Who suffered from the superstition in the marriage market? The case of Hinoeuma in Japan

Hideo Akabayashi

Faculty of Economics, Keio University*

December 26, 2006 (This version)

March 10, 2006 (First version)

Abstract

The births in 1966 in Japan dropped by 25% because of the *Hinoeuma* ("Fiery Horse") superstition, which says that a woman born in that year cannot be a good wife. Since the sex of birth is random and there is no prejudice toward Hinoeuma men, this shock can be used as a natural experiment to investigate the effects of cohort size and prejudice in the marriage market. Using data from the 1990-2000 Population Census, I estimate a net marital matching probability function of single men and women disaggregated by prefecture and cohort combination of couples. I find the matching efficiency among 1966 cohort is unusually lower than the predicted trend, especially for *men*. Additional data and analyses suggest that it is difficult to explain the results solely by education and family background of Hinoeuma children. The most likely story is that Hinoeuma men suffered loss of own marriage opportunity by discriminating women in their own cohort, while Hinoeuma women did not face prejudice from the other cohorts.

JEL classification: J12, J13, J70

Keywords: marriage market, empirical matching function, discrimination

---

*e-mail: hakab@econ.keio.ac.jp. Preliminary; comments are welcome. This research is supported by the Ministry of Education, and was completed when the I was visiting the National Bureau of Economic Research. Some of the census data was made available through the CSS at University of Tokyo, and the Japanese General Social Survey 200-2002 were made available through the SSJ Data Archive (ICSSRJ-ISS, University of Tokyo) and can be requested directly. The other data sets compiled by myself will be made available through www.japan-wikidata.org. Yoji Yamada and Hiroko Araki provided a superb assistance for cleaning the data. The usual disclaimer applies.

1 Introduction

Economic theory suggests that the probability of marital formation is influenced by various factors: preferences, the sex ratio, and the outside options (reservation utility level) which may influence the relative bargaining power and the intrahousehold allocation after marriage. However, it has been proved difficult to sort out these factors empirically. First, people migrate across areas for an economic opportunity, resulting in endogenous correlations between the sex ratio and the bargaining power. Moreover, it is difficult to detect or separate the effect of preferences in ethnicity and education from sex ratio, since people tend to live in an area stratified by preferences in ethnicity and education before marriage, making the influence of preferences confounded with the size of available mates.

In this paper, I address these issues using a unique event called "Hinoeuma," the year 1966 when the Japan's fertility dropped dramatically due to an old prejudice toward women. I examine the marriage market consequences of the prejudice and the small cohort size in Hinoeuma year using the sex difference as a natural experiment, since Hinoeuma men have never faced any prejudice. Using data grouped by prefecture and by birth cohort from the 1990-2000 Population Census of Japan, I estimate the marital matching function of single populations, controlling for prefecture-age specific fixed effect. I also use the initial birth cohort size in each prefecture multiplied by age dummies as instruments for single populations. The fixed effect estimation strategy eliminates all the age-specific, prefecture-specific marriage probability and allows us to isolate cohort effects in the estimated matching efficiency. The instrument variable (IV) strategy allows us to avoid a possible bias due to the definition of the cohort in the census and the endogeneity of unmarried population due to marriage and inter-prefecture migration.

The main findings are follows. First, surprisingly, the marital formation efficiency was unusually low for both sexes born in 1966, especially for men. Second, the Hinoeuma children were more likely to be the first child, and more likely to have attended national college, which on average has a better quality than private college in Japan. Third, using additional microdata, it is found that being the only child and attending colleges tend to discourage women from getting married. Although these findings seem contradictory and difficult to reconcile, I suggest that the most likely story is that Hinoeuma men suffered from their own superstition toward women in their cohort by losing substantial marriage possibility while Hinoeuma women did not face discrimination from the other cohorts. The Hinoeuma women may even have chosen not to get married soon because of the high quality college education allowed to them by the small cohort size, although there is some possibility that the likelihood for the Hinoeuma women to be the only child might force them to stay unmarried reluctantly. Overall the evidence suggests that the discrimination based on the prejudice toward Hinoeuma women unexpectedly created more loss of marriage opportunity to the discriminators than the discriminated. However, the interpretation proposed in this paper is far from conclusive since ideally it would require a far better microdata set than those used in the present paper. Rather, the main contribution is to document a possibility using the empirical matching function estimation that discrimination based on superstitions may lead to unexpected consequences in the marriage market in a way that perhaps has not been experienced in other countries.

This paper is built upon several theoretical and empirical studies on discrimination and marriage market. First, this paper has some relevance to experimental research that attempts to detect the existence of discrimination toward women or blacks (Goldin and Rouse, 2000; Bertrand and Mullainathan, 2004). In the present paper, the randomness of sex at birth gives a certain identifying restriction to the family background of the Hinoeuma children; the family background of boys and girls at birth are assumed to be the same. This is further discussed in this paper.

Second, by incorporating the effect of sex ratio by the demographic change, this paper is in the tradition of research of marital squeeze (Rao, 1993). In this literature, the trend in fertility rate generates imbalance in the sex ratio of desirable partners, and most empirical works focus on dowry payment as a way to reconcile the imbalance of sex ratio, particularly in the developing countries. However, this research program implicitly assumes that there is a stable preference in age-differences in the marriage market, and empirical studies typically specify a fixed age difference to calculate the relevant sex ratio.[1] In reality the relevant age difference may change if a change in the sex ratio makes finding a right mate in a specific age range difficult. Moreover, dowry is not common in most advanced countries, and the typical reconciliation of the sex ratio imbalance is the delayed or unrealized marriage, an acceptance of less preferred attributes of the partner (such

[1] Rao (1993) constructs the relevant sex ratio with men aged 20-29 and women aged 10-19.

as age difference), and the change in the intrahousehold allocation.[2] The effect of sex ratio on the probability of marriage can also be tested by dramatic historical events. In a highly related work to this paper, Angrist (2002) uses the differences in the size of second generation by ethnicity to estimate the effect of the sex ratio on the marriage probability and intrahousehold allocation. Compared to these works, the present paper uses data of age-specific marital formation to provide estimates of the effects of cohorts separately from the sex ratio, age preferences, and regional unobservable social pressure in the marriage market.

Third, emphasizing the effect of exogenous changes in cohort size, this paper is related to research on the cohort size and labor market outcome (Welch, 1979; Young, 2005). Usually, the effect of the fertility shock in a short period is difficult to detect. This paper provides a highly precise estimate of cohort effects on the marriage market outcomes using the census data and the disaggregated matching function.

Finally, this paper is related to the literature on the effects of superstition on the market outcome. Lee (2005) is perhaps the most related work in the spirit of this paper. He shows that Korean women born in the "Horse" year that comes every 12 years tend to get married less often than the other cohorts. And he estimates the causal relation between marriage and labor supply of women using the Horse year dummy as an instrument for marriage probability. However, Lee does not show whether the Horse effect can be statistically separated from other cohort effects. Further, his estimation does not show whether the Horse effect is unique to women compared to Horse men, which is the only way to prove that the existence of prejudice, not the cohort size, is driving the result. He does not mention how the cohort size of Horse year is different from the other cohorts in Korea.[3] The present paper separates the cohort size effect from discrimination by examining both men and women.

The rest of the paper is organized as follows. Section 2 provides concise background information of Hinoeuma and the trend of births in Japan. Section 3 explains the data set and the empirical strategy, and discusses the findings from the sample distributions of the marriage probability by cohort. The main data source is grouped data from the Population Census of Japan. Since the

[2] Grossbard-Shechtman and Granger (1998) examine the relation between the marital squeeze and the labor force participation of women in the U.S.

[3] Lee's paper has an advantage in that he uses large microdata to show the causality of marriage to labor force participation, which is not possible with the data in this paper.

available census data give us only "net" changes in the number of couples, it is necessary to make some decision on how to handle non-positive changes in the standard matching function framework. I try several methods to overcome this weakness. Section 4 presents the main empirical results, whether Hinoeuma did have an impact, with several robustness checks. Section 5 introduces additional data sets to draw hypotheses regarding channels through which the prejudice might have influenced the marriage market. Section 6 presents additional regression results to test these hypotheses using a micro data set, and proposes the most likely story to reconcile the seemingly conflicting results. Section 7 states a conclusion.

2 Background

According to the Chinese horoscope, Hinoeuma, or the Year of "Fiery-Horse," comes once every 60 years. The two recent Hinoeuma years were 1906 and 1966. It has been believed that a woman born in the Hinoeuma year cannot be a good wife since they are unable to control their temper. On the New Year Day of 1928, a story that two women who were born in 1906 threw themselves from the Tokyo pier, lamenting their misfortune of not being able to get married was covered in the national newspapers (Konno, 1961, p.305).

Figure 1 shows a change in the yearly total births over the past 103 years in Japan based on the Vital Statistics of Japan (VSJ, hereafter, Ministry of Health, Labor, and Welfare, Japanese Government). It is evident that there were unusual drops in the births in the two Hinoeuma years, 1906 and 1966. The births dropped by 7% in 1906, rose by 16% in 1907, dropped by 25% in 1966, and rose by 42% in 1967. Although there is always small fluctuation in the yearly births over time, the two Hinoeuma years stand out in terms of its magnitude. It is understood that a fear to have a baby girl discouraged couples from having a child in Hinoeuma years. It surprised people that the birth rate in 1966 dropped more sharply than in 1906 when most superstitions tended to disappear after the WWII.[4]

<**figure** 1 inserted here>

The maintained assumption in this paper is that the sex of birth was random during the sample

[4] The 1966 VSJ provides additional evidence that the sharp decline of births in 1966 occurred due to the prevalence of effective contraceptive devices.

period. Clearly there was no effective way to choose the sex of a baby in 1966. However, the randomness of birth does not mean that the recorded sex of births was random. The sex ratio of monthly birth counts from the VSJ (**Appendix figure 1**) suggests that the sex ratios at the marginal months of the year 1966 extremely deviate from the natural trend. It is also noticed that the drop and the hike around the margins are almost exactly in the same magnitude, suggesting that the sex ratio distortion was caused by the misrepresentation of birth month, not infanticide.[5] To give a rough estimate of its magnitude, the proportion of the misrepresentation in the year 1966 is approximately 1.2%= 5% (Dec.1965–Jan.1966)+10% (Dec.1966–Jan.1967)/12 months. If the misrepresentation of birth month were systematically correlated with the family background of the parents, it would create a potential bias in the estimates under the randomness of sex as an identifying assumption.

Keeping this caveat in mind, the low births in 1966 created a large variation in the cohort size for both men and women. This provides a setting for examining the effect of preferences toward a group of women controlling for the cohort size and the other cohort characteristics that are common to men and women.

3 Data and empirical strategy

3.1 The Data and Empirical Strategy

Every five years since 1990, the official publication of the Population Census of Japan (the Statistics Bureau, Japanese Government) has provided tables titled "Ages of Married Couples" that document the number of married couples disaggregated by the age combination of husband and wife and by prefecture. The format of the tables is reproduced in **table** 1. The age range documented is between 15 and 85 and over, making 47 x 71 x 71 prefecture-age-age cells for one census year. The ages of couples are recorded on the day of the census, October 1. Therefore, the census-age defines the "census birth cohorts" based on births from October 1 to September 30. These tables allow us to calculate the net changes in the number of married couples in each prefecture-census cohort (men)-census cohort (women) cell after the five-year interval. The Census also documents the

[5] This finding is not new. The 1966 VSJ already analyzed this issue by daily birth counts, and argued that approximately 2% of the fertility drop can be attributable to the misrepresentation of reported birth month. This issue was recently revisited by Rohlfs, Reed, and Yamada (2006) using the yearly data.

number of unmarried men and women by the census age and by prefecture. Then we can construct a transition probability from unmarried men and women to married couples at a five-year interval for each pair of census cohorts and each prefecture.

<**table** 1 inserted here>

The Census has an advantage in that it covers the whole Japanese population, allowing us to estimate the effects of Hinoeuma on marital formation with maximum precision. For example, in simple graphs of marriage rate from the 2000 Census (see **figure** 2), a slight drop of marriage rate at age 34, the Hinoeuma cohort, is already visible. However, the disadvantage of the Census is that its microdata is not available, and that the published data do not contain detailed information of family or educational background. Even if the sex of birth can be assumed as random, the choice of having a child in the Hinoeuma year or the educational investment by the parents are generally not random. There may be systematic differences in the family characteristics between the families who decided to have a child in 1966 and those who did not.

<**figure** 2 inserted here>

Therefore, I examine the effect of Hinoeuma in the following four steps. First, I closely examine the sample distributions of marriage probability by cohort combination. Second, the grouped data from the census tables are used to separately estimate the effects of preferences and cohort size in the marital matching. At this stage, the randomness of sex at birth is used to isolate the discrimination toward Hinoeuma women relative to Hinoeuma men controlling for the cohort size effect (marriage squeeze) and the family background *within* the cohort. It is important to stress that this strategy allows us to test the existence of prejudice in a gross term; it does not control for any differences in the family background *across* cohorts, or differences in the educational investment within the cohort. Failing to find a sex difference in Hinoeuma children may mean either that prejudice disappeared from preferences or that the prejudice was cancelled out with other forces.

Third, other aggregate data sets are examined to draw alternative hypotheses regarding the channels through which Hinoeuma superstition might have an impact on the marriage market. I focus on educational achievement, labor market conditions, and the birth order of Hinoeuma children. Finally, a small set of microdata with rich information of family and educational background is used to test these hypotheses. These additional data sets are explained as they come under examination.

3.2 Distribution of Marriage Probability by Cohort Combination

Figure 3 shows, for each sex, the national level distribution of marriage rate of each birth cohort on the husband-wife age difference constructed using cubic spline curves from the 1995 and 2000 Census data.

<**figure** 3 inserted here>

By looking at the marriage distribution in 1995 for each male cohort (**Figure 3.a**), it is found that the marriage rate of men to Hinoeuma women born in 1966 are lower than what can be predicted from the average age preferences in the marriage market. This deviation can be clearly seen at least male cohorts born in 1964-66. There are also some indications that the Hinoeuma women are substituted for women born in 1965 or 1967 in the marriage market. The distribution from 2000 Census shows a similar pattern.

By looking at the age difference patterns of marriage of women (**Figure 3.b**), a couple of surprising facts are observed.

First, the marriage rate of Hinoeuma women to the men in the same cohort appears to be lower than the predicted levels based on the average age preferences. However, a lower marriage rate does not mean that there is discrimination, since the cohort size of Hinoeuma men and women are significantly smaller than the other cohorts. Part of the reasons of the lower marriage rate should be attributable to the small cohort size of Hinoeuma children.

Second, the marriage rate of Hinoeuma women to the *other* cohorts of men does not appear to be lower than the predicted levels. The marriage rate to the other cohorts, especially to the men born in 1965 and in 1967 may be even higher than the predicted probabilities. This observation suggests the two possibilities: the Hinoeuma superstition remained only among Hinoeuma men or the Hinoeuma women were helped by the small cohort size to increase the marriage probability and to cancel out the negative effect of the discriminating preferences from all the male cohorts.

Third, the marriage rate to Hinoeuma men is lower not only among Hinoeuma women but also among the women in the other cohorts. This is, for instance, clearly observed for women born in

1967 and in 1968. Again, the small size of Hinoeuma men obviously contributes to the low marriage rate of women to the Hinoeuma men.

It is not possible to sort out the competing reasons by just looking at the distributions. This is why one needs to estimate the effects of cohort size in order to evaluate the degree of prejudice.

4 Estimation of Marital Matching Formation

4.1 Specification issues

I investigate whether a specific birth cohort, Hinoeuma, has any effect on the probability of marital formation. A difficulty is that the effect of Hinoeuma could be easily confounded with the fluctuation associated with cohorts. I address this difficulty by estimating the cohort effects using disaggregated data by 46 prefectures and by the cohort combination of couples.[6]

The empirical strategy I employ is a standard matching function (Petrongolo and Pissarides, 2001). Let us assume a Cobb-Douglas function that transforms available single men and women into couples. Then, the matching efficiency is measured as the residuals. If we control for birth cohorts by dummies, their coefficients estimates show the relative matching efficiency between the cohorts. If there is a significant drop in the coefficient on the Hinoeuma cohort only for women, we cannot reject the existence of the prejudice toward Hinoeuma women.

Let i represent the husband's birth year, j represent the wife's birth year, k represent the prefecture where the couple lives, and t represent the census year. Then $\log(\Delta C_{ijkt})$ is the log of the net changes in the number of couples with husband cohort i, wife's cohort j, in prefecture k in year t. $\log M_{ikt-5}$ is the log of the number of single men of cohort i in prefecture k in year $t-5$ (previous census year), and $\log W_{ikt-5}$ is defined similarly for women. The marital matching function can be written as follows:

$$\log(\Delta C_{ijkt}) = \alpha_{ij} + \beta_1 \cdot \log M_{ikt-5} + \beta_2 \cdot \log W_{ikt-5} + \lambda_{k(t-i)(t-j)} + \varepsilon_{ijkt}, \tag{1}$$

where α_{ij} is the efficiency factor constant across prefectures and ages, β_1 and β_2 are Cobb-Douglas coefficients interpreted as matching elasticities, $\lambda_{k(t-i)(t-j)}$ is the fixed effect for prefecture k, the

[6]Since the data for Okinawa prefecture before 1973 are not available, it is excluded from the analysis.

husband's age $t-i$, and the wife's age $t-j$, and ε_{ijkt} is the error term. The fixed effect is intended to capture any local social norms about the age of marriage for men and women, and their age differences. For example, a social norm that women must get married before turning 30 may be strong in some prefectures, and the norm that women should not get married to much younger men may be weaker in other prefectures. Another benefit of having the age fixed effect is that we can eliminate the possibility that a cohort effect picks up a particular age effect on marriage due to the sparseness of the census data. α_{ij} is the factor that captures the efficiency of marital formation within prefecture-age-age cells. One cell consists of data of one or two cohorts, so one prefecture-age-age cell can identify the relative matching efficiency of two consecutive cohorts. By having the cohort dummies of the husband or the wife and the prefecture-age-age fixed effects, the elasticity parameters are essentially identified by the variation in the size of the net marriages across the cohorts of the spouse.[7]

There are a couple of other caveats about applying this model to the Census data. First, the birth cohort is measured with errors since a census age cohort includes only three fourths of the calendar year birth cohort. Second, due to inter-prefecture migration and deaths, the numbers of single men and women lagged five-year do not necessarily provide accurate measures of population at risk of net changes in marriage. Single population is also endogenous because an increase of marriage leads to a decrease of singles. Finally, the net change in the number of married couples can be negative, due to migration, deaths, and divorce.

In order to address the first two issues, I employ an instrumental variable estimation strategy. The instruments used are the birth cohort size by prefecture and by sex, taken from the VSJ interacted by age dummies. It is found that there is a very strong correlation between the initial birth cohort size and the number of single men and women at each prefecture, controlling for age.[8]

A real difficulty comes from that we have only a measure of net marital formation. First, in order to estimate the matching function, all the potential mates must be included in the right hand side. It is known that not including all the potential partners would generate bias in the estimation of the matching elasticities.[9] However, one may not want to include the middle- to old- age population

[7] In principle, we can include both husband's and wife's cohort dummies. However, doing so would make the estimation highly unstable, and is avoided in this version of the paper.

[8] The first stage results to be included if necessary.

[9] Berman (1997) notes that ignoring the on-the-job search in estimating the matching function of unemployed workers and vacancies using aggregate data would bias the matching elasticities. See also Petrongolo and Pissarides

since divorce and death tend to have a large negative effect on net marriage formation. Second, divorce and death may generate not only bias in the estimation, but also a "negative" net marriage formation. The Cobb-Douglas specification does not allow negative values. In fact, the negative net marital formation can easily happen since in reality, divorce is more frequent than new marriage when couples get older or the wife is much older than the husband.

These two issues are related to each other. For example, although couples with 20 years of age gap are rare (e.g., husband and wife are 36 and 16, respectively), it is still desirable to include all the available data in the estimation to avoid bias due to missing population at risk. However, these "rare couples" are also at a higher risk of divorce or the death of a partner, and therefore, are likely to end up as natural missing values in the matching function. Since I am interested in estimating the matching function in Cobb-Douglas form, if the negative changes are ignored, we would lose 30% of the observations for couples aged no more than 45.

There is no obvious way to solve this non-positivity problem.[10] One simple way to handle this is to fill the non-positive changes by an arbitrary constant, such as unity. This is called "Imputation 1" in this paper. However, this manipulation modifies the variation in marital formation across cohorts. For example, let the net change of couples for a pair of ages, a and b, in year t be $\Delta\tilde{C}_{abt}$, suppressing the prefecture index. Note that the variation in $\Delta\tilde{C}_{abt}$ when a and b are fixed is created by cohort differences. Then suppose $(\Delta\tilde{C}_{ab1995}, \Delta\tilde{C}_{ab2000}) = (-10, 2)$. Then Imputation 1 would make the pair to $(1, 2)$, changing the effect of cohorts. At the same time, this manipulation would make the overall marriage rate higher, and modify the estimates of the matching elasticities in an unpredictable way. It all depends on how the variations across ages of spouse would be affected.

There is another method, called "Imputation 2" in this paper, which maintains the variation across cohorts but still eliminates the non-positive values. Since the interest is the effect of the cross-cohort variation within prefecture-ages cells, I will artificially make all the net marital formation positive by adding a value constant within a prefecture-age-age cell. Specifically, if $(\Delta\tilde{C}_{ij1995}, \Delta\tilde{C}_{ij2000}) = (-10, 2)$, the constant value 11 is added to make the pair $(1, 13)$. Note that this manipulation would not make the overall marriage rate higher if the fixed effect is eliminated.

(2001).

[10] I am not aware of any estimation methods that handle this type of selection with endogenous regressors in the panel data.

This imputation would keep its side effect on the within-cell variation minimum,[11] and still the results will give us information about the within-cell cohort effect — our primary interest. I compare the results with the two types of imputations with the results dropping all the non-positive net marriage to see how the handling of negativity of the net marriage formation can affect our estimation of cohort effects.

<**table** 2 inserted here>

Table 2 shows the cohorts and census years used in the empirical analysis after considering several issues discussed above. I limit the sample age to 15 through 45. This means that we have 26 x 26 cells for each measure of new marriage in each five-year interval. I also run the estimation by extending the age restriction to 48 to see the robustness of the estimates.[12]

4.2 Estimation results

4.2.1 Matching elasticities

Table 3 reports the estimates of β_1 and β_2, the elasticities of marital formation to the numbers of single men and women under the variety of controls and sample restrictions. Overall, the parameters are estimated with high precision. Rows 1 and 2 show the estimates with the simple ordinary least square (OLS) and the prefecture-age-age fixed effect model using data with only positive net marital formation. The sum of the estimated elasticities under the fixed effect model is almost equal to one, suggesting the constant return to scale in the marital matching technology. The elasticities are little changed when the wife's cohort effects are added and the age restriction is imposed in row 3. When the estimation is done by the IV method (row 4), the values of elasticities become slightly higher, suggesting that the endogeneity of single population have generated a downward bias in the estimates. When the husband's cohort is controlled, the elasticity to the single men becomes larger, somewhat strangely (row 6).

<**table** 3 inserted here>

[11] The effect of added constant cannot be eliminated by the prefecture-age-age fixed effect since all the variables are logged before running regression. For Imputation2 to be valid, we need to assume that divorce and death probability is constant across cohorts within prefecture-age-age cells, and the effect of log transformation after adding constant to make all the numbers positive is negligible relative to the effects due to increasing the number of observations in the estimation.

[12] This is the maximum age to which we can obtain reliable birth count data from the VSJ.

When the non-positive values are imputed by unity (row 7, Imputation 1), the values of elasticity become higher. When the non-positive values are imputed by a minimum constant value to eliminate missing values (row 8, Imputation 2), the estimates become very close to the case of no imputation (row 4), suggesting that Imputation 2 is a reasonable way to make use of non-positive values without generating a substantial bias. However, the standard error in row 7 is larger than that in row 4. This means that making use of non-positive values does not add much information to the elasticity estimates. This is clearly because, as I argued before, the variation in net marital function in the non-positive domain is created predominantly by divorce and death rather than by marriage — the reasons that are not relevant to the number of single populations. Therefore, the estimates in row 4 and 6 with no imputation can be considered the best method.

4.2.2 Cohort effects

Figure 4 shows the estimates of cohort effects for men and women measured in the matching efficiency normalized at year 1958 under several specifications. Similarly to what we see in **table** 3, the choice of OLS and IV or the choice of cut-off age level does not dramatically change the overall trend of cohort effects. The strong downward trends for both men and women confirm a recent decline in marriage rate in Japan. It is perhaps surprising that the downward trend is stronger for men than for women, especially for older cohorts.

It is also observed that there is a strong, isolated one-year decline in the matching efficiency for men born in 1966, the Hinoeuma year. Such one-year decline can also be detected for Hinoeuma women, but less significantly. For women, a sharp rise of cohort effect in 1967 stands out more than the decline in 1966. There also appears to be a small rise in the matching efficiency in 1965.

<**figure**s 4-5 inserted here>

To determine how distinct each cohort effect is, I perform a formal statistical test. **Figure** 5 shows the log p-value for the test of equality of pair-wise cohort effects after the linear cohort effect is detrended. This is essentially a test of equality of the two consecutive cohort dummies with the cohort linear variable controlled. The results show that the equality of dummies in 1965 and 1966, the equality of dummies in 1966 and in 1967 under are all rejected for men, and two out of four cases are rejected for women. For the other 13 years, the (possibly wrong) rejection occurs only three times for men and women, respectively, and 5 rejections out of 6 cases occur at the two end years, 1959 and 73, where the linear cohort effect may not be sufficient to trace the long-term trend. Therefore, 1966 is the single isolated year that unusually deviates from the trend of cohort effects on the marital formation efficiency. And this deviation is more pronounced for men than for women.

<**figure**s 6-7 inserted here>

In order to see how the handling of non-positive values may affect the statistical test results, **figure** 6 presents the estimated cohort effects under different imputation methods. **Figure** 7, constructed similarly to **figure** 5, shows that log p-values that correspond to the estimates in **figure** 6. **Figure** 6 shows that qualitative nature of trends and the effect of Hinoeuma does not change by imputations, although after the imputations, the trends for women and men become closer and steeper. Moreover, there is more volatility in the trends when the non-positive values are imputed, suggesting that the estimates become imprecise, as we see in **table** 3. This is confirmed by **figure** 7. Now, 5 out of 6 test statistics for men born in 1965 and 1966 are rejected to be equal, and only 2 out of 6 test statistics suggest the rejection for women. On the other hand, still only 4 out of 39 (=13 years x 3 methods) cases outside of Hinoeuma year lead to the rejection of equality for men, and only 2 out of 39 lead to the rejection for women. Again, 4 out of 5 (wrong) rejections occur at the two end years. Therefore, although statistically less robust, the imputation of non-positive values does not alter the overall results found in **figure** 4.

4.3 Reconciling the estimation results to alternative hypotheses

How can we reconcile the empirical results and the hypotheses from the distributions?

Let us start with a hypothesis that the Hinoeuma prejudice existed among all the male cohorts. This assumption may explain why the efficiency in marriage dropped for women born in 1966. However, it immediately faces the contradiction to the estimation results that only 1966 men had a lower efficiency. If there were discriminating preferences among men in 1965 or 1964, we would have to observe a similar drop of efficiency in these cohort effects. Although one can still reconcile this by assuming that the other cohorts are better than the Hinoeuma men at substituting Hinoeuma women for the other female cohorts, there is no good reason to believe it. The evidence from the distributions also contradicts this hypothesis. For example, men born in 1965 would have almost as much possibility to have a lower marriage rate by avoiding the Hinoeuma women. However, **figure 3(b)** suggests that the marriage rate of Hinoeuma women to 1965 men (1-year age difference) did not seem to be affected.[13]

Another hypothesis to reconcile is that the prejudice survived only among the Hinoeuma men. Perhaps, the Hinoeuma men were exposed to the superstitions more than any other cohorts since they are born in the same year. Then, the drop of estimated marital formation efficiency for Hinoeuma men is explained solely by the preferences. Under this hypothesis, it is interpreted that the discrimination resulted in the marital matching efficiency loss to both Hinoeuma men and women. By avoiding the Hinoeuma women, Hinoeuma men might have lost a chance to get married more than any other cohorts in equilibrium. This hypothesis is also consistent with the facts that the estimated efficiencies are slightly higher for female cohorts in 1965 and especially in 1967, suggesting the substitution behavior of male cohort in 1966. Facing a more severe competition for 1967 women, 1968 women 1968 might also have faced an increased demand.

In order to accept this hypothesis, one needs to additionally assume that substituting Hinoeuma women for the other female cohorts in the marriage market was extremely difficult for Hinoeuma men. Since the median age difference is approximately 2.0 among married couples, there should be enough possibility for Hinoeuma men to get married while avoiding women in the same cohort. However, the estimation results suggest that the loss of matching efficiency for Hinoeuma men was even larger than the loss for Hinoeuma women. It is not easy to accept that substituting the cohorts with a preferred age difference for the other cohorts was more difficult for Hinoeuma men who did not face any prejudice than for Hinoeuma women who faced some prejudice.

A third hypothesis to reconcile them is that Hinoeuma men and women are different in important ways from the other cohorts. This hypothesis suggests that some other forces than the prejudice should have made the marriage rate for both men and women born in 1966 unusually low, especially for men. In the next section, whether the Hinoeuma men and women had common distinct characteristics that can explain the drop of marriage rate.

[13] Even if, as we discussed in section 3.2, most of the discrimination toward Hinoeuma women were cancelled out by the smallness of the *female* Hinoeuma cohort, the same smallness of the *male* Hinoeuma cohort should contribute to increase the probability for Hinoeuma men to get married. However, the distribution for men does not show any sign of benefits of small cohort for Hinoeuma men. Therefore, it is difficult to believe that the smallness of the cohort size had a substantial effect to cancel out a strong prejudice among the men of all the cohorts.

5 Interpreting the Results using Background Information of Hinoeuma Children

Given the empirical results using the Census data in the previous section, I explore possible reasons that have made the marital efficiency for Hinoeuma women not to drop more than that of Hinoeuma men. Using additional data sets, I characterize the family background, educational background, and the labor market opportunity of Hinoeuma children.

5.1 Educational opportunity

The fact that the size of cohort born in Hinoeuma year is significantly smaller than the other years suggests that they might have received longer and better education than other cohorts. There are a couple of reasons for this speculation. First, the capacity of college programs, especially those at national and local public institutions, has been tightly regulated (Akabayashi, 2006). Since most of national/public institutions provide a way better quality of education than the average of private institutions in Japan (Akabayashi and Naoi, 2005), the smallness of the cohort size might have increased the probability that they receive a better education. Furthermore, there might be reasons for the parents of Hinoeuma children to invest them more than children in other cohorts. This point is discussed in **section 5.3** again.

I first explore this possibility using the government data sets on education. The School Basic Survey (SBS hereafter, Ministry of Education) records the number of all school children enrolled, entered, and graduated by all types of schools and prefectures; namely, it records the *entire universe* of children in Japan. **Figure** 8 shows the proportion of four-year college enrollments among the (mandatory) junior high school graduates by academic year cohort defined by births between April 1 and March 31. College enrollment are defined in three ways: the rate of immediate college entrants after high school graduation, the rate of college entrants after 2 years of graduation, and the rate after 4 years of graduation.[14] From the figure, it is difficult to detect any special change at Hinoeuma year.

<**figure**s 8-9 inserted here>

[14] Since the data categories are defined as the "immediate entrants," "entrants after one year," "after two years," "after three years," "after four years and beyond," I added only a half of the number in the last category. The results are little influenced by this calculation.

Figure 9 shows the proportion of national college enrollments, in the same three definitions, among the junior high school graduates. These graphs reveal a more distinct difference between the Hinoeuma children and the other cohorts; the Hinoeuma children were more likely to go to national college than the other cohorts. The fact that we barely find such a difference in **figure** 8 suggests that the overall four-year enrollment rate is determined not by the capacity but rather by the individual choice. It is understandable since the marginal 4-year colleges students go to private college where the capacity constraint is less likely to bind because of higher tuition and more flexible enrollment policy than national colleges.

Figure 10 confirms the findings from **figure**s 8-9 in cross-section data. They plot changes in four-year college and the national four-year college enrollment rate, respectively, against the fertility change in the Hinoeuma year for 46 prefectures.[15] It is difficult to find any correlation between the fertility and the four-year college enrollment (the slope is not significantly different from zero) but it is *not* difficult between the fertility and the national college enrollment (the slope is significantly differently from zero).

<**figure**s 10 inserted here>

Both time series and cross-section data consistently suggest that Hinoeuma children had a higher chance to enter national four-year college than the other cohorts. If this is true for the marginal students who enter national college, it is likely to be true that the education quality received by the Hinoeuma children were better *at any ability level*, since the Japanese higher education market is highly stratified at the initial enrolment by the entrance exam score.

In the end, a hypothesis that can be proposed here is that Hinoeuma children on average chose to delay their marriage because their educational credentials allowed to pursue a better job career than the other cohorts for both men and women.

5.2 Labor market opportunity

Holding the education level constant, the Hinoeuma children might enjoy higher earnings and job opportunities than other cohorts because of its small cohort size in the labor market. (Welch 1979).

[15] Prefectural data on the college enrollment rate by the type of institution is available only as a "gross" rate, which is defined by the number of all the entrants, including the *past* ronin students, divided by the junior high school graduates 3 years before.

Moreover, it is also possible that female children born in the Hinoeuma year may have invested in unobserved labor market skills more than other cohorts, since they might expect less marriage market opportunity. Both factors would contribute to lower marriage rate of Hinoeuma children without any prejudice. It should be observed as a higher employment opportunity after controlling for observable educational achievement. [16]

The most crucial point, whether they had a higher job opportunity, can be seen from the SBS-school graduate section. Every year, *all* the new college graduates must file their post-graduate destination to the college office. The vast majority of college-graduates are not married at the time of graduation and the initial job placement tends to have a lasting impact to their life-long employment prospects due to the lifetime employment system (Hart and Kawasaki, 2000). Therefore, the trend in the employment probability at college graduation will give us, among the available data sets, perhaps the most accurate picture of their employment opportunity before the contamination from marriage occurs.[17]

Figure 11 presents the trends in the proportion of the college graduates who are immediately employed or advanced to graduate school to the number of the graduates by the types of institutions. The graphs show a strong upward trend over the cohorts born in 1954-68 (graduating in 1977-91), reflecting the economic boom before Japan entered a long recessions. The upward trend appears stronger for female than for male, and it also helped to narrow a gap in employment opportunity between national, public, and private institutions that existed for women. Most importantly, it is not possible to detect a specific effect by the Hinoeuma year in graduates from any types of colleges. It may not be surprising since at least the enrollment capacity at national and public colleges tend to fixed and the supply graduates did not fall short.

<**figure** 11 inserted here>

The message from this examination is that for each education level, there is no evidence that

[16] Lee (2005) shows that the marital behavior and labor market behavior are likely to be determined jointly. He uses the Horse year dummy as an instrument for marriage probability and finds a large effect of marriage on the labor market participation, assuming the Horse effect is orthogonal to the propensity to work after controlling for education. However, the Horse year may have a direct effect to the labor market behavior at least through the prior choice of unobserved investment into labor market skills. If so, the effect of marriage on the labor market participation estimated by IV may be overestimated.

[17] Of course, the existence of "ronin" who enter college after several years of graduation, complicates the correspondence between birth cohorts and college graduation cohorts.

labor market condition was favorable to the Hinoeuma children enough to explain why marriage rate fell among both Hinoeuma men and women.

5.3 Family and social background

Differences in family and social background within and across cohorts can make distinct influence to the Hinoeuma men and women. First, the Hinoeuma children might be born in regions systematically different from the other regions. Second, controlling for the region, the parents who decided to have a child in Hinoeuma year may be different from the parents who avoided it. Finally, as already mentioned, even if there is no a priori difference between families with girls and boys born in Hinoeuma year, the parents who had a Hinoeuma girl may invest unobservable skills to their daughter.

First, I exploit regional differences in the fertility changes in Hinoeuma year to investigate the influence of social background. **Appendix Figure** 2 maps the average change in births before and after the Hinoeuma year in prefectures. There appears to be a large regional variation as well as spatial correlations in the size of the fertility drop in 1966; the fertility drop appears to be large in the Kanto region except Tokyo and Kanagawa, Kii-Peninsula (south of Osaka), Shikoku (smallest island), and the Eastern Kyushu.

In search for any measures correlated to the Hinoeuma effect, I ran a set of simple cross-sectional regressions of the change in births on alternative socioeconomic indicators: the share of primary industry (agriculture, fishery, forestry, and mining) among working men in 1965, the average employee income in 1966, the female education level in 1955, and the abortion rate in 1955. The results are summarized in **table** 4. The only factor that significantly affects the ratio of 1965 births to 1966 is the employee income, negatively.[18] However, the employee income is not significant for the ratio of 1967 to 1966. The primary industry ratio does not have a systematic effect. The education of women measured by the high school entrance rate in 1955 shows a weakly negative correlation to the fertility change in the expected direction. In fact, if the region dummies are controlled, the effect of female education becomes significant within a region. The abortion rate, which is likely to be correlated with the availability of abortion clinics, does not have any

[18] Rohlfs, Reed, and Yamada (2006) reaches a similar results using a more systematic method.

systematic effect.[19] Therefore, although it is possible that the effect of the superstition on the births is correlated to the income level and underlying education level at each prefecture, it is perhaps more regional and cultural phenomena, as is suggested by **Appendix figure** 2.

<**table** 4 inserted here>

Second, I revisit to VSJ data in order to characterize the family background of Hinoeuma children. Unfortunately, the mothers' education is not available in the data. Instead, the distribution of the age of mothers who gave birth is available each year. However, my tabulation did not show any significant difference in the mother's age between Hinoeuma year and the other two years (1965 and 1967) (figures omitted). Second, I looked into the distribution of the birth order of the Hinoeuma children. Here a distinctive characteristic is found. The proportion of the first child among all the births is strikingly higher in Hinoeuma year, and it is still historically the highest rate *to date*. This should be amazing given that the total fertility rate in Japan today is nearly 1 while it was 2 on average in the 1960s. **Figure 12** shows that the trend in the first child ratio along with the national college enrollment ratio (four years later after high school graduation) reproduced from **figure 8**. It shows, on the time series basis, that the rises of first child ratio and the national college enrollment ratio of 1966 cohort stand out in otherwise very stable trends. Since the first child is also likely to be the only child of the parents,[20] the Hinoeuma children may have received more attention and educational investment from parents than other cohorts (Becker and Lewis, 1973). And this might contributed to a higher national college enrollment in addition to the relaxed capacity constraint. Unfortunately, the time-series observation cannot give us more than a speculation.

<**figure** 12 inserted here>

On the other hand, it is increasingly argued in the media that an only child, especially a son, tends to face a difficulty in finding a spouse since the women in young generations are increasingly reluctant to bear a burden of taking care of elderly parents-in-law. If this is true, being the first

[19] Clearly, the actual abortions are an outcome of several factors such as social acceptance, teen pregnancy rate, school attendance rate, in addition to the availability of abortion clinics. Further, I do not find any statistics on the prevalence of inexpensive contraceptive devices such as condoms, which should also affect the degree of fertility drop due to the superstition.

[20] Adoption has been extremely limited in Japan after WWII.

child may have a direct effect to lower the probability of getting married. Since the time-series data has no say about it, I employ a microdata set to separate the two effects.

6 Some Evidence from Microdata

In this section, an attempt is made to narrow down alternative hypotheses proposed in the preceding section using a microdata set. Given its modest sample size, the analyses in this section are necessarily exploratory, not conclusive, in nature. Nonetheless, the results will highlight some likely channels through which the Hinoeuma superstition has influenced their marriage probability and the role played by their educational achievement and family background, which cannot be sort out by the aggregate or grouped data.

The Japanese General Social Survey (JGSS) is a national representative cross-section survey of men and women aged above 20 that started in 2000. The JGSS has collected extensive information of the social and family background of the sample individuals, and despite its modest sample size, it is perhaps the best individual survey publicly available in Japan.[21] For the purpose of this paper, the two most important characteristics of this data are that it has questions on the types of higher institution attended, and that the distribution of marital status reasonably fits that from the 2000 Census data.[22] However, it is still not large enough to estimate each birth cohort effect precisely. Therefore, focus is placed on the overall effects of the number of siblings, the birth order, and the educational background on the marriage probability in order to test the hypotheses developed in the previous section.

The sample is constructed by pooling the JGSS data from 2000 to 2002 and restricting the data to those with valid entries and who were born between 1964 and 1982 to match the Census sample. The resulting sample size is 2,044. The three dependent variables are examined. First, whether the attendance of 4-year national college, a question only available in 2002, influences the marriage probability is estimated. Second, the effect of general 4-year college on the marriage probability

[21] The JGSS original sample size is 2,898 in 2000, 2,790 in 2001, and 2,953 in 2002.

[22] The other publicly available data sets have several shortcomings in these regards. The Japanese Panel Survey of Consumers (1993–, The Institute for Research on Household Economics) is a survey only for young women, therefore there is no way to look at the difference between men and women. The National Family Research of Japan (1998–, Japan Society of Family Sociology) are cross-section data in 1998 and 2003, but their marital status distribution among women in the 30s is known to be highly biased. These two data sets do not have a variable of the type of college they attended, either.

is estimated using the 2000-02 data. Finally, the determinants of the college attendance and the 4-tyear national college attendance are estimated. The key independent variables are whether the respondent was the first child, whether the respondent was the only child, whether the respondent attended some college, and whether the father of the respondent attended some college. All the estimations use the probit method for both sexes separately, and include age, age squared, and dummies for years of survey as additional controls when appropriate.

<**table** 5 inserted here>

The results are presented in **table** 5. Contrary to what is widely argued, columns 1 and 2 suggest that being the only child or being the first child of parents does not significantly decrease the probability of getting married for men. The effect of being the only child is more systematically negative for women (columns 5 and 6). Having attended 4-year college or 4-year national college tends to lower the probability of getting married, but these effects are large and significant only for women. Finally, from columns 3, 4, 7, and 8, being the first child or being the only child does not significantly affect the probability to attend college or national college. Therefore, our hypothesis of quality-quantity trade-off for the Hinoeuma children is rejected.[23] On the other hand, having an educated father tends to increase the probability to go to college for both men and women.

Therefore, the hypothesis that attending national college lowered the marriage probability among Hinoeuma children seems consistent with the microdata only for women. Although the small sample size may be the primary reason for not finding the significant result for men, the size of the coefficient estimates of education (columns 1 and 2) seems too small relative to those for women (columns 5 and 6) to explain the findings in the matching function. A better career possibility by graduating national college is likely to have given Hinoeuma women an additional reason for not getting married soon by choice.

This insignificant result on the effect of being only child for men rejects the hypotheses that caring elderly parents discourages women to get married to Hinoeuma man. However, the same hypotheses cannot be rejected for women, although such possibility is not widely discussed.[24]

[23] For the older cohorts in JGSS, being the first child has a statistically significant negative effect on the probability of attending 4-year college for both men and women (table omitted). Such a birth order effect seems to have disappeared for younger cohorts including Hinoeuma children.

[24] The social pressure of caring elderly parents is excessively strong to female children in Japan. Therefore, if a female child is the only child, it is possible that the parents do not strongly encourage her marriage, which may force her to put a high priority on her parents-in-law.

Since the sex is random at birth, if other things are equal, these findings tend to predict that Hinoeuma women have a lower marriage rate than Hinoeuma men, contrary to the results from the matching function estimates. Therefore, the available evidence of education opportunity and family background of Hinoeuma children makes the estimation results in section 4 more puzzling.

The fact that I do not find a strong quality-quantity trade-off for college attendance (columns 3 and 7) is consistent with the aggregate data that indicate that college attendance rate was not affected by the Hinoeuma fertility drop. The microdata evidence for national college attendance (columns 4 and 8) does not contradict a rise in the national college attendance rate for Hinoeuma children since the small cohort size can explain it fully. Therefore, the small cohort size, not the family environment, seems to be the strongest reason for the Hinoeuma children to attend national college, although we still need to have detailed information of parental education of Hinoeuma children.

Therefore, the only story that is consistent with most of the evidence is that the Hinoeuma men experienced a significantly low marriage rate because of their own discriminatory preferences. Although there is a possibility that Hinoeuma women also lost some marriage opportunity from the Hinoeuma men, **figure 3** suggests that it is unlikely that they faced as much discrimination from the other male cohorts. Based on this hypothesis, it was primarily Hinoeuma men, not the Hinoeuma women, who lost the opportunity of getting married by the superstition. The only possible reason of a low marriage prospect for Hinoeuma women that may not be favorable is that they tend to be the only child of the parents.

This story is not free from shortcomings since it does not explain why Hinoeuma women are better at substituting the ages of the spouse than Hinoeuma men. Further, the available evidence does not completely rule out the other possibilities such as an influence of other unobserved differences in the family background and investment. Without a large, unified microdata set with richer information on the family background, it is currently difficult to further quantify the contribution of these factors that might have influenced the marriage market behavior of Hinoeuma children.

7 Conclusion

In this paper, the marriage market consequences of the prejudice and the small cohort size are examined using the sex difference in children born in Hinoeuma year as a natural experiment, since Hinoeuma men have never faced any prejudice while the small cohort size affected both men and women. Using the data from Japanese Population Census, I estimate the marital matching function of single populations disaggregated by prefecture and by cohorts controlling for prefecture-age specific unobservable fixed effect on the marriage probability. It is found that the marriage formation probability is unusually low for the Hinoeuma cohort, especially for men. I do not find evidence that the labor market opportunity was favorable to Hinoeuma children, but I find some evidence that they received a higher quality of education than the other cohorts. I also find that Hinoeuma children are more likely to be the first child of the parents. Finally, I analyze additional microdata to see how the birth order might have affected the later outcomes of children, and find that attending college and being the only child tend to lower the marriage rate for women but not for men. Based on the available evidence, the only possible reason for the low marriage rate for Hinoeuma men is that they suffered from their own discrimination toward women in their own cohort and their loss of marriage opportunity. This story suggests that Hinoeuma men are perhaps the only cohort who lost by the superstition in the marriage market despite a favorable cohort size for them in education and marriage markets.

This interpretation echoes the original theory of discrimination by Becker (1971). In his theory, firms that discriminate minority workers fail to maximize the profit and tend to be driven out from the market in the long run. Based on the interpretation in this paper, the Hinoeuma men did not maximize the chance to get married because of the prejudice. Of course, since discrimination and prejudice are embodied in preferences, the welfare consequences of the Hinoeuma superstition cannot be evaluated in the same way as the original theory for firms.

The findings and interpretations presented in this paper are far from conclusive. Whether the favorite story in this paper is sufficient for explaining a decline in marriage rate for both Hinoeuma men and women still remains to be more fully examined. A more important contribution of this paper is as the first step using the empirical matching function to sort out discrimination from the market forces and family background in the marriage market where these forces tend to interplay in a complex way.

References

[1] Akabayashi, Hideo. 2006. "Private Universities and Government Policy in Japan." *International Higher Education*. 42(Winter): 17-19.

[2] Akabayashi, Hideo, and Naoi Michio. 2005. "Why is there no Harvard among Japanese private universities?" manuscript.

[3] Angrist, Josh. 2002. "How Do Sex Ratios Affect Marriage and Labor Markets? Evidence from America's Second Generation." *Quarterly Journal of Economics*. 997-1038.

[4] Becker, Gary. 1971. *The Economics of Discrimination*. 2nd ed. Chicago: University of Chicago Press.

[5] Becker, Gary, and H. G. Lewis. 1973. "On the Interaction between the Quantity and Quality of Children." *Journal of Political Economy.* 81(2) part 2: S279-S288.

[6] Berman, Eli. 1997. "Help Wanted, Job Needed: Estimates of a Matching Function from Employment Service Data." *Journal of Labor Economics*. 15: S251–S292.

[7] Bertrand, Marianne, and Sendhil Mullainathan. 2004. "Are Emily and Greg More Employable than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination." *American Economic Review*. 94(4): 991-1013.

[8] Carus, Paul. 1992. *Chinese Astrology: Early Chinese Occultism*. Selanger Darul Ehsan, Malaysia: Pelanduk Publications.

[9] Goldin, Claudia, and Cecilia Rouse. 2000. "Orchestrating Impartiality: The Impact of 'Blind' Auditions on Female Musicians." *American Economic Review*. 90(4): 715-41.

[10] Grossbard-Shechtman, Shoshana and Clive W.J. Granger. 1998 "Women's Jobs and Marriage—Baby-Boom versus Baby-Bust. *Population*, 53(September): 731-52 (in French).

[11] Hart, Robert A. and Seiichi Kawasaki 1999. *Work and Pay in Japan.* Cambridge University Press.

[12] Konno, Ensuke. 1961. *Gendai no Meishin* ("Modern Superstitions"). Tokyo: Shakai Shisosha (In Japanese).

[13] Lee, Jungmin, 2005. "Marriage, Female Labor Supply, and Asian Zodiacs." *Economics Letters*, 87(3): 427-32.

[14] Petrongolo, Barbara, and Christopher A. Pissarides. 2001. "Looking into the Black Box: A Survey of the Matching Function." *Journal of Economic Literature*. 39(June): 390-431.

[15] Rao, Vijayendra. 1993. "The Rising Price of Husbands: A Hedonic Analysis of Dowry Increases in Rural India." *Journal of Political Economy*. 101(4): 666-77.

[16] Rohlfs, Chris, Alexander Reed, and Hiroyuki Yamada. 2006. "Missing Women and the Year of the Fire Horse: Changes in the Value of Girls and Child Avoidance Mechanisms in Japan, 1846, 1906, and 1966." Manuscript.

[17] Young, Alwyn. 2005. "The Gift of the Dying: The Tragedy of AIDS and the Welfare of Future African Generations." *Quarterly Journal of Economics*. 120(2):423-466.

[18] Welch, Finis. 1979. "Effects of Cohort Size on Earnings: The Baby Financial Bust." *Journal of Political Economy.* 85: S65-S97.

Table 1. The format of the "Ages of Married Couples" in the Population Census of Japan

Husband's age \ Wife's age	15	16	17	18	19	⋯	84	85+
15	0	0	0	0	0	⋯	0	0
16	0	0	2	1	0		0	0
17	1	0	4	4	3		0	0
18	1	3	11	38	33		0	0
19	2	9	24	71	113		0	0
⋮	⋮						⋮	⋮
84	0	0	0	0	0	⋯	116	93
85+	0	0	0	0	0	⋯	1235	3079

Source: 2000 Population Census of Japan, Hokkaido.

Table 2. The correspondence of birth cohort, census year, and age in the Population Census of Japan

Birth cohort \ Census year	1990	1995	2000
1947-1950	40-43	45-48	
1951-1955	35-39	40-44	45-48
1956-1960	30-34	35-39	40-44
1961-1965	25-29	30-34	35-39
1966-1970	20-24	25-29	30-34
1971-1975	15-19	20-24	25-29
1976-1980		15-19	20-24

Note: Each entry is the age range that corresponds to the birth cohort (row) and the census year (column). The table shows only ages used in the empirical analysis in the paper.

Table 3. Selected results of the estimates of the marital matching elasticities

	Model and controls	N	β_1	β_2
(1)	OLS, no control	77712	0.418	0.470
			(0.005)	(0.004)
(2)	FE + year	77712	0.411	0.650
			(0.016)	(0.019)
(3)	FE + wife's cohorts, ages$\leq$45	49849	0.393	0.581
			(0.030)	(0.030)
(4)	FE-IV, wife's cohorts, ages$\leq$45	48841	0.511	0.669
			(0.034)	(0.034)
(5)	FE-IV, wife's cohorts, ages$\leq$48	60511	0.515	0.581
			(0.033)	(0.032)
(6)	FE-IV, husband's cohorts, ages $\leq$45	48841	0.291	0.848
			(0.048)	(0.025)
(7)	FE-IV, wife's cohorts, ages$\leq$45, Imputation 1	54598	0.712	0.605
			(0.045)	(0.044)
(8)	FE-IV, wife's cohorts, ages$\leq$45, Imputation 2	62217	0.521	0.676
			(0.053)	(0.055)

Note: β_1 and β_2 are the elasticities of the net marital formations to the number of single men and women, respectively (equation 1). FE is the fixed effect estimation within the prefecture-husband's age-wife's age cells. "Wife's (husband's) cohorts" means that wife's (husband's) cohort dummy- and trend- variables are included. Unless otherwise noted regarding imputation, the negative values in the net marriage formation is set missing. The standard errors are in the parentheses.

Table 4. The relation between prefectural socioeconomic characteristics and the ratio of births before and after the Hinoeuma year (1966).

Dependent variable Independent variable	Birth ratio 1967/1966	Births ratio 1965/1966
Primary industry ratio	-0.186	0.086
	(0.122)	(0.113)
Log annual employee earnings	-0.014	-0.037
	(0.016)	(0.014)
Female high school enrollment	-0.091	-0.252
at 15	(0.185)	(0.164)
Abortion /100 women	-0.009	0.006
	(0.009)	(0.008)

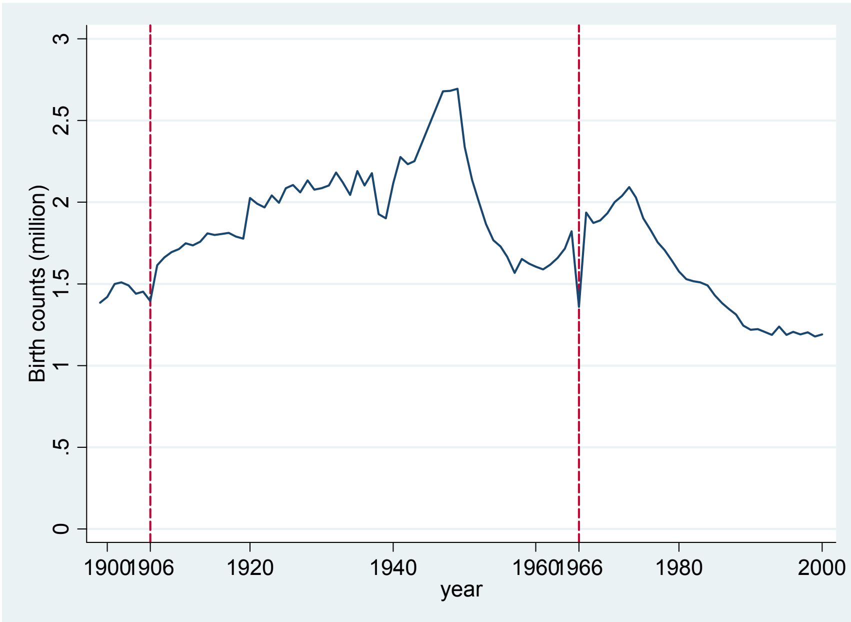
Note: Each entry is the coefficient estimate on the change in births from a single regression with each alternative explanatory variable listed in column 1. The dependent variables are the ratio of births in 1965 to 1966, and the ratio of births in 1967 to 1966. The number of observations is 46 prefectures, excluding Okinawa. The standard errors are in the parentheses. Primary industry ratio is the proportion of men above 15 working in agriculture, fishery, forestry, or mining among all the working men in 1965 Census. Log employee earnings is based on 1966 Prefectural Income Accounting (Kenmin Shotoku Toukei). Female high school enrollment rate is calculated based on 1955 SBS. Abortion rate is calculated by the reported number of abortions per the number of women aged 15 to 49 in Statistical Report on Maternal Health Care (Bosei Hogo Toukei Houkoku).

Table 5. The effects of family and educational background to the marriage probability

	Men				Women			
Dep. variable	Married	Married	Nat 4 college	4 college	Married	Married	Nat 4 college	4 college
Sample year	2002	2000-02	2002	2000-02	2002	2000-02	2002	2000-02
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
First child	-0.001	-0.005	0.006	0.024	0.063	0.026	0.015	-0.032
	(0.061)	(0.037)	(0.038)	(0.035)	(0.058)	(0.036)	(0.027)	(0.024)
Only child	-0.040	0.009	0.069	0.041	-0.322	-0.196	-0.012	0.062
	(0.121)	(0.066)	(0.094)	(0.064)	(0.095)**	(0.064)**	(0.046)	(0.055)
National 4-year	-0.025				-0.318			
college	(0.088)				(0.096)**			
4-year college		-0.060				-0.234		
		(0.036)				(0.043)**		
Father attended			0.088	0.467			0.132	0.301
college			(0.054)	(0.037)**			(0.045)**	(0.035)**
Observations	332	946	332	946	395	1098	395	1098

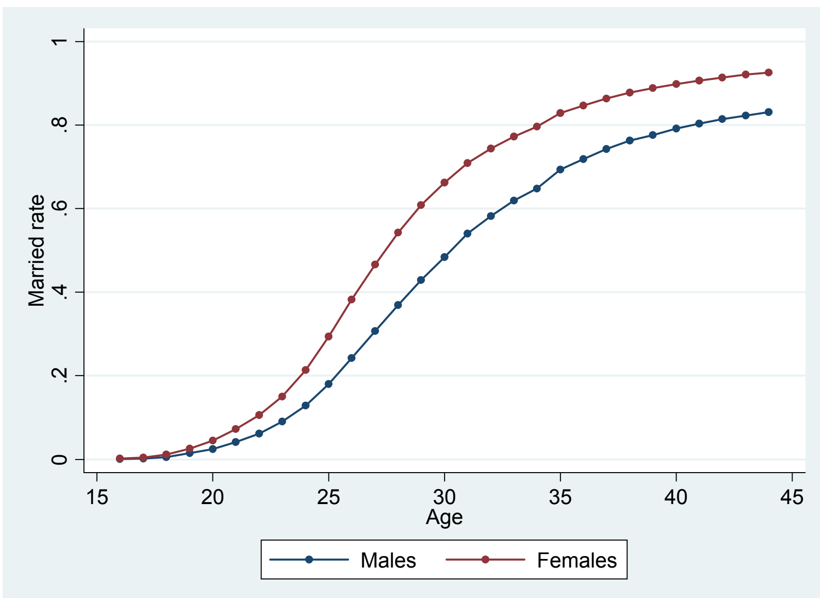
Note: All the estimations use the data from the Japanese General Social Survey with brith year between 1964 and 1982. The dependent variable for columns 1, 2, 5, and 6 is whether the respondent is married at the time of survey. The dependent variable for columns 3 and 7 is whether the respondent have attended national/public 4-year college. The dependent variable for columns 4 and 8 is whether the respondent have attended 4-year college. The estimation method is the probit model controlling for age, age squared, and the year of survey (even numbered columns only). "4-year college" is a dummy variable that takes one if the respondent have ever attended 4-year college. "National 4-year college" is the dummy that takes one if the college attended was a national/public institution. "Father attended college" is a dummy that takes one if the respondent's father have attended some college. Standard errors in parentheses. * significant at 5%; ** significant at 1%

Figure 1. The total birth counts in Japan: 1899-2000



Note: Based on the Vital Statistics of Japan. The vertical broken lines indicate the two recent Hinoeuma years, 1906 and 1966.

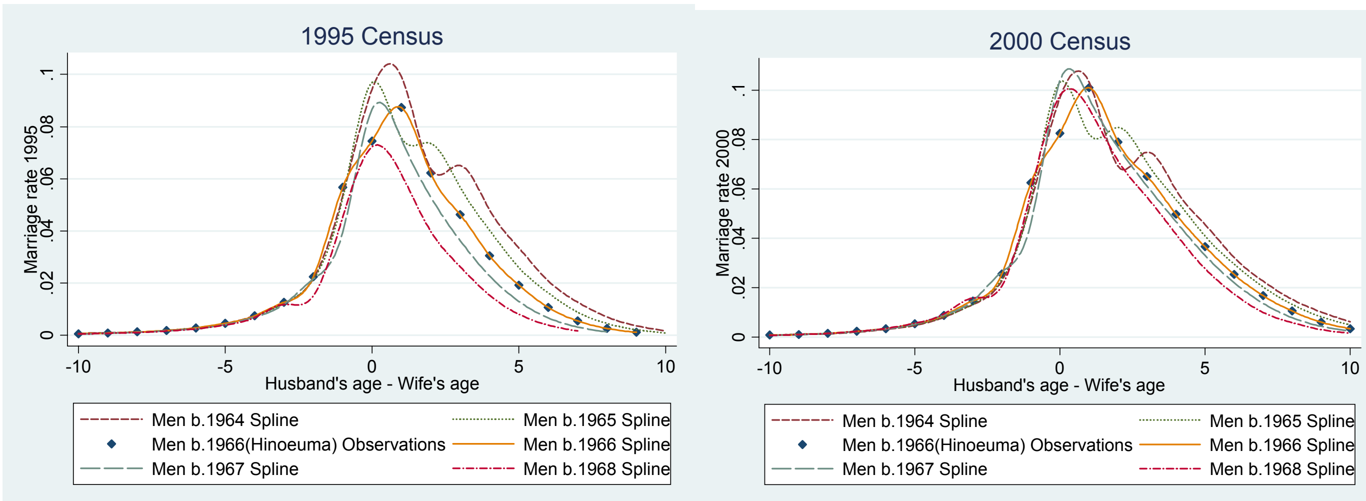
Figure 2. The ratio of married population by age and by sex in 2000



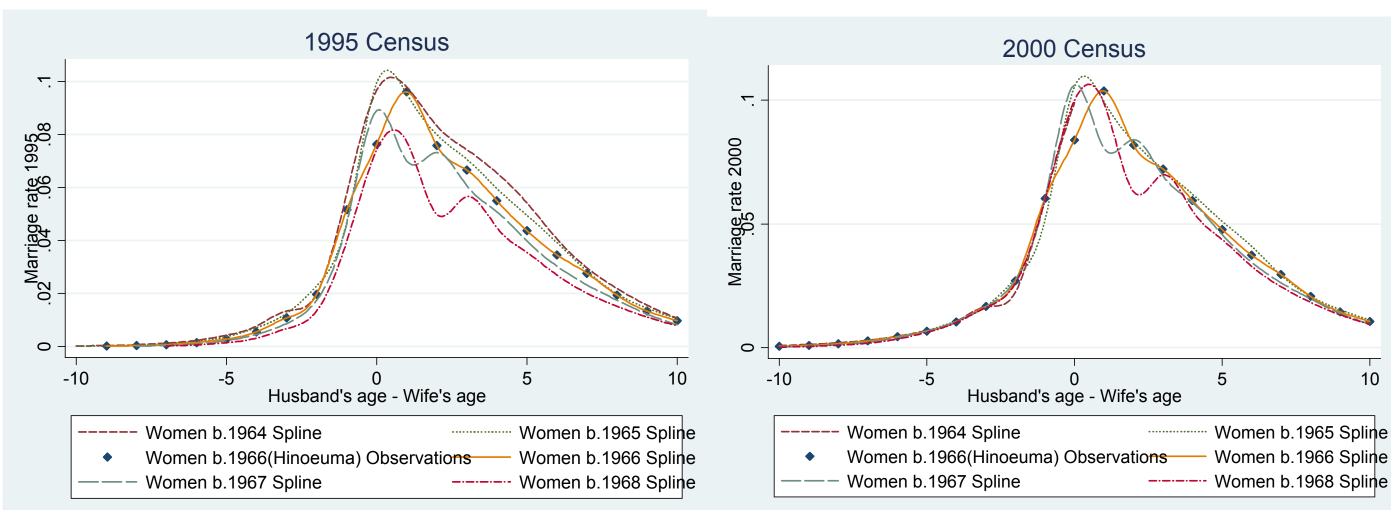
Source: 2000 Population Census of Japan

Figure 3. The distribution of marriage rate against the husband-wife age difference by sex and year

(a) Men



(b) Women

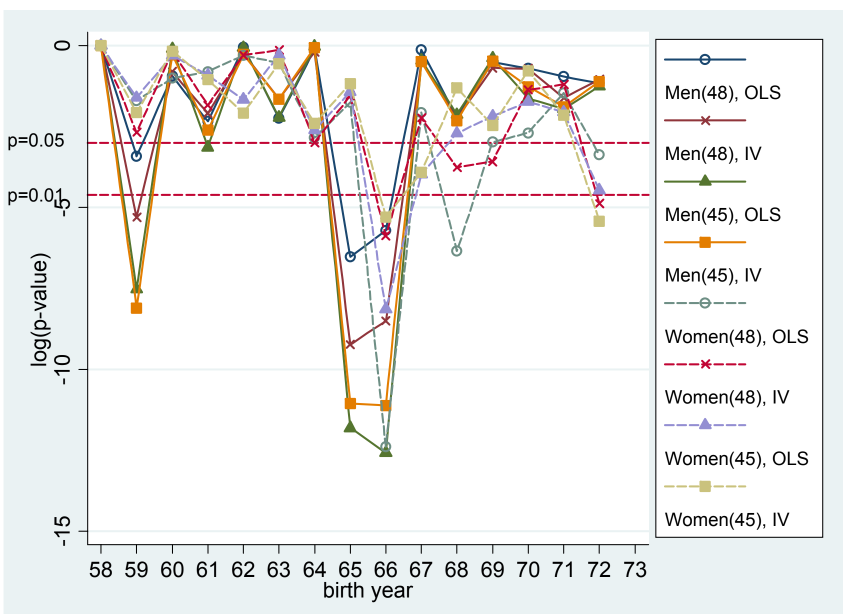


Note: The author's calculation from the Census 1995 and 2000. The denominator to calculate the marriage rate is the total population of each age cohort and the numerator is the number of the married to spouses that have each age difference.

Figure 4. Effects of birth cohorts on the marital formation efficiency estimated by OLS and IV.

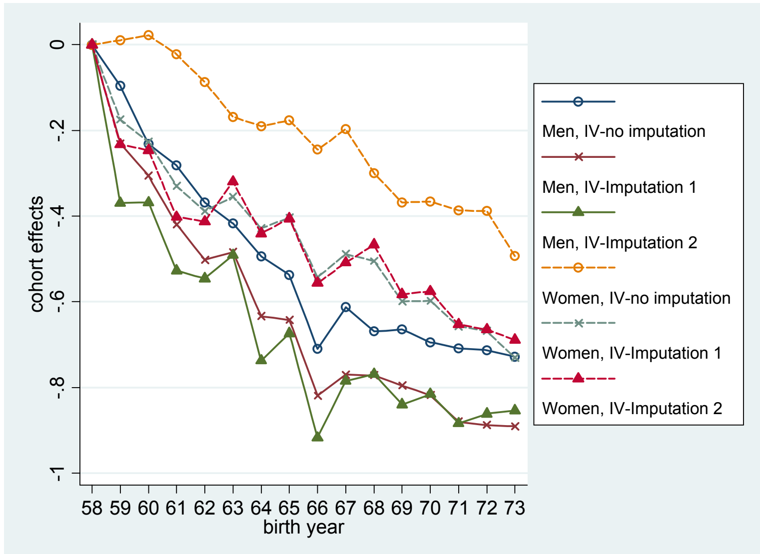
Note: The graphs are constructed using the estimated cohort trend and dummy effects included in the estimation of the net marital formation function. Each graph shows the estimates from one regression. All the estimations are conducted with negative values in the net formation left missing. IV shows the estimates using the birth cohort size interacted by age dummies as instruments for the number of single population. The maximum ages included in the regressions are shown in the parentheses.

Figure 5. Test statistics for the equality of pair-wise cohort effects estimated by OLS and IV



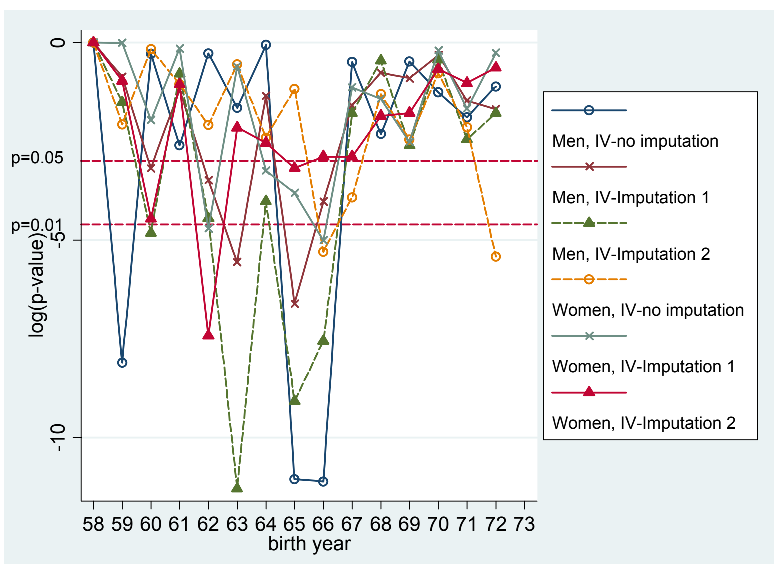
Note: The vertical axis is the log(p-value) for the test of the equality of each pair of consecutive cohort dummy effects. The result for the equal effects of birth year t and t+1 is shown at birth year t. As the legends suggest, each graph corresponds to the estimation result depicted in figure 4.

Figure 6. Effects of birth cohorts on the marital formation efficiency estimated IV with different imputation methods.



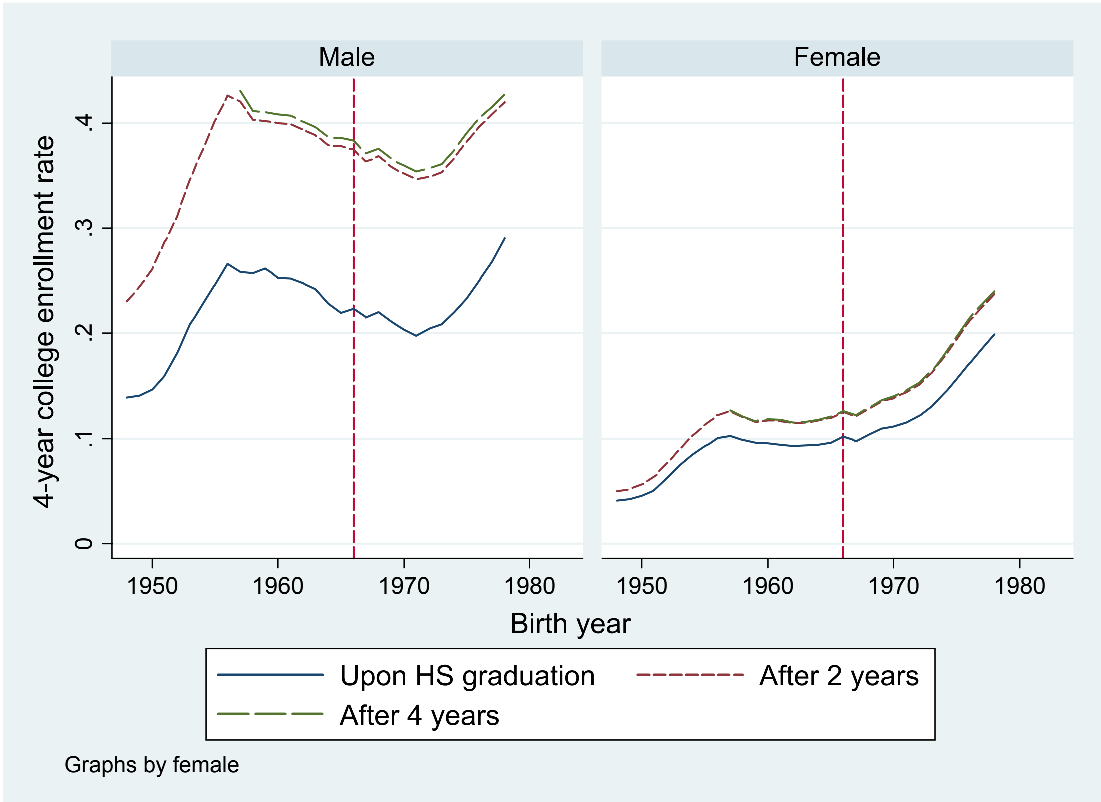
Note: The graphs are constructed using the estimated cohort trend and dummy effects included in the estimation of the net marital formation function. Each graph shows the estimates from one regression. All the estimations are conducted by IV for ages no greater than 45. "No imputation" means that non-positive values in the net formation are left missing, "Imputation 1" means that non-positive values are replaced by 1, and "Imputation 2" means that a minimum constant value within prefecture-age-age cells is added in order to eliminate non-positive values.

Figure 7. Test statistics for the equality of pair-wise cohort effects estimated by IV with different imputation methods



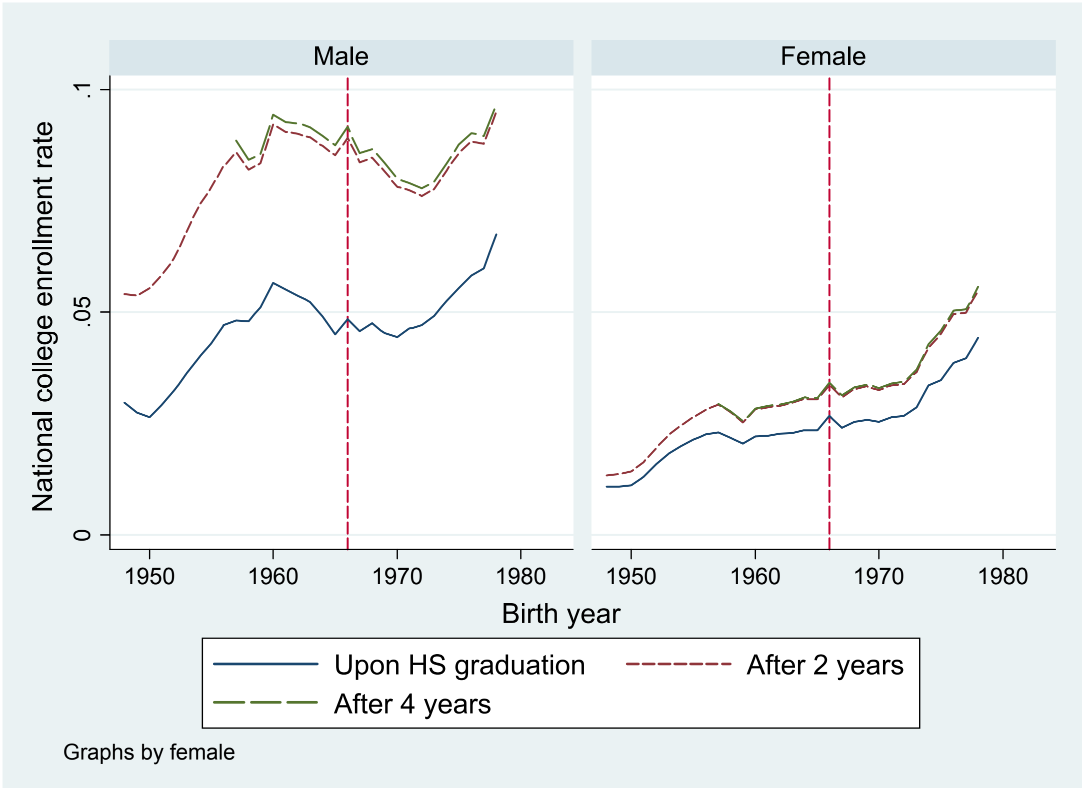
Note: The vertical axis is the log(p-value) for the test of the equality of each pair of consecutive cohort dummy effects. The result for the equal effects of birth year t and t+1 is shown at birth year t. See the note to **figure** 5 for the definitions of the imputation methods. As the legends suggest, each graph corresponds to the estimation result depicted in figure 6.

Figure 8. The enrollment rate of four-year college by birth cohort



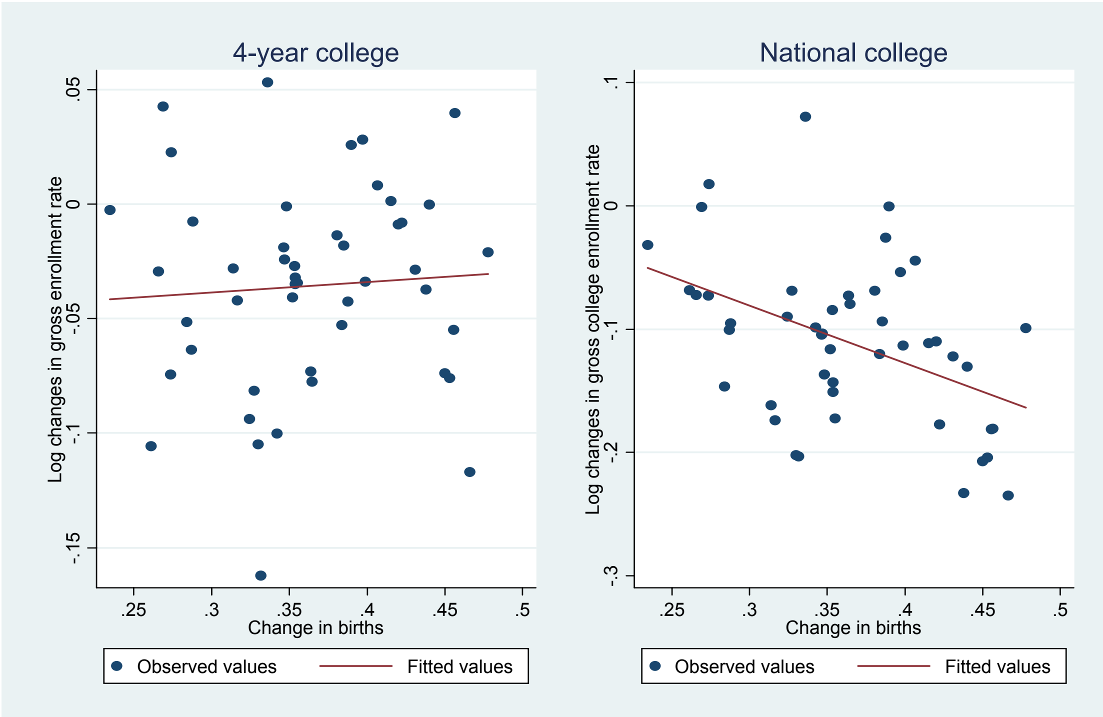
Source: Basic School Survey. The entrants are measured in three definitions. First definition (Upon HS graduation) counts the college entrants immediately after the high school graduation. "After 2 years" counts the sum of entrants after 2 years of high school graduation. "After 4-years" counts the sum of college entrants after 4-years of high school graduation. The denominator is the number of junior high school graduates 3 years before.

Figure 9. The enrollment rate of national four-year college by birth cohort



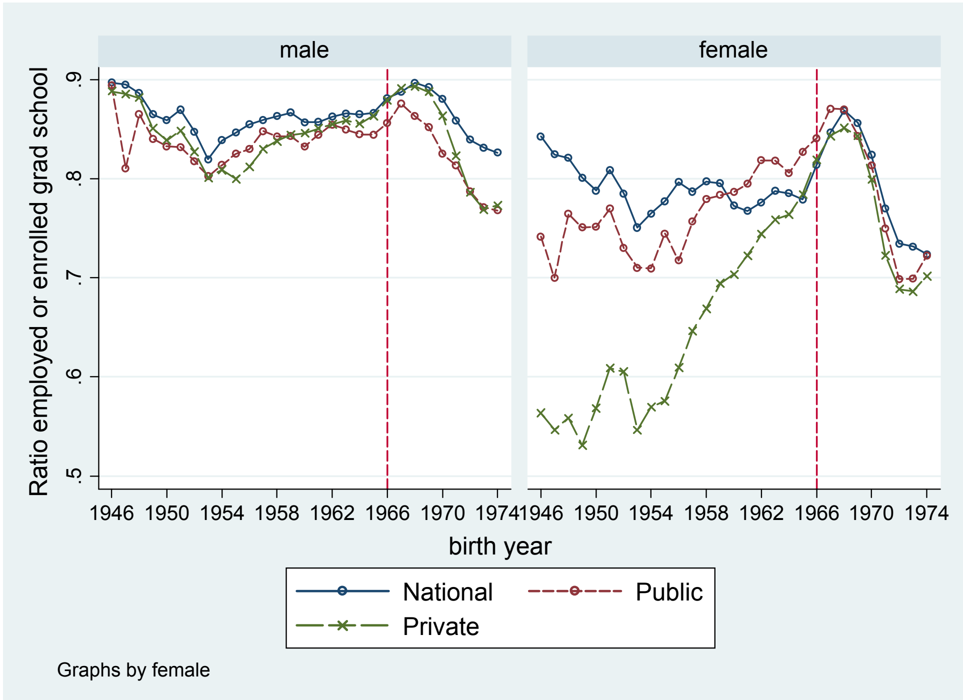
Source: Basic School Survey. The entrants are measured in three definitions. First definition (Upon HS graduation) counts the college entrants immediately after the high school graduation. “After 2 years” counts the sum of entrants after 2 years of high school graduation. “After 4-years” counts the sum of entrants after 4-years of high school graduation. The denominator is the number of junior high school graduates 3 years before.

Figure 10. The relation between changes in birth counts and gross college enrollment rates between 1966 and 1967.



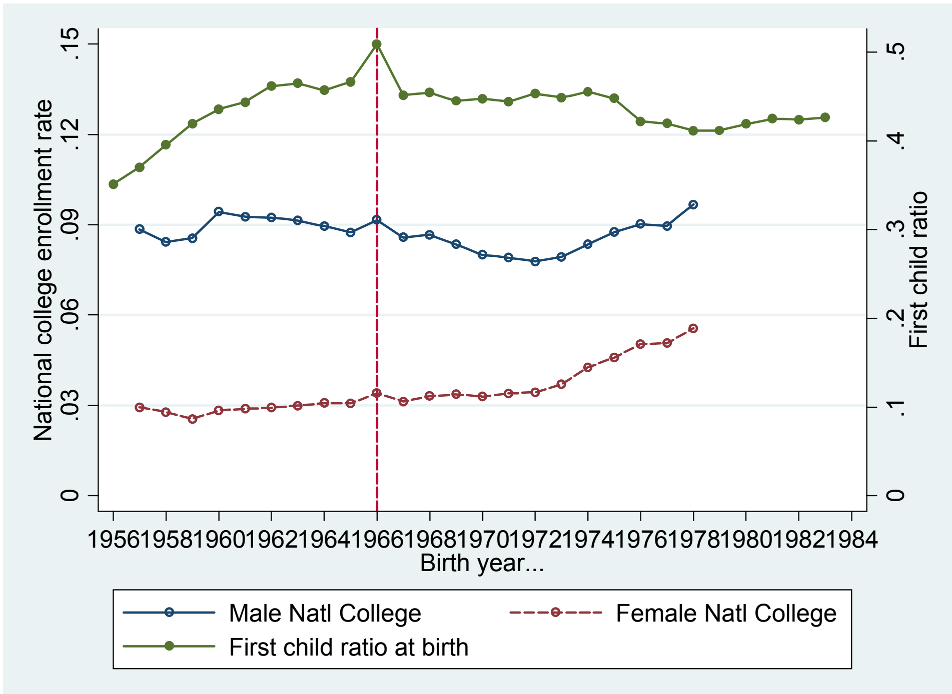
Source: Author's calculation using Basic School Survey and Vital Statistics of Japan. Gross enrollment is defined by the freshman enrollment divided by the junior high school graduates three years before. The change in birth is the differences in log births between 1967 and 1966. Fitted values show the linear regression lines.

Figure 11. The ratio of successful placement upon college graduation by the birth year and by the types of institution



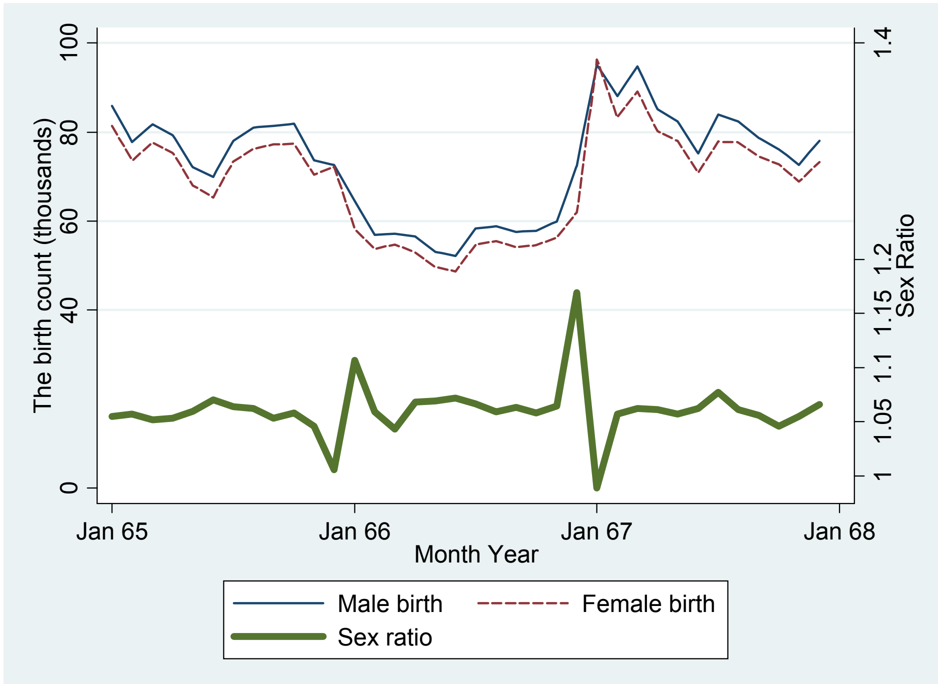
Source: Basic School Survey. The vertical axis measures the ratio of student who either immediately employed or entered graduate school upon graduating four-year college in March of age 22. The ratio is drawn for national college, public college, and private college, respectively.

Figure 12. The ratio of first child and the enrollment rate of national college for men and women.

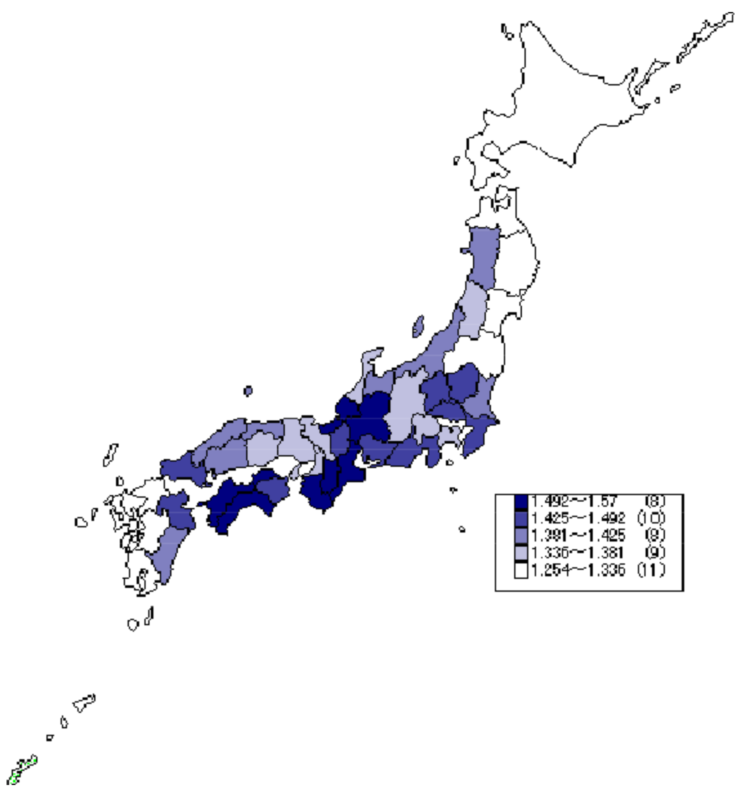


Source: Basic School Survey and Vital Statistics of Japan The national college enrollment rate is the same as "After 4-years" in **figure** 9. First child ratio, measured in the right axis, is the ratio of first children in the total births.

Appendix figure 1. The monthly birth counts and the sex ratio: 1965-1967



Appendix **figure** 2 Geographic Distribution of Hinoeuma Effects on Births (Incomplete)



Note: The prefectures, excluding Okinawa, were colored based on the average effect of Hinoeuma superstition on the fertility; calculated as 0.5 x (1965 births + 1967 births) / 1966.

Source: The Vital Statistics of Japan.