Searching for Mr. Right: The duration of remaining single based on evidence from Japan

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Abstract

The age at first marriage for women has increased in Japan over the past decade. Previous studies show both rising female labor force participation and education levels attribute to the delay in marriage for women, but only for a small fraction. Applying search theory indicates that the utility of being singles, the arrival rate of marriage offers, the discount rate and change in distribution of men all affect the duration of remaining single. In theory, the change in variance of the distribution of men raises women's reservation utility but has an ambiguous effect on the duration of remaining single. This paper examines this hypothesis with a discrete proportional hazard model using the 1993-99 Japanese Panel Surveys of Consumers. The main finding is that highly educated women, working either full time or part time or as students and living in a larger city all tend to delay marriage. On the other hand, an increase in distribution of men in terms of mean characterized by wage attributes to raising the probability of getting married earlier for women. Men's distribution in terms of variance characterized by the unemployment rate turned out to be a factor for marriage delay in Japan. It suggests the larger the variance, such as a more risky situation for women, the less likely they are to encounter a Mr. Right. Moreover, the observed delay in marriage among Japanese women is also partially explained by the effect of decreasing mean and increasing variance of distribution of men due to long term economic recession.

JEL classification: C41, J12 and J64
Keywords: Marriage, duration analysis, discrete proportional hazard model, Japan.

1 Introduction

Being a thirty something singleton—is no longer an exceptional phenomena in the "civilized world." An increased duration of the single status does not necessarily imply an individual is worse off: after all, to some extent, we choose whether or not to marry. Thus choosing to remain single longer must have its benefits.

It takes time and effort for a woman or a man to find a partner. For the realization of marriage, the first necessity is to meet someone, the second is to know whether he or she is the "right" someone. Both are time consuming activities. Letting a potential partner know you are attractive enough—a person with enough pizzazz – also requires a certain amount of effort(Burdett and Coles (2001)).

This paper explores several explanations for the rise in the average age of marriage for women from a search-theoretic view point. Although there are many applications for a marital search, the focus of these studies is more on equilibrium rather than on the duration of being single. Many empirical studies of marriage behavior found several factors can contribute to a delay in marriage for women, such as labor supply, a rise in education levels, and the effect of tax. However, without a theoretical framework these findings are difficult to interpret.

The work of Loughran (2002) is closest to the present paper. He applied search theory to interpret estimation results. Search theory suggests an increase in the variance of the distribution of men leads to an increase in a woman's reservation utility. Thus Loughran (2002) assumes a rise in women's reservation utility contributes to delayed marriage. However, according to Mortensen (1986) the effect of changing the variance of men's distribution on the reservation utility of a woman and on the duration of being single are not necessarily the same. As will be shown later, the effect on the duration of being single is undefined, since it depends on the shape of the distribution of men.

The rise in a woman's age at marriage over the last ten years in Japan coincides with a dramatic increase in the unemployment rate due to long term economic recession. On top of other factors which can be inferred from the search theory, the focus of this paper is whether the recent increase in unemployment rate affects the duration of women being single or not: a higher unemployment rate does correspond to a larger variance of the distribution of marriageable men.

Using a theoretical search approach, it is shown that a change in variance of the distribution of men, the arrival rate of marriage offers, the utility of being single and the discount rate, all affect women's reservation utility for marriage. Consequently these factors also influence the duration of being single.

These hypothesis are tested from the result of a comparative statics analysis of the above search parameters in the Japanese marriage market. The analysis uses panel data with accurate information on durations of being single and other characteristic parameters.

A discrete time proportional hazard model is used to utilize the time varying nature of parameters and the coarse measurement of the duration.

Section 2 shows the decline in the rate of marriage and other related facts from

the Japanese data set. Section 3 contains a brief review of the literature. A single sided marital search model is then constructed in section 4 following Burdett and Coles (1999) and the effect of parameters of the model analyzed based on Mortensen (1986). The econometric methods and specifications of the transition rates into marriages are presented in section 5. The estimation results are discussed in section 6 and section 7 draws conclusions.

2 Late marriage in Japan

Figure 1: Age of marriage

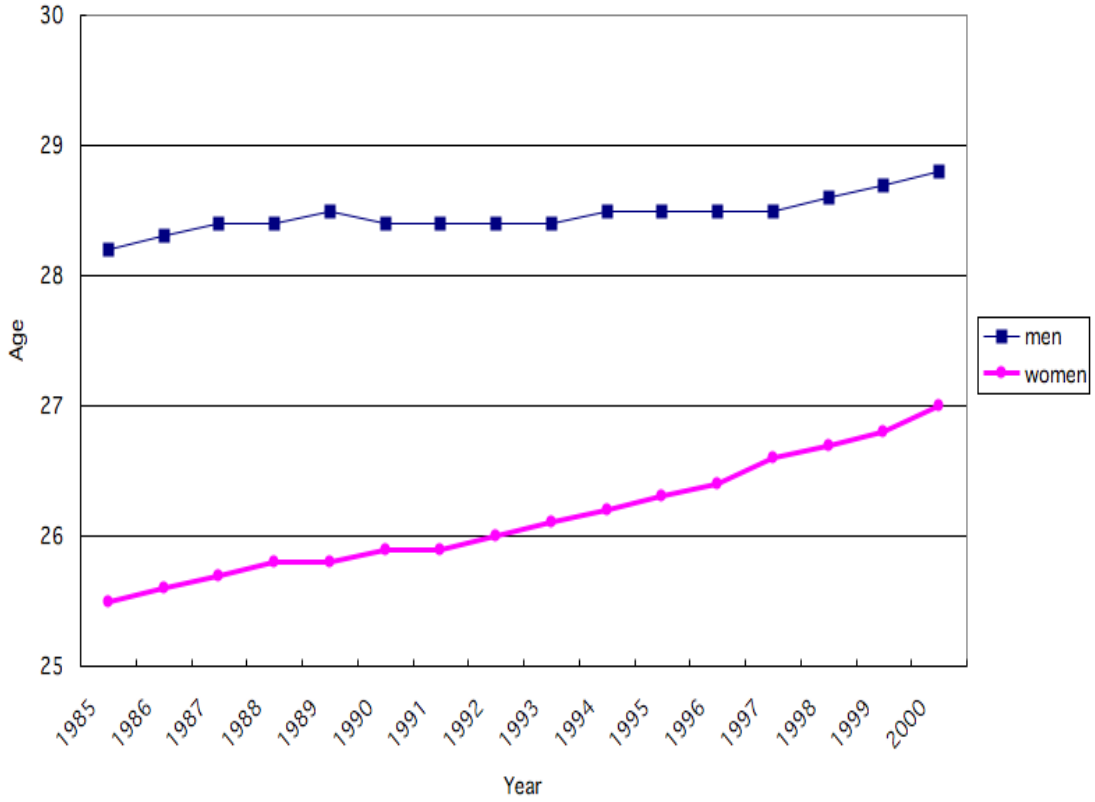
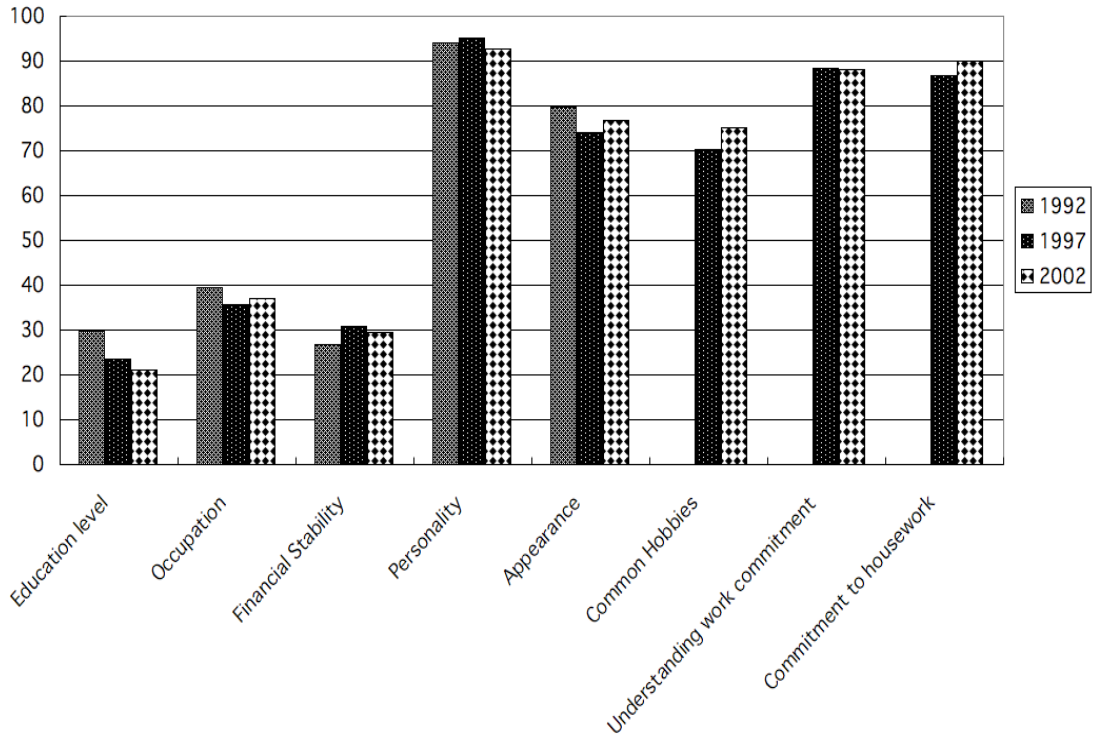


Figure 1 shows the age at marriage for both men and women from 1985 to 2000. The age at marriage for women increases gradually until the end of the 80's and then shows a rather steep rise in the 90's in contrast to a relatively constant trend for men. The remarkable number of Japanese women still single in their late 20's has attracted much public attention. According to the 12th national survey on marriage and fertility, the number of both men and women in their late 20's who are willing to delay marriage

Figure 2: Men's requirements for a marriage partner, by single men of 18-34 years

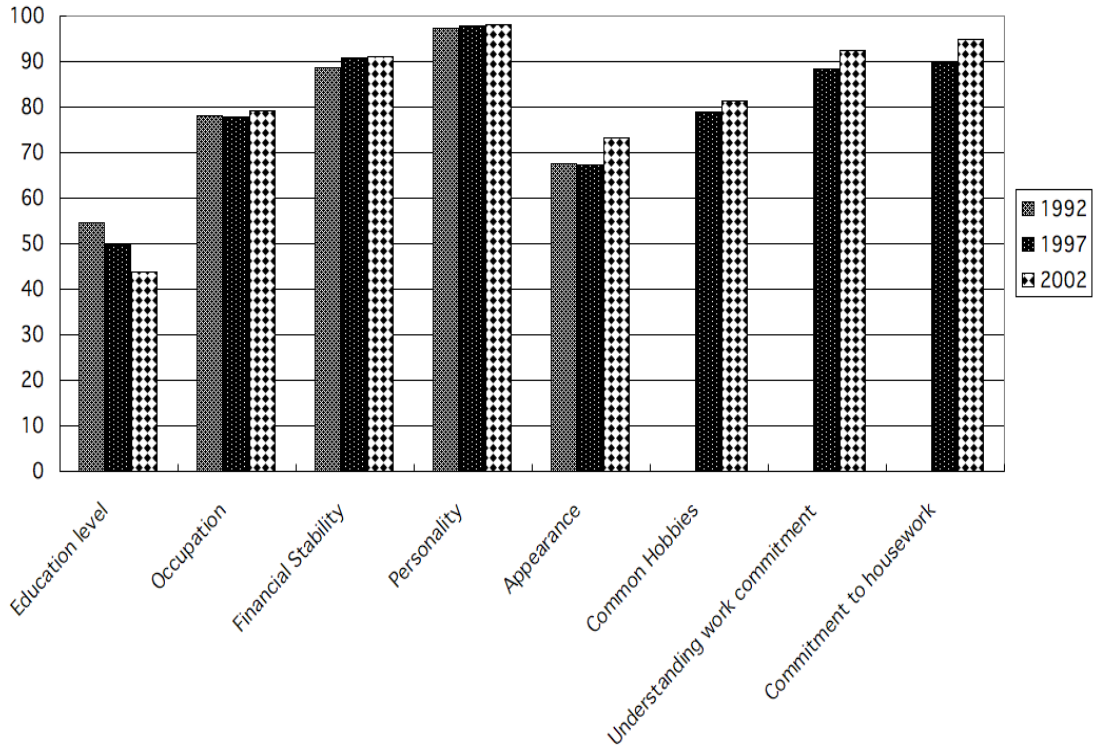


is increasing[1]. The 1987 to 2002 surveys also reveals changes in the opinions of women regarding the benefits of marriage. While opinions of the benefits of forming a family and raising children are increasing, those of being socially acceptable and obtaining society's trust are declining. Opinions on the benefits of financial stability are also increasing. Moreover single women who want to marry by a certain age declined from 54.1 percent in 1987 to 42.9 percent in 1997, while single women who say they will not marry until they find an ideal partner increased from 44.5 percent in 1987 to 56.1 percent in 1997. A similar tendency is formed for men. Although both men and women show a similar preference to refrain from marriage at an early age, why have only women shown such a strong trend to delay marriage over the last ten years?

In the "Basic Survey on the Population problems in 1995", the reasons for delaying marriage was asked of sample ages between 20 and 69. The most popular reason given was "an increase in people who do not choose to get married", accounting for 24.3 percent, followed by "an improvement of in the financial stability of women (17.5 %)" and then "Higher requirements for a future spouse (11.7 %)."

[1]The 12th national survey on marriage and fertility ('Dai 12-kai kekkonn to shussan ni kannsuru zennkoku chosa") can be downloaded from the official web site of the National institute of population and social security research in Japan.

Figure 3: Women's requirements for a marriage partner, by single women of 18-34years



The above views are consistent with a consensus of public opinion, such as an improvement in women's status makes women more selective which contributes to delaying marriage. The 12th national survey on marriage and fertility indicates that both women and men with higher education tend to have higher requirements for a marriage partner in terms of education level and occupation. Figures 2 and 3 show the requirements for a marriage partner from the point of view of both single men and women. Pronounced differences can be seen. Understandably, "Personality" is the most important factor for both. "Commitment to housework" and "Understanding work commitment" are equally important to both men and women. However 90 percent of women require "Financial stability" compared with only 30 percent of men. Similarly, nearly 80 percent of women consider "Occupation" of marriage partner important compared with only 40 percent of men. Women's requirements in every category are higher than those of men. Although women are shown to have higher requirements for a marriage partner, this does not fully explain the significant delay in marriage change of the past ten years. Because the trend of each category between 1992 and 2002 did not show significant changes exception of "Education level" which showed even downward trend for both men and women.

Descriptive analysis

The data set are from the Japanese Panel Survey of Consumers (JPSC) which has been conducted by the institute for research on household economics since 1993. Panels 1-7 covering 1993-99 are used in the analysis. The sample starts in 1993 with 1500 women aged 24-34 (CohortA). In 1997, an additional 500 samples of women aged 24-27 was included. The data provides streams of information on personal characteristics, wage, income, employment and marital status.

The number of observations and the proportion of married and singles in the JPSC data set are shown in Table 1. Thus the data set contains roughly 70 % of married and 30% of single women in each panel. As the interest lies in late marriage and the rate of marriage is presented by age cohorts from the JPSC data.

Table 1: Observations and marital status by JPSC panel (1993-99)

Panel	1	2	3	4	5	6	7
married	66.8	70.7	74.6	77.1	67.2	71.1	74.3
single	33.2	29.3	25.4	22.9	32.7	28.9	25.7
obser#	1500	1415	1341	1289	1749	1628	1537

Marriage

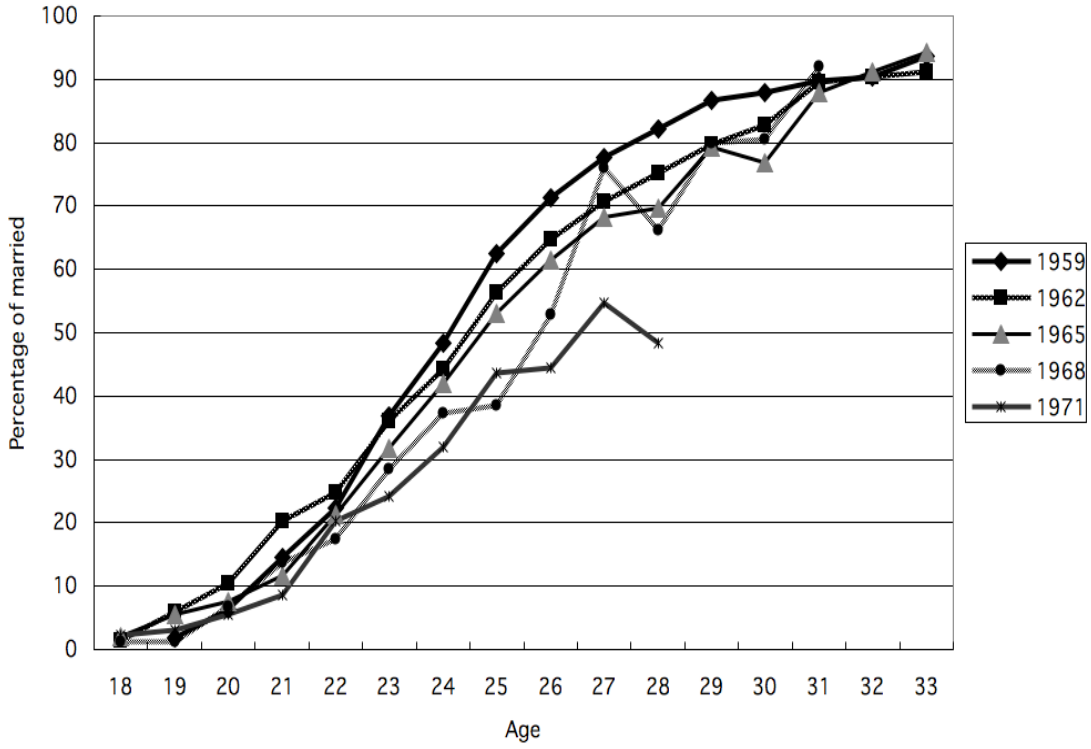
Figure 4 exhibits the basic trend of declining marriage rate by selected age cohorts. The younger the age cohort, the lower the rate of marriage at the same age. For example only 30 percent of women born in 1971 were married at 24 years compared with 50 percent of women born in 1959.

The latest popular view in Japan for the causality of late marriage is the so called "parasite single" hypothesis. "Parasite single" implies singles living with parents even after they get employment. Since the parents pay for all living expenses, singles can live comfortably with lesser responsibility in comparison to living independently. Such people who become a "parasite" on their parents may be less likely to marry due to the comfort of being a "parasite single."

The 12th national survey on marriage and fertility shows the proportion of men living with their parents increased by approximately 10 percent between 1992 and 2002, while the proportion of women living with parents was unchanged. Although both single men and women living with parents accounts for nearly 70 percent of singles, there has been no significant change in this trend for women over the last ten years. The survey suggests the increase in part time employment or unemployment due to the economic recession may have induced the tendency of men to live with parents.

Also the data set does not really support the "parasite single" hypothesis. Figure 5 presents the change in the structure of household members. 70-80 percent of singles live with parents with the same budget. Even though the JPSC data set has information of the structure of household members for singles only from panel 5 (1997), it shows a

Figure 4: Rate of marriage, JPSC



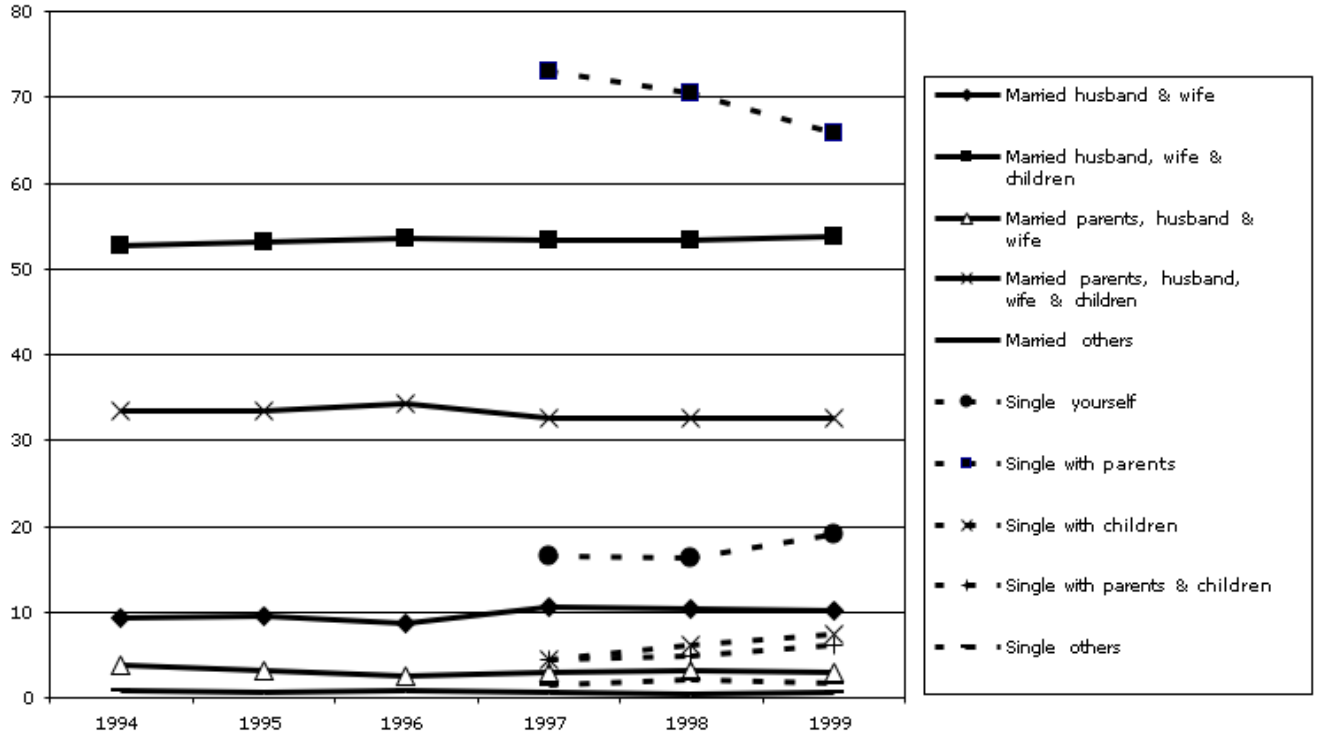
declining trend in the proportion of single women living with their parents. Hence the "parasite single" hypothesis for late marriage will not be examined.

In reference to the improvement in the status of women, considerable changes in education level can be seen from the JPSC data set as presented in Figure 6. Significant increases in university graduates in comparison with decreases in high school graduates for the younger age cohorts indicates an immense rise in the education level of women. The introduction of equal employment opportunity for women in Japan in 1986 might have contributed to encourage women to obtain higher education.

However, feminism in Japan has never been combative. Not so many women want to be a twenty-something professional who works and plays hard and ends up choosing to remain single. The data set shows 75 percent of single women were willing to marry while 25 percent thought marriage was not necessary or intended not to marry in the future. Interestingly, more than 60 percent of the women who were willing to marry pointed out that finding the "right" person was an obstacle.

While economists cannot analyze an issue like the "right" person for a woman, observable indicators such as those Figure 3 can be analyzed. Japanese women care relatively more about "Financial stability" and "Occupation" than Japanese men. The dramatic rise in the unemployment rate due to the long term economic recession might

Figure 5: Family Structure, JPSC

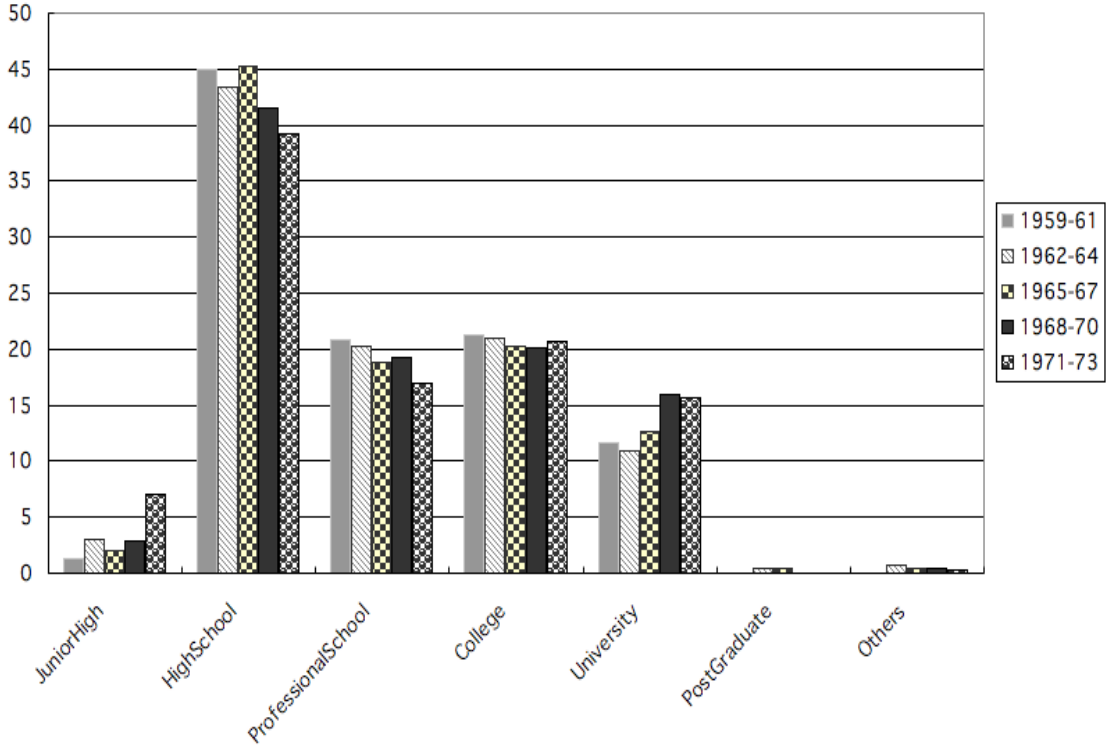


have violated the financial stability and occupation of some men.

Figures 7 and 8 show changes in the unemployment rates for marriageable ages since 1990. The unemployment rate for both men and women rose sharply in the 90s, especially in the younger age group. Although the unemployment rate for women tends to be higher than for men, because women care more about the "Financial stability" and "Occupation" of a marriage partner, the sharp increase in the male unemployment rate might influenced the delay in age at marriage for women.

The descriptive analysis presents a significant change in the education level of women and the unemployment rate for both men and women over the last ten years. The combination of a higher education level for women and a higher unemployment rate for both men and women might have some relevance in relation to delayed marriage for Japanese women. The previous literature is now reviewed in order to explore of the causation for the late marriage in further detail.

Figure 6: Education level by age cohort, JPSC

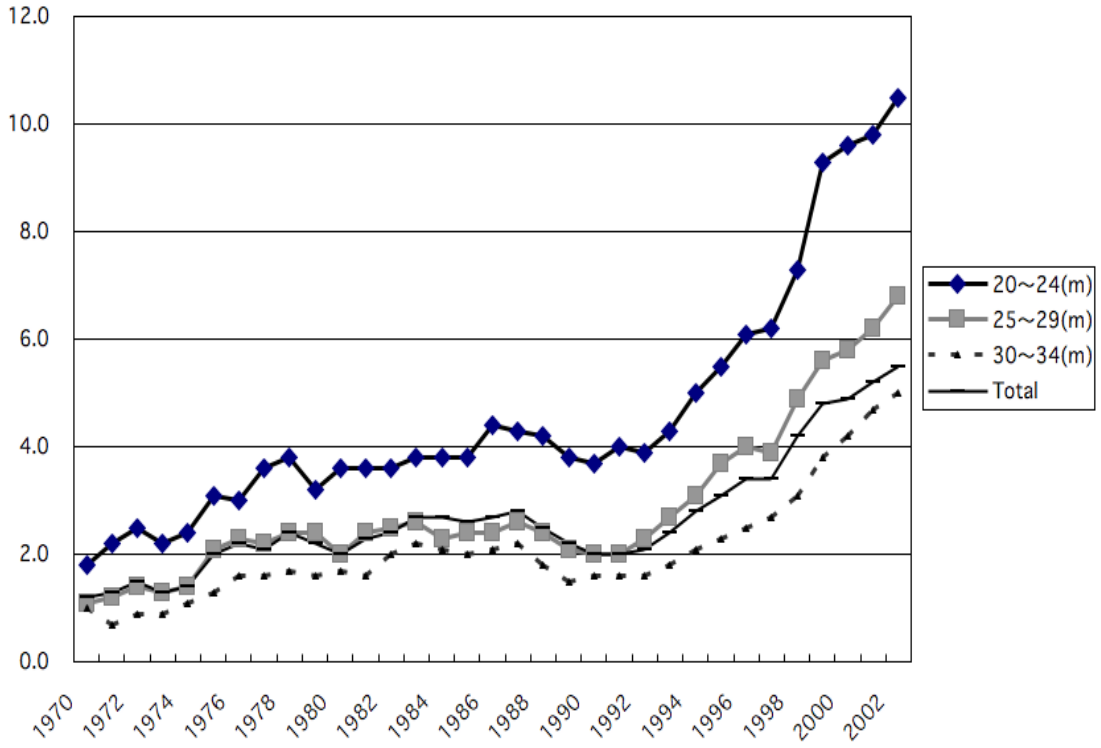


3 Previous studies

Many hypotheses for delay in marriage can be found in the literature on marriage behavior. A common view is linked to the labor market, such as an increase in female labor supply attributes to later marriage or a decline in the marriage rate. The interaction between marriage and the labor market are theoretically modeled in the seminal work on marriage by Becker (Becker (1973), Becker (1974)). The comparative advantage of the productivity of a spouse in both the market and the household determines the gains from marriage. Thus decision to marry for women depends on the gain from her labor supply. Van Der Klaauw (1996) estimates a female's work and marital status decision in each period of her life cycle. The earnings of both husband and wife, race, education and the presence of children are found to affect a woman's decision making. Ueda (2000) also estimates dynamic decision making on marital status, labor supply and childbearing for Japanese women with the same data set as used in the present paper. However her focus is more on joint decisions relating to childbearing and labor supply. Also the assumption made for decision making for marriage does not include a search aspect.

The effect of tax on marriage was estimated with a discrete hazard model of the marriage (Alm and Whittington (1999)). Edlund and Pande (2002) examined the effect

Figure 7: Male unemployment rate by sex and age, Labor Force Survey



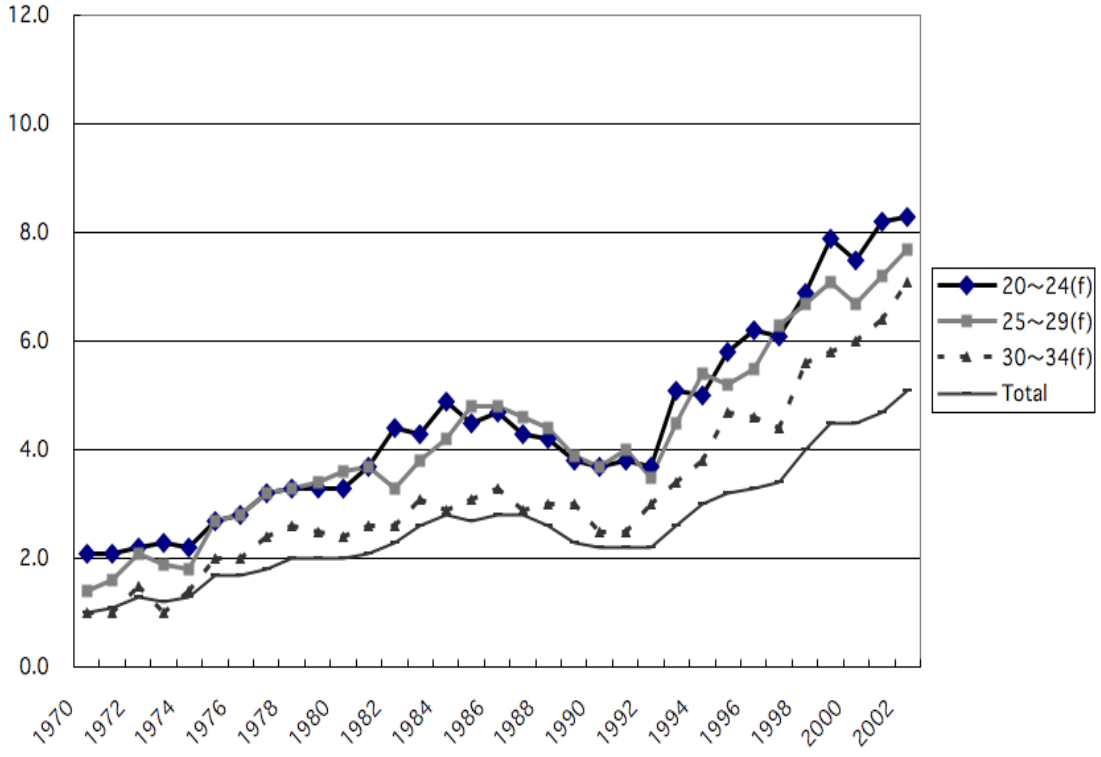
of gender gap in political preferences on the declining rate of marriage.

However in general a decision to marry involves both women and men rather than doing a cost benefit analysis for marriage from one side.

A search model is very attractive to look at the marriage market since it explains the process of realization of marriage between men and women.

A search theoretic marriage model has been formally modeled in many studies. Becker (1973) modeled the marriage market equilibrium and derived interesting implications of marriage behavior such as assortative mating. Job search model is applied to a marriage model by Mortensen (1988) along the line with partnership formation. Burdett and Coles (1997) develop further and shows that assortative mating can be explained as a class partition as a result of multiple steady state equilibria of marriage market with non-transferable utility. Accordingly Burdett and Coles (1999) and Shimer and Smith (2000) extend to the case of transferable utility. Burdett and Wright (1998) analyzes possibility of multiple equilibria in the two sided search with non transferable utility and shows the log-concavity condition guarantees the uniqueness. A wonderful paper of Burdett and Coles (2001) includes "self-improvement" to equip more pizzazz to improve your class in a marriage market equilibrium. "Self-improvement" changes the distribution of pizzazz and hence it leads to the different equilibria. The main focus

Figure 8: Female unemployment rate by sex and age, Labor Force Survey



of these theoretical studies is to analyze the equilibrium corresponding to the research interest. The interesting theoretical extension is including the stage of premarital cohabitation in to the model (Sahib and Gu (2002)). Bougheas and Georgellis (1999) extends marital search theory to marriage dissolution by introducing learning process and examines the effect of cost of divorce on decision making process of both marriage and divorce. The search equilibrium of marriage and divorce is analyzed by Cornelius (2003) and found the separation probability affects on the decision.

Many empirical studies implicitly apply search theory to interpret the estimation results. Boulier and Rosenzweig (1984) examined the interaction among years of schooling, the age of marriage for women and "quality" of husband which is measured by his expected earnings at the time of marriage. The positive assortative mating with respect to schooling was observed however which lowers the gain from marriage for women. Correspondingly the results indicate less attractive women with more schooling tend to marry later. The findings are interesting though the process of search and decision making is not included.

The effect of changes in sex ratios in the same ethnic group on the rate of marriage for US second generation immigrants are estimated by Angrist (2002). Meng and Gregory (2002) has examined the determinants of marriage between immigrants and the native-

born including probability of meeting a potential partner within the same characteristic group.

Wood (1995) examined the hypothesis of declining "marriageable" men attributes to lower marriage rates among black women in the U.S. The effect of the pool of "marriageable" men on the proportion of married women were estimated in terms of income levels, employment and an industry of jobs. Blau et al. (2000) found that better female labor markets contribute to worse female marriage markets and worse male marriage markets contribute to lower the marriage rate of women.

Following Mortensen (1986), Loughran (2002) explicitly modeled the effect of mean and variance of distribution of men on the reservation utility of women. Increases in wage inequality of men, employment and average wage of women all negatively affect on the female propensity to marry. On the other hand, rises in both average wage of men and female unemployment rate contribute to increase the propensity to marry for women. However the effect of search parameters on the propensity to marry cannot be inferred from the change in the reservation utility. Also the wage inequality measured only three points in the analysis time might be an issue because of the time dependency in the wage inequality variable.

Previous studies of marriage in Japan

Some of the findings in the studies of marriage behavior for Japanese women are consistent with the findings in the descriptive analysis of this paper. In Abe and Kitamura (1999), the effect of the change in education level on the distribution of age at first marriage is estimated. A higher level of education shifts the distribution of age at first marriage towards the right.

In line with the "Parasite singles" hypothesis, Kitamura (2002) estimates the impact of family structure and employment status on the decision to marry. Combining the results from two estimations he concludes part-time and casual work and living with parents are all negatively related to the decision to marry.

Higuchi (2001) found an impact from the unemployment rate on the timing of marriage. A high unemployment rate at the time of graduation speeds up the timing of marriage. On the other hand, a high unemployment rate in the years after graduation contribute to a delay in the timing of marriage. He concludes that marriage decisions are more likely to be based on employment opportunities than on fluctuations in the wage rate.

Ueda (2000) estimates the utility from marriage with a dynamic decision making model. The results shows the utility from work is higher for full time than part time workers. On the other hand the utility from marriage provided a negative sign for both.

Each finding, such as a higher education level for women, unemployment rates, and family structure, contributing to marriage delay is interesting, but difficult to interpret without a structural model. Applying a search model is a good method for interpreting causality.

4 A search theoretic model of marriage

The Burdett and Coles (1999) search theoretic model of marriage is extended by explicitly introducing the time to find a husband. The basic framework of the search model is that there are frictions in the marriage market. Agents will spend time and cost during the search process for the realization of marriage. Imperfect information implying the opportunities to encounter a potential partner is unknown to agents are assumed. Instead they know the distribution of opportunities. Both the market friction and imperfect information set up a situation in which the marriage market does not clear hence single women and men coexist.

The good traded in the marriage market is pizzazz which is supposed to be characterized by real numbers. When a woman decides to marry, her payoff equals her potential partner's pizzazz.

4.1 The model

A one sided search is considered. This assumes the arrival rate of marriage proposals to a woman is exogenous. The strategic procedure of the realization of marriage in general can be simplified as follows. First, a man proposes to a woman. Second, the woman decides whether or not to accept his proposal. Finally, marriage will be realized if she accepts. As long as the man is the one who proposes and the woman is the one who makes the decision, she can take the arrival rate of marriage proposals as exogenous. The marriage proposal itself can be considered as a result of his making a decision whether or not to marry with the woman (a draw from distribution of women). Thus applying a one sided search is rather appropriate given this common practice of proposals being made by the man.

Consider the large number of women looking for husbands. Marriageable men are characterized by the distribution of pizzazz denoted by $F(x)$. Suppose Miss i enters a marriage market where each woman is attempting to contact a single man. Miss i will encounter a potential man with arrival rate α where α is given by the parameter of an exponential distribution. Although it takes a random time to meet Mr. Right, Miss i can immediately tell the amount of pizzazz x of the potential man. If the potential man with pizzazz x is greater than her threshold level of pizzazz R, she will be perfectly convinced he is Mr. Right. They will marry and permanently exit the market. For the sake of simplicity it is assumed the agents will not divorce if they marry, and Miss i will remain single if she declines the marriage offer. Also these women and men live infinitely and have the same positive rate of time preference, r.

Suppose Miss i searches for a husband and her life time utility is;

$$\int_0^\infty C(t)e^{-rt}dt \tag{1}$$

$$\text{with} \quad C(t) = \begin{cases} x & \text{if marry} \\ b & \text{if single} \end{cases} \tag{2}$$

T is denoted as the time to find a husband. α is the arrival rate of proposals of marriage. The time to find a husband depends on the distribution and density of opportunities for encountering Mr. Right given by;

$$\begin{aligned} \tau \sim \Phi(t) &= \text{Prob}(T \leq t) && (3)\\ &= 1 - \text{Prob}(T < t) && (4)\\ &= 1 - e^{-\alpha t} && (5) \end{aligned}$$

and the density;

$$\Phi'(t) = \alpha e^{-\alpha t} \tag{6}$$

Thus T depends on the arrival rate which is distributed according to the exponential distribution. For instance, Miss i knows the exact location of Mr. Right, but it takes a random amount of time T to get to the given location.

Miss i's expected life time utility when single, V_s consists of the instantaneous utility of remaining single, b and the expected value of decision making of whether or not to marry, V_d (a draw from distribution of men) as follows.

$$V_s = \mathbf{E}[\int_0^T be^{-rt}dt + e^{-rT}V_d] \tag{7}$$

Substituting equation (6) obtains,

$$V_s = \frac{b}{\alpha + r} + \frac{\alpha}{\alpha + r}V_d \tag{8}$$

Let $V_m(x)$ be the value of marriage in hand which is obtained corresponding to the cut-off rule. The draw of marriage V_d can be expressed as follows.

$$V_d = \mathbf{E}\max(V_m, V_s) = \mathbf{E}\max(\frac{x}{r}, V_s) \tag{9}$$

Substituting equation (9) into equation (8),

$$(r + \alpha)V_s = b + \alpha\mathbf{E}\max(V_s, \frac{x}{r}) \tag{10}$$

Miss i will receive one offer at each period from a known distribution of men characterized by pizzazz, $F(\bar{x}) = \text{Prob}(x \leq \bar{x})$ with finite mean $\mathbf{E}x$. Miss i accepts the proposal which is greater than her threshold amount of pizzazz where $x \geq R$ corresponding to the cut-off rule. R is the threshold amount of pizzazz at which Miss i is indifferent between accepting or declining the proposal. In other words, the threshold amount of pizzazz is equivalent to the opportunity cost of being single such that $R = rV_s$. Using this relation, substituting out $V_s = \frac{R}{r}$ in equation(10), obtains the threshold amount of pizzazz which is referred to as the reservation utility.

$$R = b + \frac{\alpha}{r}\int_R^{\bar{x}}(x - R)dF(x) \tag{11}$$

Since $R = rV_s$, the reservation utility/the optimal search strategy is the sum of the utility obtained when Miss i is single plus the expected surplus from the optimal search strategy.

Integrating by parts equation(11) can be rewritten as

$$\begin{aligned} rV_s = R &= b + \frac{\alpha}{r}\int_R^{\bar{x}}[1 - F(x)]dx & (12)\\ &= b + \frac{\alpha}{r}\varphi(R) & (13)\end{aligned}$$

Thus the optimal search strategy is the function of b, α, r, and $F(x)$. The interest is in the impact of change in these parameters on both the reservation utility and the duration of remaining single.

The duration of remaining single can be easily expressed by the hazard rate. The hazard rate is the probability of Miss i getting married at time t, denoted H_t.

$$H_t = H = \alpha[1 - F(R)] \tag{14}$$

The hazard is regarded as exhibiting choice and chance, the former represented by $1 - F(R)$ and the latter by α. The hazard rate in this stationary, infinite-horizon model, does not depend on t. The hazard H occurs randomly hence the mean duration until the next arrival is given by;

$$\begin{aligned} \mathbf{E}T_H &= \int_0^{\infty} tHe^{-Ht}dt \\ &= \frac{1}{H}\end{aligned}$$

The duration of remaining single is presented by the inverse of the hazard rate.

Comparative statics

The interest here is in the impact of changes in parameters on both the reservation utility and the duration of remaining single.

Arrival rate of marriage offers: α

The impact of change in the arrival rate of proposals on the reservation utility is;

$$\frac{\partial R}{\partial \alpha} = \frac{\varphi(R)}{r + \alpha[1 - F(R)]} > 0 \tag{15}$$

Thus the more proposals, the higher the reservation utility. Obviously Miss i will be very choosy if she becomes popular. However the effect on duration is,

$$\frac{\partial H}{\partial \alpha} = 1 - F(R) - \frac{\alpha F(R)' \varphi(R)}{r + \alpha[1 - F(R)]} \tag{16}$$

which is ambiguous. Thus it is necessary to impose the condition on $F(x)$ as to which density function $f(x)$ is log concave, to rule out counter intuitive cases (Burdett (1981), Burdett (1996)). The effect of the arrival rate on the hazard rate is positive under the log concave condition of the distribution of men's pizzazz. Hence the higher the arrival rate of proposals, the shorter the duration of remaining single. In other words, when Miss i has a greater chance of receiving proposals, she is less likely to become a thirty something singleton. Even though she has become selective, the effect on getting married is greater under the log concave condition of the distribution of men's pizzazz.

Instantaneous utility of being single: b

Clearly the effect of an increase in the instantaneous utility of being single is positive on reservation utility. Accordingly it is negative on the hazard rate. The greater the instantaneous utility of being single the greater the reservation utility and it also implies a longer duration for remaining single. This result provides a sufficient reason for the existence of thirty something singletons.

$$\begin{aligned} \frac{\partial R}{\partial b} &= \frac{r}{r + \alpha[1 - F(R)]} > 0 \\ \frac{\partial H}{\partial b} &= -[1 - F(R)]F(R)' < 0 \end{aligned}$$

Discount rate: r

When Miss i becomes myopic, her reservation utility is lower and her duration of remaining single shorter. No doubt if Miss i is blind, it won't make her at all choosy hence she will marry soon.

$$\begin{aligned} \frac{\partial R}{\partial r} &= -\frac{r\alpha\varphi(R)}{r + \alpha[1 - F(R)]} < 0 \\ \frac{\partial H}{\partial r} &= -[1 - F(R)]F(R)' \frac{\partial R}{\partial r} > 0 \end{aligned}$$

Analysis of the distribution of the pizzazz of single men

Following Mortensen (1986) the effect of change is analyzed in the distribution of men's pizzazz on both the reservation utility and the duration of remaining single in terms of mean and variance of $F(x)$. For example, if a woman consider a man's salary as a proxy of pizzazz, a rising unemployment rate as a result of economic recession will affect the

distribution of men's salaries and therefore her reservation utility and the duration of remaining single will have some effect.

Mean

Let G denotes a cumulative distribution function which has a greater mean by μ than that of F.

$$G(x+\mu) = F(x) \qquad \text{for all} \quad x \tag{17}$$

Similarly the hazard function can be rewritten as follows.

$$H(\mu) = \alpha[1 - G(R(\mu))] = \alpha[1 - F(R(\mu) - \mu)] \tag{18}$$

The effect of change in mean on the reservation utility

Substituting G which has larger mean than F into equation (11),

$$\begin{aligned}(r+\alpha)R(\mu) &= \alpha \mathbf{E}_G\{x\} + \alpha \int_0^{R(\mu)} G(x)dx + rb & (19)\\ &= \alpha\mu + \alpha \mathbf{E}_F\{x\} + \alpha \int_0^{R(\mu)} F[x-\mu]dx + rb & (20)\end{aligned}$$

Taking a derivative of equation (19) with respect to μ shows the positive effect of increasing mean on the reservation utility.

$$\begin{aligned}\frac{\partial R(\mu)}{\partial \mu} &= \frac{\alpha\{1 - F[R(\mu)-\mu] + F(-\mu)\}}{r + \alpha\{1 - F[R(\mu)-\mu]\}}\\ &= \frac{H}{r+H} > 0\end{aligned}$$

That is, when the mean of distribution of men's pizzazz increases, women will become more selective.

The effect of change in mean on the duration

However the effect on the hazard rate goes in the opposite direction as follows.

$$\begin{aligned}\frac{\partial H(\mu)}{\partial \mu} &= \alpha F'[1 - \frac{\partial R(\mu)}{\partial \mu}]\\ &= \alpha F'[1 - \frac{H}{r+H}] > 0\end{aligned}$$

Thus if the mean of the distribution of men's pizzazz increases the duration of remaining single becomes shorter. As before, even though Miss i becomes highly selective, overall the effect on hazard overcomes. Therefore if on average men become more attractive, Miss i will marry soon even though she has become more selective.

Variance

Similarly let K be a mean preserving spread of F which places more weight on the tails but keeps the mean of the distribution unchanged.

$$K(x,\sigma) = F(x) \qquad \text{when} \quad \sigma = 0 \tag{21}$$

Thus the hazard function can be rewritten as follows,

$$H(\sigma) = \alpha[1 - K(R(\sigma),\sigma)] \tag{22}$$

Similarly substituting a mean preserving spread K of F into equation (11), gives

$$(r+\alpha)R(\sigma) = \alpha \mathbf{E}_F x + \alpha \int_0^{R(\sigma)} K(x,\sigma)dx + rb \tag{23}$$

The effect of change in variance on reservation utility

As before, taking a derivative of equation (23) with respect to σ shows in general the ambiguous effect on the reservation utility. However, according to the property of the mean preserving spread, there will be a positive effect as follows[2]

$$\frac{\partial R(\sigma)}{\partial \sigma} \mid_{\sigma=0} = (r + \alpha[1 - F(R)])^{-1} \alpha \int_0^{R(\sigma)} \frac{\partial K(x,0)}{\partial \sigma} dx \geq 0 \tag{24}$$

In terms of riskiness, larger variance with a mean preserving spread implies more risk. Since a man with a great amount of pizzazz might be encountered with higher probability than previously so will encountering a man with less pizzazz have a higher probability as well. Hence as risk increases women will be more fussy about choosing the "right" one.

The effect of change in variance on the duration

Larger "risk" increases reservation utility. However, the effect on the duration of remaining single is ambiguous, since several empirical marital search studies assume an increase in variance of the distribution of men leads to delay in marriage due to an increase in women's reservation utility. However the effect of the risk on duration does not necessarily make the duration longer. The sign is undetermined since the sign of the second term of the right hand side in equation (25) is undefined which depends on the shape of the distribution.

$$\frac{\partial H(\sigma)}{\partial \sigma} = -\alpha F(R)' \frac{\partial R(\sigma)}{\partial \sigma} - \alpha \frac{\partial K(R(\sigma),\sigma)}{\partial \sigma} \tag{25}$$

[2]The property of the mean preserving spread:

$$\lim_{\sigma \to 0} \int_0^{\bar{x}} \frac{K(x,\sigma) - F(x)}{\sigma} dx = \int_0^{\bar{x}} \frac{\partial K(x,0)}{\partial \sigma} dx \geq 0 \qquad \text{for all} \quad x$$

.

This comparative static analysis shows that an increase in the instantaneous utility of being single, b causes marriage delay. On the other hand, an increase in the arrival rate of marriage offers α, a discount rate r, and mean of the distribution of men's pizzazz μ contribute to earlier marriage. However an increase in variance of the distribution of men's pizzazz σ, shows an ambiguous effect on the duration of remaining single. The effects of the above parameters inferred from search theory are tested in the following econometric analysis.

5 Econometric analysis

Our interest lies in the effect of search parameters on delaying marriage. As in equation (14), the probability of Miss i accepting a proposal is the product of chance and choice, i. e., a proposal will be made to her is the interval of time from t to Δt with a probability that if such a proposal is received it will be worth accepting.

As a result of her search, she receives proposals from time to time. She would find some acceptable and some not. The concern here is with the process of Miss i's decision making on the choice to marriage.

The data set observing the age of marriage, the duration of remaining single, can be measured in the annual time intervals from when Miss i is 19 years old. The effect of search parameters on the duration of remaining single can be estimated by using a hazard model (Lancaster (1990), van den Berg (2000), Wooldridge (2002), Jenkins (2004)).

Specification and hypothesis

The search model considered in section 4 implies the expected duration of remaining single depends on the arrival rate of marriage offers α, instantaneous utility of being single b, a discount rate r, and the distribution of men's pizzazz in terms of mean μ and variance σ.

$$\lambda(t|\mathbf{z}(\mathbf{t})) = \lambda(t|\alpha, b, r, \text{distribution of men's pizzazz}) \tag{26}$$

Arrival rate of marriage offer α

The arrival rate of marriage offers α is exogenously determined in this model. The random time of encounter with a single man who will propose is affected by residence such as inhabitants is in a town, a city or a large metropolitan area. Intuitively, a larger population signifies more opportunities to encounter single men. In reality, there are more single women and men in a large city. The consideration here is the random time of encountering a man who will provide a marriage offer. In this sense, the random time will be shorter in a small town, simply because of its smaller size. Thus the bigger the size of the city, the longer the time available to encounter a man who is ready to

commit. In our study, **Metro** represents the 13 large metropolitan areas in Japan[3]. The population in each of these 13 large metropolitan areas (**Metro**) is more than one million exception of Chiba city. A **City** has a population of more than thirty to forty thousand, and a **Town** has less than that. These residential variables are treated as time invariant variables because of data constraint and because only 2.9 percent of all single women during the survey period moved before marriage. Therefore residence is predicted backwards, which means residence before marriage is based on the result from the single samples during the survey periods. Multi nominal logit is used to estimate whether women moved to a bigger or a smaller city or remained in the same location after marriage, with parameters such as age, education level and employment status. Whether or not they moved after marriage is predicted for married samples and accordingly the dummy variables created for a residence before marriage. Table 2 shows that before marriage 32 percent lived in 13 large metropolitan areas (**Metro**), 53 percent lived in **City** and 15 percent lived in **Town**.

Instantaneous utility of single b

Employment status (**Fulltime**, **Parttime**, **Student** or **NotWorking**) and years of schooling (**Schooling**) are included as a proxy of observable instantaneous utility when single. The data contains a history of employment status and years of schooling, thus these are time varying variables. Simply, long years of schooling mean a higher investment for a woman (self improvement) which implies a higher utility in remaining single. Also a full time or part time employment status implies a stream of earnings in comparison to not working. Thus full time or part time employment status also increases the utility of being single. Implication of being a **Student** is the same as years of schooling. Thus longer years of schooling, full time or part time, being a student will decrease the hazard, i.e., contribute to marriage delay.

Discount rate r

Although the exogenous discount rate r is simply unobservable which can be included in the error term, the female unemployment rate (**UnempF**) can be considered as the discount rate. On top of a long standing traditional expectation in Japan that a man should financially support his wife, most women still want financial stability from marriageable men as can be seen in Figure 3. The female unemployment rate has been included for every year by age groups, 15-19, 20-24, 25-30, 30-34 and 35-40 years old from Labor Force Survey. Suppose women face a higher unemployment rate every year, so that getting a job she wants is more difficult. A highly competitive job market will lower the value of future financial prospects. Thus the higher the discount rate, the shorter the duration of remaining single.

[3]The 13 large metropolitan areas are Tokyo(23 districts), Sapporo, Sendai, Chiba, Yokohama, Kawasaki, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Kitakyushu and Fukuoka.

Men's distribution: Mean μ and Variance σ

The distribution of men's pizzazz is considered in terms of mean and variance. The hypothesis is that changes in the distribution of men's pizzazz due to the long term economic recession in Japan affects the rate of marriage. Therefore consideration is given to change in men's pizzazz in terms of macro economic indicators, such as the growth rate of men's mean wage as **Mean** and the male unemployment rate as **Variance** of men. The annual growth rate of men's mean wage is included. Male unemployment rates for each year by age groups are included in the corresponding age group of women. Higher mean implies a higher growth rate of men's mean wage, which also makes women more choosy. However if the overall effect on the chance of encountering Mr. Right becomes higher she will marry earlier. However, the effect of variance of distribution of men is ambiguous.

Age Cohort and Year of Graduation

Since the interest here is in the determinants of the different probability for getting married in each time interval by age cohort groups, the age cohort group parameters are included. **Coh1** is women born in 1959-61, **Coh2** represents 1962-64, **Coh3** represents 1965-1967, **Coh4** represents 1968-1970, and **Coh5** represents 1971-1973.

Also it is not common in Japan to marry during the years of undertaking study. However, the year of graduation is considered to have a big effect on the probability of getting married. Thus a **Graduation** (Year Of Graduation) parameter is included.

5.1 Data

The data are from JPSC and Labour Force Survey. Females from both cohort A and B are examined. The advantage of the JPSC data is accurate information on the history of employment status for all samples from 18 years old, apart from the waves of panel. In addition to employment history, JPSC also contains education level, year of graduation and residence, which enables inclusion of most information as time-varying variables. The Labour Force Survey (LFS) provides average wage growth and unemployment rate by age cohorts. The disadvantage of the data set is that all the information is reported annually and also only contains the age at marriage for a current marriage. Average age of marriage in our data is 26.4 years old which is close to the average age at first marriage in Japan (26.8 years old in 1999). Also the Individuals are censored when they did not marry within the survey periods.

The hazards are estimated from Miss i is 19 years old to the age of marriage to utilize the information of the history of covariates from 18 years old. The sample included 1967 women or 16232 women-analysis time. Women who married at the age less than 18 years old are excluded.

Descriptive statistics for the sample are given in Table 2.

A more complete illustration of the pattern of marriage and censoring by age cohorts can be seen in Tables 3 and 4. The Kaplan-Meier survivor estimates are also presented.

Table 2: Summary statistics

Variable	Mean	Std. Dev.	N	Min.	Max.
Indicator of married and age of marriage					
Married	0.726	0.446	1967	0	1
Age of marriage	26.398	3.503	9474	19	40
Arrival rate					
Metro	0.32	0.466	16232	0	1
City	0.53	0.499	16232	0	1
Town	0.15	0.357	16232	0	1
Instantaneous utility of single					
Fulltime	0.62	0.485	13155	0	1
Parttime	0.125	0.33	13155	0	1
Not-working	0.036	0.187	13155	0	1
Student	0.219	0.414	13155	0	1
Schooling(Years of Schooling)	13.423	1.819	16232	9	23
Discount rate					
UnempF(Female Unemployment rate)	4.568	1.068	16232	2.5	7.7
Distribution of men					
Mean	3.336	1.772	16232	-.2	9.6
Variance	4.534	1.874	16232	1.5	9.3
Age cohorts and indicator of year of graduation					
Coh1	0.199	0.4	16232	0	1
Coh2	0.214	0.41	16232	0	1
Coh3	0.212	0.409	16232	0	1
Coh4	0.205	0.404	16232	0	1
Coh5	0.169	0.375	16232	0	1
Graduation	0.108	0.311	16232	0	1

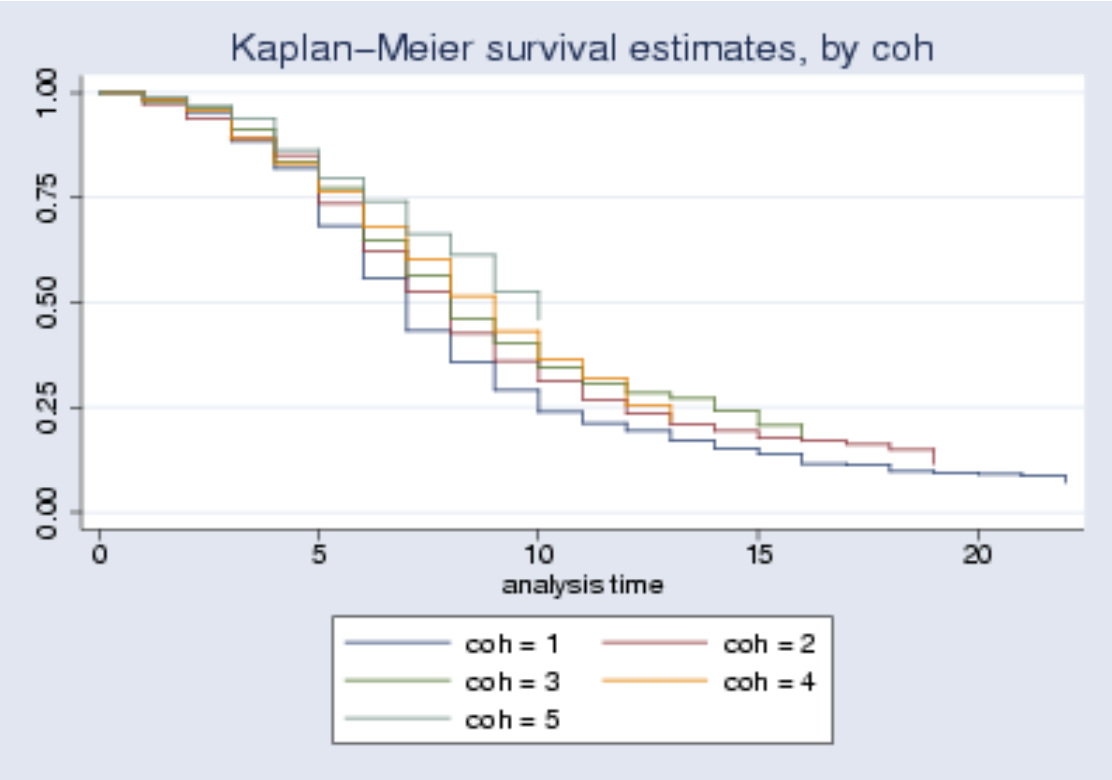
Table 3: Failures, Censorings and the Kaplan-Meier Empirical Survivor: Cohort 1-2

Cohort	**Period**	**Risk**	**Failures**	**Censored**	**Survivor**	**Std. Err.**
Cohort1	1	381	7	0	0.9816	0.0069
	2	374	11	0	0.9528	0.0109
	3	363	26	0	0.8845	0.0164
	4	337	25	0	0.8189	0.0197
	5	312	52	0	0.6824	0.0239
	6	260	47	0	0.5591	0.0254
	7	213	48	0	0.4331	0.0254
	8	165	28	0	0.3596	0.0246
	9	137	26	0	0.2913	0.0233
	10	111	20	0	0.2388	0.0218
	11	91	10	0	0.2126	0.0210
	12	81	7	0	0.1942	0.0203
	13	74	9	0	0.1706	0.0193
	14	65	7	1	0.1522	0.0184
	15	57	5	4	0.1389	0.0177
	16	48	8	1	0.1157	0.0166
	17	39	1	1	0.1128	0.0164
	18	37	5	0	0.0975	0.0155
	19	32	1	1	0.0945	0.0153
	20	30	1	10	0.0913	0.0152
	21	19	1	7	0.0865	0.0151
	22	11	2	9	0.0708	0.0159
Cohort2	1	394	11	0	0.9721	0.0083
	2	383	14	0	0.9365	0.0123
	3	369	18	0	0.8909	0.0157
	4	351	16	0	0.8503	0.0180
	5	335	45	0	0.7360	0.0222
	6	290	45	0	0.6218	0.0244
	7	245	38	0	0.5254	0.0252
	8	207	39	0	0.4264	0.0249
	9	168	26	0	0.3604	0.0242
	10	142	19	0	0.3122	0.0233
	11	123	17	2	0.2690	0.0223
	12	104	13	4	0.2354	0.0214
	13	87	10	5	0.2083	0.0206
	14	72	5	2	0.1939	0.0201
	15	65	6	4	0.1760	0.0196
	16	55	2	4	0.1696	0.0194
	17	49	2	22	0.1627	0.0192
	18	25	2	10	0.1496	0.0197
	19	13	3	10	0.1151	0.0232

Table 4: Failures, Censorings and the Kaplan-Meier Empirical Survivor: Cohort3-5

Cohort	**Period**	**Risk**	**Failures**	**Censored**	**Survivor**	**Std. Err.**
Cohort3	1	397	8	0	0.9798	0.0071
	2	389	7	0	0.9622	0.0096
	3	382	20	0	0.9118	0.0142
	4	362	30	0	0.8363	0.0186
	5	332	25	0	0.7733	0.0210
	6	307	50	0	0.6474	0.0240
	7	257	33	0	0.5642	0.0249
	8	224	41	6	0.4610	0.0250
	9	177	22	6	0.4037	0.0247
	10	149	22	5	0.3441	0.0241
	11	122	13	3	0.3074	0.0236
	12	106	8	6	0.2842	0.0232
	13	92	4	6	0.2718	0.0230
	14	82	9	24	0.2420	0.0225
	15	49	7	20	0.2074	0.0228
	16	22	3	19	0.1791	0.0248
Cohort4	1	421	7	0	0.9834	0.0062
	2	414	11	0	0.9572	0.0099
	3	403	28	0	0.8907	0.0152
	4	375	25	0	0.8314	0.0182
	5	350	29	0	0.7625	0.0207
	6	321	34	6	0.6817	0.0227
	7	281	33	17	0.6017	0.0239
	8	231	33	7	0.5157	0.0248
	9	191	31	16	0.4320	0.0249
	10	144	23	12	0.3630	0.0247
	11	109	13	31	0.3197	0.0245
	12	65	13	32	0.2558	0.0252
	13	20	3	17	0.2174	0.0296
Cohort5	1	374	4	0	0.9893	0.0053
	2	370	8	0	0.9679	0.0091
	3	362	11	0	0.9385	0.0124
	4	351	28	0	0.8636	0.0177
	5	323	25	0	0.7968	0.0208
	6	298	21	11	0.7406	0.0227
	7	266	28	12	0.6627	0.0246
	8	226	17	83	0.6128	0.0256
	9	126	18	60	0.5253	0.0291
	10	48	6	42	0.4596	0.0357

Figure 9: Kaplan-Meier survival function by Agecohort, Japanese women, JPSC



Formally, the survivor for time interval $\bar{t} \in [t-1, t)$,

$$\hat{S}(t) = \prod_{\bar{t}=1}^{n} \left[\frac{(N_{\bar{t}} - E_{\bar{t}})}{N_{\bar{t}}} \right] \tag{27}$$

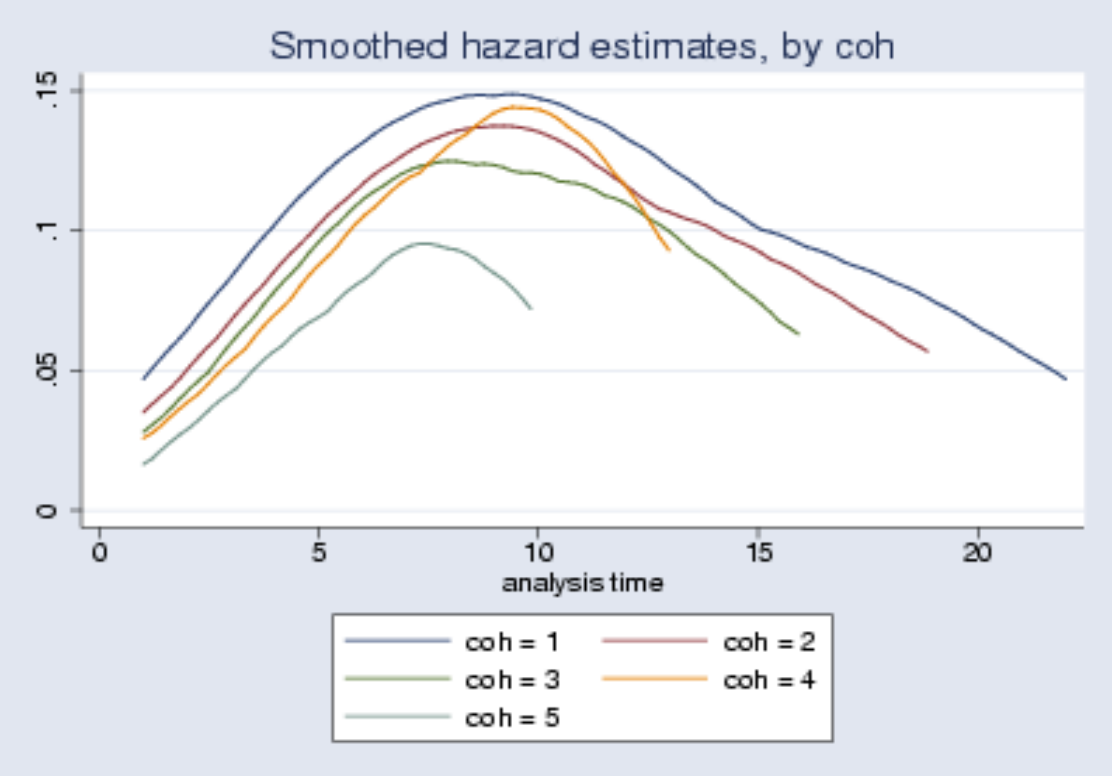
where $N_{\bar{t}}$ is the number of women in the risk set for interval $\bar{t}$. $E_{\bar{t}}$ is the number of women who marry in interval $\bar{t}$.

Thus the Kaplan-Meier survivor estimates simply show the fraction of singles at each period. In Figure 9, the younger cohorts exhibit higher survival rates at the same time interval.

Period 1 is the analysis time when the woman is 19 years old, and more than half of the women got married after period 7 (25 years old) in cohort 1, after period 8 (26years old) in both cohorts 2 and 3, after period 9 (27 years old) in cohort 4 and after period 10 (28 years old) in cohort5. Thus the younger the age cohort, the longer the period of remaining single.

Figure 10 shows the estimated hazard calculated as a smoothed kernel density estimation of the hazard contributions. The hazard rate is the inverse of the survival rate, which exhibits the fraction of married women at each period. The hazard is decreasing

Figure 10: Estimated hazard function by Agecohort, Japanese women, JPSC



for the younger age cohort, while the peak in each cohort appears in more or less the same period, except for age cohort 4. Declining hazard rates can be seen for the younger age cohorts or delaying the timing of marriage as in cohort 4.

5.2 The Discrete time proportional hazard model

Our measurement of the duration of remaining single is coarse, such as annual, it is important to account for the discreteness in the estimation.

The discrete time hazard model summarizes the information of remaining single or getting married in each time interval in a sequence of binary outcomes.

The observed random variable is the time to find a husband which is the duration of remaining single T measured in discrete time. Define the probability that a woman at time t will marry in a short interval of time Δt given that she is left single until time t and also given the vector of covariates up through time t, $\mathbf{z(t)}$.

$$P(T < t + \Delta t | T \geq t, \mathbf{z(t)}) \tag{28}$$

The hazard function which is the average probability of getting married per unit time is derived after dividing this probability by Δt.

$$\lambda(t|\mathbf{z}(\mathbf{t})) = \lim_{\Delta t \to 0} \frac{P(T < t + \Delta t | T \geq t, \mathbf{z}(\mathbf{t}))}{\Delta t} \tag{29}$$

However as we only have discrete time Δt, thus imposing a restriction in equation 29 for $\Delta t \geq 1$ year.

We make the assumption that the hazard has a proportional hazard form.

$$\lambda_{cont.}(t|\mathbf{z}(\mathbf{t})) = \lambda_0(t) \exp\Big(\mathbf{z}(\mathbf{t})'\beta\Big) \tag{30}$$

where $\lambda_0(t)$ is the baseline hazard at time t, and $\mathbf{z}(\mathbf{t})$ is a vector of time varying covariates.

The discrete model can be estimated semi-parametrically without restrictions on the baseline hazard along the line with Meyer (1990) and others (Narendranathan and Stewart (1993),Han and Hausman (1990)). Non-parametric methods have the big advantage of avoiding misspecification of the baseline hazard. However it is not appropriate for the purpose of this paper. The determinants of different hazard in each time interval will be examined by the age cohort, in order to examine why women delay marriage for the younger cohorts. Thus controlling each time interval non-parametrically is equivalent with assuming everyone has an identical time pattern for the hazard. Hence the Weibull form will be specified on the baseline hazard.

From the proportional hazard specification assumption, the discrete time hazard $\lambda_{disc.}(t|\mathbf{z}(\mathbf{t}))$ is defined by

$$\begin{aligned} \lambda_{disc.}(t|\mathbf{z}(\mathbf{t})) &= P[T < t + \Delta t | T \geq t] \\ &= 1 - \exp\Big[- \int_t^{t+\Delta t} \lambda(s|\mathbf{z}(\mathbf{t}))ds \Big] \end{aligned}$$

In the discrete time frame we assume that $\mathbf{z}(\mathbf{t})$ is constant between t and Δt.

$$\begin{aligned} \lambda_{disc.}(t|\mathbf{z}(\mathbf{t})) &= 1 - \exp\Big[- \exp(\mathbf{z}(\mathbf{t})'\beta) \cdot \int_t^{t+\Delta t} \lambda_0(s)ds \Big] \\ &= 1 - \exp\Big[- \exp(\mathbf{z}(\mathbf{t})'\beta + \zeta(t)) \Big] \end{aligned}$$

where

$$\zeta(t) = \ln\Big[\int_t^{t+\Delta t} \lambda_0(s)ds \Big] \tag{31}$$

and the baseline hazard is specified as follows.

$$\begin{aligned} \lambda_0(t) &= \alpha t^{\alpha-1} && (32) \\ &= \exp\Big(\log\alpha + (\alpha - 1)\log t \Big) && (33) \\ &= \exp\Big(\delta_0 + \delta_1 \log t \Big). && (34) \end{aligned}$$

Thus if δ_1 is positive, there is positive monotonic duration dependence. When a parametric form of baseline hazard is assumed, the misspecification leads to inconsistent estimation of β. Here it is assumed there is positive monotonic duration dependence of probability of getting married because in Japan women are more likely to get married when they are getting older.

Let k_i be the observed duration of the ith woman until marriage or censored such as $k_i = \min(\text{int}(T_i), C_i)$ where C_i is the censoring time.

The likelihood for an individual i can be written as

$$L_i = \lambda_i(k_i)^{c_i} \Delta t \cdot \prod_{t=1}^{k_i-1} \Big[1 - \lambda_i(t)\Delta t\Big] \tag{35}$$

where c_i is a censoring indicator ($c_i = 1$ if $T_i \leq C_i$: uncensored, $c_i = 0$ if censored). The first term shows the probability of being married at time k_i and the second term shows the probability of remaining single through time until $k_i - 1$. Also $\Delta t = 1$ so that we can drop it. The log-likelihood is,

$$\begin{aligned}
\log L_i &= c_i \log[\lambda_i(k_i)] + \sum_{t=1}^{k_i-1} \log[1 - \lambda_i(t)] \\
&= c_i \log\Big[1 - \exp[-\exp(\mathbf{z}(\mathbf{k_i})'\beta + \zeta(k_i))]\Big] - \sum_{t=1}^{k_i-1} \exp\Big[\mathbf{z}(\mathbf{t})'\beta + \zeta(t)\Big].
\end{aligned}$$

The log-likelihood is maximized with respect to β and the elements of ζ which is a coefficient of $\log t$, δ_1 as in equation (32)[4].

6 Estimation results

Table 5 presents the estimation results of the maximum likelihood estimation of a hazard model of remaining single. The coefficients of expected hazard are presented in three specifications. Thus a positive coefficient means a higher probability of getting married and vice versa. The above model is also estimated with unobserved heterogeneity since ignoring this causes a biased estimation. However, a likelihood-ratio test of these specifications cannot reject the hypothesis of a zero variance of gamma-distributed unobserved heterogeneity.

Specification (1) is the full model from the specification. Coefficient of the baseline hazard shows positive. Since the older the women the more the likelihood of marrying, there is a positive time dependence on the hazard. Age cohort shows all negative sign relative to cohort 1. Thus, the younger the age cohorts the less the likelihood of getting married. However, only the youngest age cohort is significant. Also the indicator of year of graduation shows a strong negative effect on the hazard.

[4]The estimation is carried out in Stata using the "pgmhaz8" program written by Stephen Jenkins.

Table 5: The hazard model estimate: from single to married (Weibull baseline hazard)

Specification	(1)		(2)		(3)	
Variable	**Coef.**	**(Std. Err.)**	**Coef.**	**(Std. Err.)**	**Coef.**	**(Std. Err.)**
Baseline hazard						
$\log t$	0.269**	(0.106)	0.339***	(0.054)	0.369***	(0.104)
Age cohort & Year of graduation						
Coh1						
Coh2	-0.093	(0.087)	-0.118	(0.086)	-0.088	(0.087)
Coh3	-0.041	(0.093)	-0.141	(0.089)	-0.025	(0.093)
Coh4	-0.025	(0.100)	-0.140	(0.096)	-0.004	(0.100)
Coh5	-0.361***	(0.128)	-0.509***	(0.123)	-0.343***	(0.128)
Graduation	-0.673***	(0.142)	-0.709***	(0.141)		
Instantaneous utility of single						
NotWorking						
Fulltime	-0.429***	(0.116)	-0.420***	(0.116)	-0.424***	(0.116)
Parttime	-0.396***	(0.131)	-0.390***	(0.131)	-0.395***	(0.131)
Student	-2.244***	(0.210)	-2.274***	(0.210)	-2.133***	(0.209)
Schooling	0.003	(0.017)	0.006	(0.017)	-0.019	(0.016)
Arrival rate						
Town						
Metro	-0.420***	(0.090)	-0.420***	(0.090)	-0.426***	(0.090)
City	-0.193**	(0.076)	-0.190**	(0.076)	-0.199***	(0.076)
Discount rate						
UnempF	0.199***	(0.055)	0.041	(0.039)	0.212***	(0.055)
Distribution of men						
Mean	0.084***	(0.029)			0.090***	(0.029)
Variance	-0.123***	(0.044)			-0.135***	(0.044)
Intercept	-2.551***	(0.454)	-2.175***	(0.283)	-2.524***	(0.454)
Observations	13155		13155		13155	
Censored	538		538		538	
Subjects	1967		1967		1967	
Log likelihood	-3653.6		-3662.6		-3666.7	

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Parameters of instantaneous utility of remaining single show the expected sign except for **Schooling**. Employment status variables **Fulltime**, **Parttime**, and **Student** attribute a negative hazard from being single in comparison to **NotWorking**. **Student** has a strong negative effect on hazard, which indicates a high unlikelihood of marrying while still a student. Being a student is self improvement in the sense of self investment which raises the utility of being single, because it is financially difficult to marry without earnings on top of paying her self improvement costs. Individuals working full time or part time decreasing the probability of marriage are also provided in other studies. **Schooling** somehow shows a positive effect on hazard which is counter intuitive however though it is not significant. Specification (3) is the model without an indicator variable for year of graduation. **Schooling** turns out a negative sign as expected, though it is not significant in this specification. Also the absolute value of log likelihood in specification (3) is greater than specification (1). Thus the year of graduation affects more on hazard rather than on years of schooling.

Living in a large metropolitan area (**Metro**) and **City** decreases the probability of marriage relative to a **Town**. From this theory, it can be interpreted that the arrival rate is lower in bigger cities so that living in a bigger city decreases the probability of marriage. The arrival rate here assumes exogenous which is characterized by the coefficient of density of opportunities of encountering Mr. Right. Even though there are many more men in bigger cities, there are also for less opportunities to encounter Mr. Right.

The female unemployment rate shows positive on hazard which can be considered as a discount rate. Thus a high female unemployment rate raise the discount rate due to an increase in the uncertainty of financial stability in the future. This fear is likely to facilitate a woman to marry earlier. However, women still delayed marriage or were less likely to marry even though experiencing continuous periods of high unemployment due to the economic recession that commenced in 1991.

Since the interest lies in the effect of men's distribution on the duration of remaining single, men's distribution is included in terms of mean and variance. Mean is characterized by the average growth rate of men's wage, and attributes positive on hazard. Thus increasing the mean of men raises the probability of women marrying. However, the variance of men which is characterized by the male unemployment rate turns out to be negative. Since the sign from the theoretical model would not be determined, it is left for the empirical result. Thus the higher the variance meaning the more risky the situation, the longer the duration of remaining single in Japan[5]. Without the variables of distribution of men as in specification (2), the effect of the discount rate (female unemployment rate) becomes insignificant. Also the absolute value of log likelihood is smaller in specification (1) than (2). Thus the female unemployment rate (interpreted as a discount rate here) itself does not significantly affect hazard. Deriving the result from the estimated coefficient of the female unemployment rate variable without considering the supply side effect might mislead the interpretation.

[5]Loughran (2002) obtains the similar result in the U.S.. The variance in his study is in terms of variance of wage.

Thus the determinants of the longer duration of remaining single for the younger generation are accounted not only by women's characteristics such as employment status or education in previous studies, but also by supply side effects characterized by a search model such as distribution of men. As in the previous studies, it is found here that full time and part time employment, being a student and living in a bigger city contribute to the longer duration of remaining single. A high mean of distribution of men facilitates women marrying earlier. However the mean of growth rate of men's wage in Japan became less or even negative during the lengthy economic recession. Thus decreasing the mean of growth rate of men's wage because of the recession has contributed to marriage delay. Combined with the effect of high variance, which refers to the high male unemployment rate, the economic recession in Japan continues to produce a situation such as low or negative mean and high variance of distribution of men which might attribute to delaying marriage for Japanese women.

Even though a high female unemployment rate contributes to the increase in hazard, the effect of the distribution of men dominates the behavior of women thus the overall effect appeared to delaying marriage.

7 Conclusion

The present paper contributes to the literature of empirical studies of marriage behavior by explicitly modeling the supply side (men's distribution) in a search theoretical framework. A single-sided search model was applied to the behavior of a woman searching for a husband.

Applying search theory indicates the utility of being single, the arrival rate of marriage offers, the discount rate and change in men's distribution all have any effect on the duration of remaining single.

The impact of changes in the above parameters of the optimal search strategy for finding a husband were analyzed. As a result of the comparative static analysis, an increase in the instantaneous utility of being single causes marriage delay. On the other hand, an increase in the arrival rate of marriage offers, the discount rate, and the mean of the distribution of men's pizzazz contribute to earlier marriage. However the increase in variance of the distribution of men's pizzazz, shows an ambiguous effect on the duration of remaining single.

In the empirical analysis, this hypothesis was examined with a discrete proportional hazard model using the 1993-99 JPSC panel data set and LFS. The main finding as in the previous studies is that women working full time or part time, as students, a living in a bigger city tend to delay marriage.

The female unemployment rate, which can be interpreted as a discount rate, is positively related to the hazard. However marriage delay for women is still observed under the high unemployment rate due to the long term economic recession. The parameters of distribution of men provide further detailed explanation of the longer duration for women remaining single in Japan. An increase in men's distribution in terms of mean characterized by the average growth rate of men's wage contributes to the positive haz-

ard. On the other hand, increasing the variance in terms of the male unemployment rate related negatively to the hazard. Thus the higher the variance the longer the duration of remaining single. The economic recession in the last decade provided a situation of low or negative mean and a high variance of men's distribution. The results suggest the unfavorable men's distribution due to the long term economic recession significantly contributed to the longer duration of Japanese women remaining single.

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