket in the left-hand side is

$$\int_{\overline{w}}^{\infty} (w - w^*) dF(w) = \int_{\overline{w}}^{\infty} w dF(w) - \int_{\overline{w}}^{\infty} w^* dF(w) = \int_{\overline{w}}^{\infty} w dF(w) - \frac{w^*}{2}$$

Thus, the following holds:

$$\Lambda = \frac{\overline{w}}{2} - \int_{w^*}^{\overline{w}} F(w) dw + \int_{\overline{w}}^{\infty} w dF(w) - w^* \tag{17}$$

Since the increase in the truncated mean raises the expected value of the upper tail,

$$\frac{\partial}{\partial \overline{w}} \int_{\overline{w}}^{\infty} w dF(w) > 0.$$

Additionally, an increase in the upper-tail dispersion raises the expected value of the upper tail:

$$\frac{\partial}{\partial \sigma_U} \int_{\bar{w}}^{\infty} w dF(w) > 0$$

Thus, from (16), the following holds:

$$\frac{\partial \Lambda}{\partial \sigma_U} > 0 \tag{18}$$

On the other hand, with an increase in the lower- tail dispersion, $\frac{\partial F(w)}{\partial \sigma_L} > 0$ holds, so that the following holds from (17):

$$\frac{\partial \Lambda}{\partial \sigma_L} = -\int_{w^*}^{\bar{w}} \frac{\partial}{\partial \sigma_L} F(w) dw < 0 \tag{19}$$

From (18) and (19), the following are derived:

$$\frac{\partial w^*}{\partial \sigma_{\mathrm{U}}} > 0 \tag{20}$$

$$\frac{\partial w^*}{\partial \sigma_L} < 0 \tag{21}$$

The dispersion in the upper tail of male wage distribution has a marginal effect on the probability of acceptance of a marriage offer as described below:

$$\frac{\partial p}{\partial \sigma_U} = -\lambda F'(w^*) \frac{\partial w^*}{\partial \sigma_U} - \lambda F_{\sigma_U}(w^*, \sigma_U) < 0 \tag{22}$$

Here, $F_{\sigma_U}(w^*, \sigma_U)$ in the second term of the right-hand side is a partial differentiation of the distribution function of the dispersion (σ_U) in the upper tail. Thus, it is zero if the reservation wage is lower than the median, as assumed above. Therefore, the greater dispersion in the upper tail raises the reservation male wage (in the first term of right-hand side) and the single-female rate.

On the other hand, the probability of acceptance of an offer of marriage, expressed as the size of the dispersion (σ_L) in the lower tail, is described as follows:

$$\frac{\partial p}{\partial \sigma_L} = -\lambda F'(w^*) \frac{\partial w^*}{\partial \sigma_L} - \lambda F_{\sigma_L}(w^*, \sigma_L) \tag{23}$$

The right-hand side indicates the difference between the effect of the decline in the female reservation wage due to the higher male wage inequality in the lower tail (the first term) and the effect of the variance of the male wage distribution below the female reservation wage (the second term). However, a strong possibility exists that the dispersion of the male wage distribution in the lower tail is so large that the latter effect is dominant, considering the increasing number of low-income non-regular employees among young Japanese men. Therefore, when the latter effect exceeds the reduction effect of the female reservation wage, the acceptance probability of a marriage offer drops, and the single-female rate rises. This point needs to be clarified in positive analysis.

3.3. Estimation model

I examine the theoretical hypothesis mentioned above, using a probit model in which the dependent variable is whether the female is single or not. The estimation model is shown in (24):

$$y_i^* = x_i\alpha + I\beta + M\gamma + \varepsilon_i \quad y_i = 1 \ if \ y_i^* > 0, \quad \text{and } 0 \ otherwise \tag{24}$$

where i represents the ith female.

The explanatory variables are female individual attributes x_i, such as age group and education background, male wage inequality indices or labor market condition indices I, such as the 90%/50% tile ratio, the 50%/10% tile ratio, the non-regular employment rate, and the unemployed rate, which I mostly focus on. I also use the control variable M, such as the sex ratio, the female habitation dummy variable in large urban areas, as the proxy variable for the marriage markets,[6,7] where ε_i is the error term. The sex ratio is the male-to-female ratio in the marriage market by age group and year. The higher the ratio, the greater the advantage for women in the marriage market and, therefore, the lower the single-female probability. The single-female probability is probably higher in

[6] However, some previous studies include other employment conditions such as female regular employment, non-regular employment, and unemployment as explanatory variables, I have not added these variables in this paper because many females retire or change their status to non-regular employment on marriage or childbirth, causing endogeneity between the employment condition and marriage behavior. I have not included female wage, either, as the explanatory variable for a similar reason.

[7] I have not included the year dummy variable because the regular or non-regular employment rate and the year dummy show a certain amount of correlation (correlation coefficient = 0.5–0.7).

large urban areas than in other areas because the social norm of marriage in large urban areas is not as strong as in other areas. In addition, the single-female probability would be lower, and the female age group therefore higher.

4. Data

In this paper, I use official Japanese statistics (anonymous individual data) from the Employment Status Survey for 1992, 1997, and 2002,[8] obtained from the Kobe University Micro-data Archive in Japan.

Considering that the data are anonymous, information on prefectures and households (with more than nine members) is kept secret, and age and wage information is not indicated in actual numbers but as class values, to avoid identification of an individual or household. However, I actually use resampled data, which comprise 80% of the entire sample. Thus, the sample size is approximately 2,370,000 over three years.

In this paper, I restrict the sample to the 25–44 female age group because women younger than 25 years include students and approximately 90% of women are married by age 44.[9] Finally, the sample for analysis includes 367,690 women.

It is assumed that the potential marriage partners are males of the same age group and year. Marriage market segmentation by education background is not assumed.[10]

In this paper, I use an hourly, and not yearly, wage because the cyclical change in labor supply influences yearly wage inequality (Loughran, 2002). I calculate the logarithm median wage and the wage inequality indices using an hourly wage. I also calculate the male employment index and sex ratio in the marriage market for each age

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[8] Currently, data are available only for these three years.

[9] Because the 2002 questionnaire does not distinguish between divorcees or widows and single women, it must be noted that the single-female rate for 2002, unlike in other years, includes divorcees and widows.

[10] I assume that the women's potential marriage partners belong to the same 5-year age group because the mean age difference between man and woman at the first marriage was 2.6 years in 1992, 2.4 years in 1997, and 1.7 years in 2002. This gap has been gradually reducing according to the Annual Population and Social Security Surveys carried out by the National Institute of Population and Social Security Research. In addition, I also assume, following Gould and Paserman (2003), that the potential marriage partners are from all educational backgrounds, because changes in wage inequality may affect female education choice. These are the reasons I set the marriage market the way I did in this paper.

group and year.[11]

The descriptive statistics of the variables used in this analysis are shown in Table 1.

Figure 3 shows the change in the kernel distribution of the 25–44 male age group's logarithmic hourly wage for 3 years (unwaged persons are excluded).

The overall the wage distribution seems to be more skewed to the upper side in 1997 than in 1992. It then shifted, overall, to the lower side with a slightly higher lower-tail inequality in 2002 than in 1992.

5. Estimation results and discussion

5.1. Baseline estimation results

I first compare the estimation results on the effect of male wage inequality indices when the mean male wage and median male wage are controlled for.

5.1.1. Male inequality indices with mean wage control

Table 2 shows the baseline estimation results when the mean male wage is controlled for. I use the 90%/50%, 50%/10%, and 90%/10% tile ratios as the wage inequality indices in the upper tail, in the lower tail, and for the whole distribution, respectively.

The coefficient of the mean male wage does not have a statistically significant effect, but the sign is negative in all cases for the single-female probability. Thus, the result is by and large consistent with the theoretical hypothesis.

The coefficient of the 50%/10% tile ratio, the index being considered here, has a significant positive effect at the 1% level when it is used as an explanatory variable, either alone or in combination with the 90%/50% tile ratio. Thus, the result is consistent with the theoretical hypothesis. The coefficient of the 90%/10% tile ratio has a significant positive effect at the 1% level. On the other hand, the coefficient of the 90%/50% tile ratio does not have a significant effect.

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[11] I use the median of each wage grade as the personal wage and multiply it 1.25 times for the high-end yearly wage group, more than 10 million yen. Furthermore, the real wage is based on the 2002 consumer price index. From 2002, however, each wage group in the Employment Status Survey questionnaire is further subdivided. Therefore, I standardize the wage groups according to those of 1992 and 1997, following Shinozaki (2001), Kambayashi (2010a), and Yugami and Sasaki (2011), to remove the influence of class interval changes on the setup conditions of wage inequality indices. In addition, I define the non-regular employment rate, following Ohta (2007), in terms of all employees and the unemployment rate as a proportion of the population.

The marginal effect is the increase in the single-female probability (by approximately 1.7%) for every 1% rise in the 50%/10% tile ratio of the male wage in the marriage market.

Among the control variables, the dummies for being above a college graduate and for female habitation in large urban areas have a consistently significant positive effect at the 1% level. Thus, the results are not consistent with the theoretical hypothesis derived by the mean-preserving spread but are consistent with the theoretical hypothesis derived by the median-preserving spread.

5.1.2. Male inequality indices with median wage control

Table 3 shows the baseline estimation result, controlling for the median male wage. The median male wage does not have a statistically significant effect, but the sign is negative in all cases for the single-female probability. Thus, the result is by and large consistent with the theoretical hypothesis.

In this estimation, I use the 90%/50%, 50%/10%, and 90%/10% tile ratios. The 50%/10% tile ratio, the inequality index being considered here, also has a significant positive effect at the 1% level when it is used as explanatory variable, either alone or in combination with the 90%/50% tile ratio. Thus, the result is consistent with theoretical hypothesis. The coefficient of the 90%/10% tile ratio also has a significant positive effect at the 1% level.

The marginal effect is the increase in the single-female probability (by approximately 1.7%) with a 1% rise in the 50%/10% tile ratio of the male wage in the marriage market when the median wage is controlled for. As with the median wage, this result is consistent with the theoretical hypothesis derived by the median-preserving spread.

5.1.3. Estimation results on male employment indices

Table 4 shows the estimation results on male employment condition indices when the mean or median male wage is controlled for. The marginal effect of median wage control is the increase in single-female probability (by approximately 0.02% and 0.03%, respectively) per 1% rise in the male non-regular employment rate and the unemployed rate in the marriage market. The coefficients of both the non-regular employment rate and the unemployed rate have a significant positive effect at the 1% level in both cases. These results are consistent with those of previous studies.

From the above results, it is confirmed that the deterioration of male employment indices have a significant positive effect on the single-female rate.

Considering the nature of data in this paper, however, both results are similar because the mean wage and median wage are exactly the same. It is of enormous significance that I obtained a result that is consistent with the theoretical hypothesis by using an estimation model that can capture asymmetric changes in male wage inequality around the median wage more exactly than previous methods could.

5.2. Contributory factors of single-female rate changes

Using the estimation results on the marginal effect of male wage inequality and employment condition indices, I try to predict the magnitude of change in the single-female rate from 1992 to 2002. Table 5 shows how much of the change in the single-female rate can be explained by the male wage inequality trend according to the estimated marginal effects in Tables 3 and 4.

The single-female rate of the 25-44-age group has risen 15.43% in these 10 years. In this period, the average changes in the 90%/50% and 50%/10% tile ratios of the male wage in the same age group are a 5.5% decrease and a 9.7% increase, respectively.

In addition, the marginal effect coefficients are -0.030 and 1.690, respectively, when the above indices are simultaneously used as explanatory variables. Thus, the predicted changes are 0.2% and 16.4%, respectively, based on the average changes multiplied by the coefficients of marginal effect.

From these results, the changes in the male 90%/50% and 50%/10% tile ratios explain 1.1% and 106.3%, respectively, of the rise in the single-female rate. In other words, the 50%/10% tile ratio, representing the wage inequality size in the lower tail, has a significant explanatory power for the rise in the single-female rate. Furthermore, with a similar calculation, the male non-regular employment rate can predict 53.3% of the rise in the single-female rate. This index has a significant explanatory power, too.

5.3. Estimation results based on married male data

Gould and Paserman (2003) believe that, when a large number of single men tend to be low-income non-regular employees, male wage inequality increases in the lower tail. To control for this reverse causality, I estimate the model using only married male data.[12] Table 6 shows the estimation results.

The coefficient of the 50%/10% tile ratio has a significant positive effect at the 1% level when it is used as an explanatory variable, either alone or in combination with the 90%/50% tile ratio. The marginal effect is the increase in single-female probability (by

[12] An analysis based only on married male data has merits in that not only is the influence of reverse causality removed but the influence of the inequality generated by changes in the returns to skill, ability, etc., on the single-female rate is also examined.

approximately 1.0%) per 1% rise in the 50%/10% tile ratio. In addition, the coefficients of the non-regular employment rate and unemployed rate have significant positive effects at the 1% level, similar to the results in Table 4. These findings confirm the robustness of the results in Tables 3 and 4.

5.4. Estimation results based on wage inequality and employment indices

This study assumes that a high male non-regular employment rate is reflected as an increase in male wage inequality in the lower tail. I therefore consider the male wage inequality indices as explanatory variables.

The results confirm that the greater male wage inequality in the lower tail has a significant positive effect on the single-female rate. In addition, I also use the employment condition indices as explanatory variables, separately, and estimate the effects. The estimation results confirm that the non-regular employment rate also has a significant positive effect on the single-female rate.

Then, how does the result turn out if both wage inequality and employment condition indices are simultaneously used as explanatory variables? According to the theoretical hypothesis, the marginal effect of wage inequality indices is considered significant. On the other hand, the significance and marginal effect of the employment condition indices are absorbed by the wage inequality indices and become negligible.

Table 7 (columns 1 and 2) shows the estimation results based on the 90%/50% and 50%/10% tile ratios as well as the male non-regular employment or unemployed rate.

The coefficient of the 90%/50% tile ratio is negative, but does not have a statistically significant effect on the single-female rate. The coefficients of the 50%/10% tile ratio and the non-regular employment rate together have a significant positive effect on the single-female rate. However, the 50%/10% tile ratio does not have a statistically significant effect in combination with the unemployed rate, although the sign is positive. Thus, I can confirm that the result is almost robust, although the marginal effect of the 50%/10% tile ratio, independent of the non-regular employment rate, is one-half lower when considered along with the non-regular employment rate.

On the other hand, the male non-regular employment rate and the unemployed rate have a significant positive effect at the 1% level on the single-female rate. In neither case does the marginal effect become as small as the result in Table 4. In other words, I obtained a result different from the hypothesis.

How can this result be interpreted? The rise in the non-regular employment rate is believed to reflect the greater wage inequality in the lower tail, which might in turn be related to just one point. An employment condition index such as the non-regular

employment rate may capture the uncertainty effects of employment that the wage inequality index cannot capture.

In other words, it is suggested that women predict the long-term increase in low-income, unstable employment in the marriage market considering not only the greater male inequality in the lower tail but also the rise in the non-regular employment rate based on the designation. Therefore, they postpone marriage. This is also consistent with Oppenheimer's argument that job uncertainty delays marriage.

Incidentally, it is believed companies could manage human resources—develop ability, for example—according to the designation. Furthermore, companies tend to hire non-regular employees by designation and treat them as a buffer for labor adjustment because lay-off of regular employees costs much more in Japan than does that of non-regular employees.

I now further discuss non-regular employment, a common form of work for young men and a social issue recently in Japan. "Regular employment" and "non-regular employment" are "name at work (designation)" types in the Employment Status Survey. Such a classification method is peculiar to Japan. It is uncommon in the United States and in European countries for classification of employment status. In addition, the survey also classifies positions according to the employment agreement. In other words, workers with an agreed employment term of more than one year are classified as permanent employees, and those with a term of less than one year are grouped as temporary employees.

Considering the name-at-work classifications and employment status based on the agreed term, we can classify employment positions into four categories: permanent regular employment, temporary regular employment, permanent non-regular employment, and temporary non-regular employment. Therefore, non-regular employment is classified into two categories: permanent non-regular employment and temporary non-regular employment.

In Japan, permanent non-regular employees have increased in recent years (Kambayashi, 2010b). It is recognized that permanent non-regular employment is often renewed many times, so that the actual duration of service is relatively long, though at low wages (Koyō no Arikata ni Kansuru Kenkyukai [Meeting to study systems of employment] 2009). However, non-regular employees' contracts, even if permanent, have increasingly not been renewed recently with the deteriorating labor market conditions.

Do the increasing permanent and temporary non-regular employment rates have different effects on the single-female rate? I show the estimation results using the

indices in Table 7 (columns 3 and 4). The results show that both indices have a significant positive effect at the 5% level on the single-female rate. In addition, the marginal effect of permanent non-regular employment is slightly larger than that of temporary non-regular employment. Therefore, even if the name "non-regular" is the same, the marginal effect of increasing male permanent employment is larger than that of male temporary employment when the effects of increasing inequality in the lower tail are controlled for. Thus, the possibility that the increasing male permanent non-regular employment rate will accelerate the rising single-female rate is a concern.

6. Conclusion

Clarifying the tendency among young women to remain single or delay marriage, putatively the main cause of the declining birthrate in Japan, is a socially urgent need.

Some recent studies in the United States and other countries have applied the implications of the search model to marriage behavior. These studies, based on the mean-preserving spread, have concluded that women might delay marriage in response to the increasing inequality in the upper tail of the male wage distribution.

However, the phenomenon of the greater inequality in the lower tail than the upper tail of the male wage distribution in Japan is due to the rising male non-regular employment rate. Therefore, the previous analysis framework could not strictly analyze a phenomenon such as this. Besides, a sophisticated study with Japanese individual data is difficult to carry out because of data availability limitations.

In this paper, I model the relationship between asymmetric change in the male wage distribution due to rising male non-regular employment rates and female marriage behavior, using the "median-preserving spread" framework. This method allows us to analyze, for the first time, the effect of asymmetric inequality change between the upper and lower tails of the wage distribution on the marriage search model, assuming that the rising non-regular employment rate reflects increasing male wage inequality in the lower tail. I then examine the theoretical hypothesis by empirical analysis, using a large Japanese individual dataset.

The results show that the increasing male inequality in the lower tail has a significant positive effect on the single-female rate when female education background, age group, sex ratio, and male median wage are controlled for. Thus, the results are consistent with the theoretical hypothesis. Besides, the contribution to the rising single-female rate is considerably large.

In other words, while the bottom of the distribution dropped below the low income level in Japan, the inequality in the lower tail has increased since the 1990s. The

increasing male inequality in the lower tail is proposed as one of the significant factors of the rising single-female rate.

However, the increasing wage inequality in the lower tail and the rising non-regular employment rate, when simultaneously used as explanatory variables, show a significant positive effect on the single-female rate. Non-regular employment might be interpreted as the long-term job uncertainty that Oppenheimer deliberates on. From this result, it is suggested that women predict a long-term rise in lower income, unstable male employment in the marriage market by considering, according to the designation, not only the increasing male inequality in the lower tail but also the rising non-regular employment rate. Therefore, they delay marriage.

The policy implication derived from the results of positive analysis is that raising the low male wage level and supporting a shift from non-regular to regular employment by improving the labor market environment would play an important role in increasing the female marriage rate in Japan.

To that end, an ability development program, employment training improvement, and the establishment of an evaluation system for occupation ability are necessary. Improving income security is an additional requirement. However, the conditions and requirements are different for permanent versus temporary non-regular employees. Thus, the remedial measures implemented should be appropriate to each category.

Nevertheless, I could not precisely establish the superiority of the new analysis framework over the previous methods in some analyses because of data limitations. The significant academic contribution of this study is that I rigorously analyzed, not only normatively but also positively, the remaining-single or delaying-marriage mechanisms in Japan. To do so, I applied the “median-preserving spread,” a new analysis framework, to a marriage search model and obtained results different from those of previous studies such as Loughran (2002) and Gould and Paserman (2003). Employing the search model, I found, theoretically and empirically, that women might delay marriage in response to increasing inequality in the lower tail of the male wage distribution.

How did these influences affect the so-called lost-decade generation born in the 1980s, which faces job scarcity? To examine this question, the researcher would need to accumulate substantial data. This remains a future challenge.

In addition, because of data limitations I could not conduct a fixed effect model analysis for residence area, which some conventional studies have done. This examination is also a future challenge and a prospect for this research horizon.

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Fig.1. Trends of the single-female rate and the male non-regular employment rate.

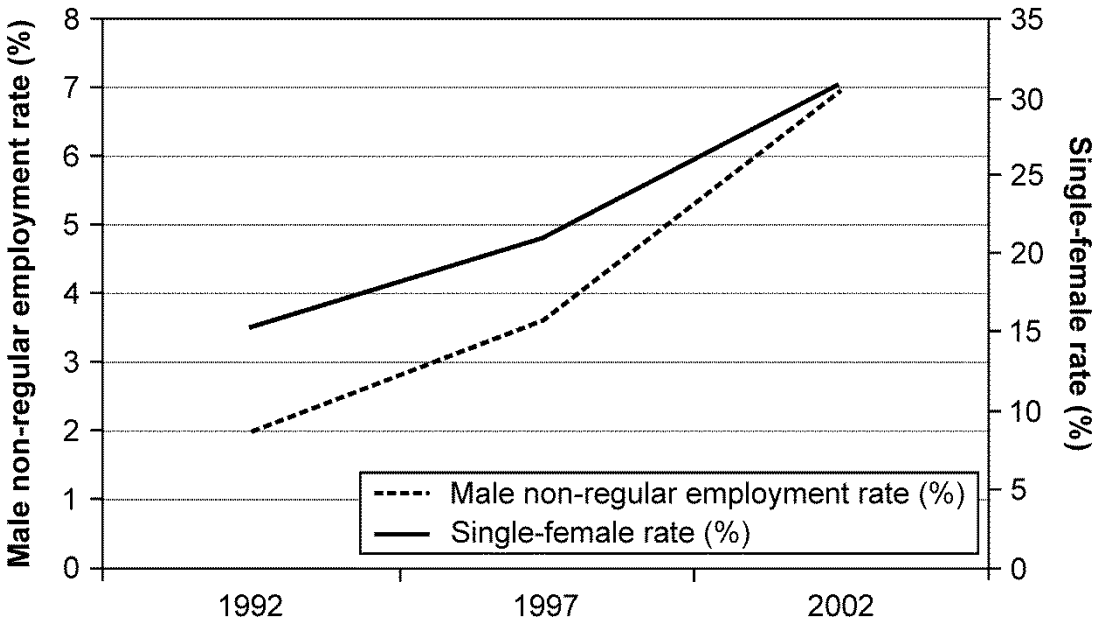

Fig.2. Trends of the single-female rate and the male non-regular employment rate.

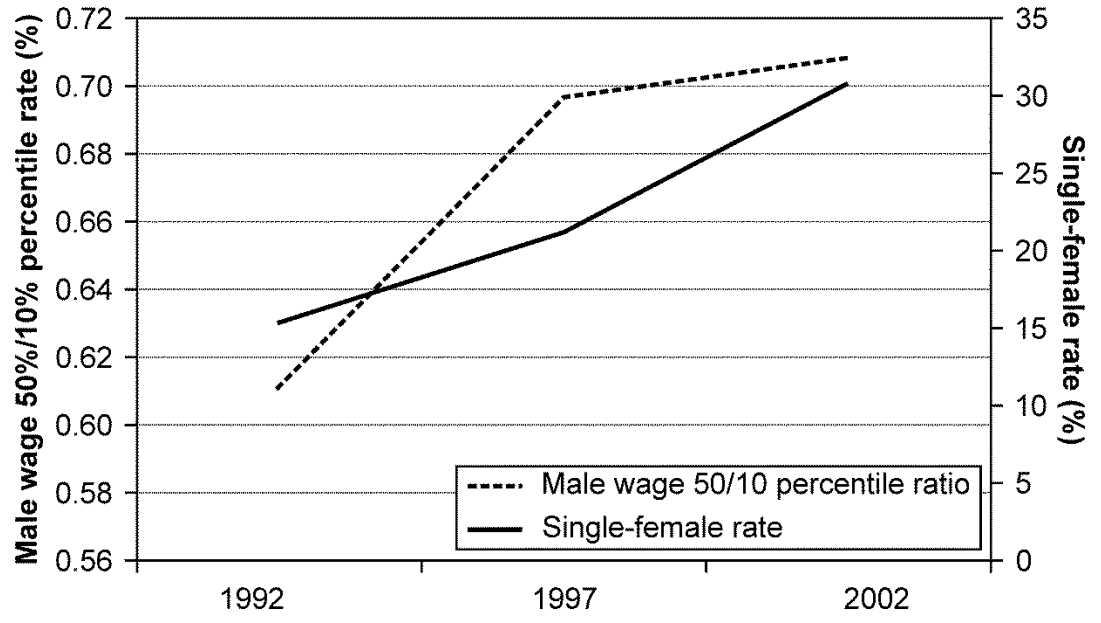

Fig.3. Changes in the kernel distribution of male logarithmic hourly wage (Data source: Employment Status Surveys of 1992, 1997, and 2002).

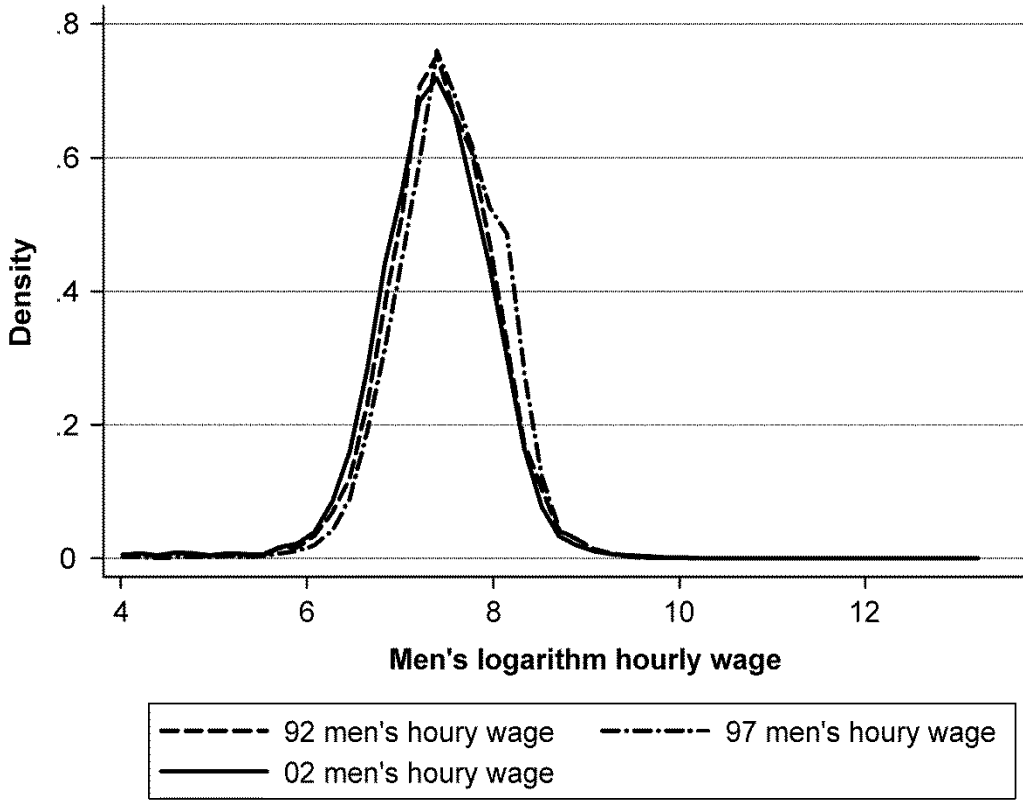

Table 1: The descriptive statistics of the variables

Variable		Women of ages 25–44 years				
		Obs.	Mean	Std. Dev.	Min.	Max.
Female age-group dummy	25–29 years old	367690	0.238	0.426	0	1
	30–34 years old	367690	0.235	0.424	0	1
	35–39 years old	367690	0.243	0.429	0	1
	40–44 years old	367690	0.283	0.451	0	1
Female education background dummy	Below junior high graduate	367690	0.075	0.264	0	1
	High school graduate	367690	0.539	0.498	0	1
	Graduate from vocational school	367690	0.272	0.445	0	1
	Above college graduate	367690	0.110	0.313	0	1
Female single probability		367690	0.219	0.414	0	1
Male logarithmic hourly wage in marriage market	Mean (logarithmic)	367690	7.452	0.177	7.128	7.735
	Median (logarithmic)	367690	7.497	0.188	7.148	7.823
	90%/10% tile ratio	367690	1.300	0.163	1.043	1.540
	90%/50% tile ratio	367690	0.599	0.073	0.462	0.698
	50%/10% tile ratio	367690	0.701	0.102	0.570	0.842
Male employment condition in marriage market	Regular employment rate (%)	367690	96.238	2.626	88.650	98.270
	Non-regular employment rate (%)	367690	3.762	2.626	1.730	11.350
	Permanent employment rate (%)	367690	90.489	3.415	81.626	94.202
	Temporary employment rate (%)	367690	5.069	1.352	3.588	8.503
	Unemployment rate (%)	367690	4.369	2.146	2.185	9.678
Sex ratio in marriage market		367690	90.827	2.414	88.602	94.486
Female habitation dummy in large urban areas		367690	0.322	0.467	0	1
Year dummy	1992	367690	0.372	0.483	0	1
	1997	367690	0.331	0.471	0	1
	2002	367690	0.297	0.457	0	1

Note: The regular/non-regular employment rate is the ratio of regular/non-regular employees to all employees.

Table 2: The marginal effects of various male inequality indices
(Baseline estimate result 1)

	Male wage inequality indices (tile ratios)			
	90%/10%	90%/50%	50%/10%	90%/50%+ 50%/10%
Log male mean wage	-0.011	-0.275	-0.008	-0.066
	(0.184)	(0.216)	(0.154)	(0.140)
Log male wage	0.802	0.367	1.743	0.084
Inequality	(0.257) ***	(0.465)	(0.302) ***	(0.374)
Indices	-	-	-	1.725
	(-)	(-)	(-)	(0.334) ***
Number of obs.	367690	367690	367690	367690
Pseudo R2	0.153	0.149	0.156	0.156

Notes:

1. Men in the marriage market were considered with controls for age group, year dummy, and mean wage.

2. Dependent variable: single female = 1, others = 0.

3. Other explanatory variables are female education background dummy, female age-group dummy, sex ratio in marriage market, and female habitation dummy in large urban areas.

4. Within the second-step parentheses are standard errors modified by clustering based on age group, education background, and year dummy.

5. ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 3: Marginal effects of various male wage inequality indices
(Baseline estimate result 2)

	Male wage inequality indices (tile ratios)			
	90%/10%	90%/50%	50%/10%	90%/50%+ 50%/10%
Log male median wage	0.024	-0.377	-0.120	-0.130
	(0.194)	(0.257)	(0.164)	(0.189)
Log male wage	0.838	0.118	1.687	-0.030
Inequality	(0.300) ***	(0.581)	(0.289) ***	(0.447)
Indices	-	-	-	1.690
	(-)	(-)	(-)	(0.298) ***
Number of obs.	367690	367690	367690	367690
Pseudo R2	0.153	0.149	0.156	0.156

Notes:

1. Men in the marriage market are considered with controls for age group, year dummy, and mean wage.

2. Dependent variable: single female = 1, others = 0.

3. Other explanatory variables are female education background dummy, female age-group dummy, sex ratio in marriage market, and female habitation dummy in large urban areas.

4. Within the second-step parentheses are standard errors modified by clustering based on age group, education background, and year dummy.

5. ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 4: Marginal effects of various male employment indices
(Baseline estimate result 3)

	Non-regular employment rate		Unemployment rate	
	Log male Mean wage	Log male Median wage	Log male Mean wage	Log male Median wage
Log male mean or	0.049	0.089	-0.057	-0.009
Median wage	(0.156)	(0.184)	(0.117)	(0.136)
Male employment	0.020	0.021	0.029	0.030
Condition indices	(0.007) ***	(0.007) ***	(0.007) ***	(0.007) ***
Number of obs.	367690	367690	367690	367690
Pseudo R2	0.157	0.157	0.160	0.160

Notes:

1. Men in the marriage market are considered with controls for age group, year dummy, and mean wage.

2. Dependent variable: single female = 1, others = 0.

3. Other explanatory variables are female education background dummy, female age-group dummy, sex ratio in marriage market, and female habitation dummy in large urban areas.

4. Within the second-step parentheses are standard errors modified by clustering based on age group, education background, and year dummy.

5. ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 5: Estimation results of contributions to change in single-female rate

	Average change	Marginal effect	Predicted change	Contribution
ΔSingle-female rate	0.15428			
ΔMale 90%/50% tile ratio	-0.055	-0.030	0.002	1.1%
ΔMale 50%/10% tile ratio	0.097	1.690	0.164	106.3%
ΔSingle-female ratio	0.15428			
ΔMale non-regular employment rate	3.917	0.021	0.082	53.3%

Table 6: Marginal effects of male wage inequality and employment condition indices based only on married male data on single-female rate

	Male wage inequality indices (tile ratios)				Employment condition indices	
	90%/10%	90%/50%	50%/10%	90%/50%+ 50%/10%	Non-regular Employment Rate	Unemployment rate
Male median	0.105	-0.389	-0.128	-0.182	-0.077	-0.010
Wage	(0.256)	(0.274)	(0.228)	(0.251)	(0.143)	(0.104)
Male wage	1.191	-1.367	1.101	-0.283	0.050	0.107
Inequality	(0.352) ***	(0.409)	(0.204) ***	(0.508)	(0.012) ***	(0.017) ***
Indices	-	-	-	0.939	-	-
	(-)	(-)	(-)	(0.265) ***	(-)	(-)
Number of obs.	367690	367690	367690	367690	367690	367690
Pseudo R2	0.150	0.153	0.155	0.156	0.159	0.162

Notes:

1. Men in the marriage market are considered with controls for age group, year dummy, and mean wage.

2. Dependent variable: female – single = 1, others = 0.

3. Other explanatory variables are female education background dummy, female age-group dummy, sex ratio in marriage market, and female habitation dummy in large urban areas.

4. Within the second-step parentheses are standard errors modified by clustering based on age group, education background, and year dummy.

5. ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.

Table 7: Estimation results based on simultaneous use of male wage inequality and employment indices

	Male employment indices			
	Non-regular Employment rate	Unemployment Rate	Permanent and Non-regular Employment rate	Temporary and Non-regular Employment rate
Male median wage	0.018	-0.099	-0.052	-0.020
	(0.159)	(0.127)	(0.160)	(0.158)
90%/50% tile ratio	-0.234	-0.316	-0.261	-0.211
	(0.314)	(0.288)	(0.298)	(0.329)
50%/10% tile ratio	0.869	0.450	0.772	0.976
	(0.385) **	(0.427)	(0.374) **	(0.396) **
Male employment	0.015	0.026	0.032	0.029
condition indices	(0.007) **	(0.008) ***	(0.014) **	(0.014) **
Number of obs.	367690	367690	367690	367690
Pseudo R2	0.158	0.160	0.159	0.158

Notes:

1. Men in the marriage market are considered with controls for age group, year dummy, and mean wage.

2. Dependent variable: single female = 1, others = 0.

3. Other explanatory variables are female education background dummy, female age-group dummy, sex ratio in marriage market, and female habitation dummy in large urban areas.

4. Within the second-step parentheses are standard errors modified by clustering based on age group, education background, and year dummy.

5. ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.