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Impute the Prime-age Sex Ratio in Post-War Taiwan Using Censored Data

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Abstract

The civil war between the Nationalists and the Communists in China during 1945-1949 resulted in an enormous influx of immigrants to Taiwan, majority of who were single male soldiers in their 20s or 30s. In addition, a military marriage ban in the 1950s prevented most of the immigrant soldiers from getting married until 1959. These two factors have profound but distinct influences on the *effective* prime-age sex ratio in the marriage market in post-war Taiwan. Unfortunately, the official population data in Taiwan—collected through a civilian household registration system—did not include the military and thus did not reveal the true male population until the late 1960s. This paper proposes a method that addresses both concerns of the marriage ban and the data censoring to impute the effective prime-age sex ratio. The imputation result shows that the effective prime-age sex ratio first rose in the 1950s, peaked in the 1960s, and then declined in the 1970s. At its peak, the ratio implies that on average as many as 120 men were competing for only 100 women in the marriage market.

Key words: civil war, marriage ban, sex ratio, marriage squeeze, China, Taiwan

1. Introduction

Sex ratio at the prime ages of marriage—usually defined as the ratio of prime-age men to prime-age women times 100—is one of the most popular measures of marriage squeeze (Akers 1967). Yet, in some circumstances, certain groups at the prime ages in official population data may be censored. For example, military personnel, who also compete in the marriage market, may be censored for the sake of national security. If they account for a significant share of the prime-age population, using the censored data to calculate the sex ratio can cause a serious bias. In addition, legal restrictions such as marriage ban for certain groups can also affect the supply and demand in the marriage market. A sex ratio that fails to take these factors into account is unlikely to reflect the true intensity of marriage squeeze. Taiwan in the post-war period serves as a good example.

In 1945, Taiwan, an island lying off the south-east coast of mainland China, was returned from the Japanese to the Chinese Nationalists government, which was then based in the mainland. Almost in the same time, a civil war (1945-1949) between the Nationalists led by Chiang Kai-shek and the Communists led by Mao Zedong burst out. Chiang Kai-shek and his military were eventually defeated and fled to Taiwan with hundreds of thousands of followers. The enormous influx of the civil war immigrants— military personnel, government officials, and civilians—caused a dramatic shock to the demographic structure on the island.

The exact number of the civil war immigrants has long been seriously debated among demographers, economists and sociologists in Taiwan as well as overseas (Barclay 1954; Jacoby 1967; Ho 1978; Chen and Yeh 1982; Liu 1986; Lin 2002; Francis

2011). Various estimates suggest that the number ranges from .6 to 1.25 million, while the local population was merely 6 million (Lin 2002). Among this group, the military alone was estimated to account for .55~.6 million (Jacoby 1966; Ho 1978). Moreover, the composition of this group was highly male-biased. Francis (2011) suggests that men outnumbered women by a factor of 4 to 1, which led to a significant rise in the sex ratio in Taiwan.

Since the variation in the sex ratio was mainly caused by the civil war, this nature presumably could be exploited to study various *causal* effects of the marriage squeeze in post-war Taiwan. However, the official population data in Taiwan—collected through an island-wide civilian household registration system—did not include the military until the late 1960s. Moreover, most of the immigrant soldiers were single males in their 20s or 30s when they arrived in Taiwan. This implies that the prime-age sex ratio *observed* in the official population data before 1970 is very likely biased downward.

What makes it more complicated is a military marriage ban in the 1950s that prevented most of the immigrant soldiers from getting married until the ban was substantially relaxed in 1959 (Lin 2002). In essence, the ban served as a buffer that held off the shock of the immigrant soldiers to the marriage market in Taiwan until the 1960s. Meanwhile, Chiang Kai-shek began to conscript young Taiwanese men in the mid-1950s to replace the aging immigrant soldiers. In principle, conscripted Taiwanese men were also subject to the marriage ban. However, unlike their immigrant counterparts, Taiwanese soldiers generally served for a much short period. Besides, they usually remained socially connected and thus could still compete in the marriage market even when they were in the military. Note that Taiwanese soldiers were also excluded from the

official population data during the period of their service. I will discuss this in more details later.

In this paper, I propose a method that addresses both concerns of the marriage ban and the censored data to impute the prime-age sex ratio in the marriage market in the post-war period. A distinguished feature of my method is that the imputation is guided by marriage patterns observed from a sample consisting of both the civil war immigrants and the native Taiwanese who were at their prime ages during the three decades after 1949. For convenience, the prime-age sex ratio directly observed in the censored official population data is called *the observed sex ratio* hereafter, and the one that I impute is called *the effective sex ratio*.

The rest of this paper is organized as follows. The second section profiles the sample consisting of the prime-age cohorts in the post-war period. The third section describes the military marriage ban and its effects. The fourth section introduces the censored official population data. The fifth section illustrates the prime-age sex ratio *observed* from the censored data. The sixth section presents the imputation procedures and results. I conclude in the last section.

2. A Sample of Prime-age Cohorts in the Post-war Period

To understand the *ex post* marriage patterns of the civil war immigrants and the Taiwanese in the post-war period, I first utilize a longitudinal survey called *Survey of Health and Living Status of the Middle-aged and the Elderly in Taiwan*. The survey provides two samples. The first one was drawn in 1989 and consists of 4,049 individuals who were born during 1893-1929. In 1996, the survey aged in another sample of 2,462 individuals who were born during 1930-1946. I combine the two to get the widest range

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of birth cohorts with sampling weights.[1] In this combined sample, the youngest were of age 3 in 1949 and 33 in 1979. About 85.6% of them were born in Taiwan, 13.9% in mainland China and less than .6% in other countries. The survey offers information about sex, birth year and place, arrival year in Taiwan and marriage history etc. In the following analysis, I only focus on those who were born in Taiwan and mainland China.

Figure 1 illustrates when those born in mainland China arrived in Taiwan. It is shown that most of them were the civil war immigrants, as 76% of them arrived during 1945-1951, and, especially, 45% of them arrived during 1949-1950. Meanwhile, 83% of them are male, which confirms that the immigrants are highly male-biased. By the time they stepped on the soil of Taiwan, 66% of men aged at least 15 years old were still single, while the percentage for women is only 14%. Moreover, for the cohort born before 1930, about 78% of men and 5% of women were serving in the military when they came to Taiwan.[2] Figure 2 shows that they were mostly in their 20s or 30s when they arrived, especially for the immigrant soldiers.

So far, the profile of this combined sample suggests that the majority of the civil war immigrants were single male soldiers in their 20s or 30s when they came to Taiwan. In the next section, I examine how the military marriage ban affected their marriage behavior.

3. The Military Marriage Ban

After fleeing to Taiwan, Chiang Kai-shek did not allow the immigrant soldiers to get married in order to prepare for counterattacking mainland China (Lin 2003). The

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[1] Because the two samples were drawn with unequal probabilities of selection (1/472 for the sample in 1989 and 1/1155 for the sample in 1996), I use the inverse of their respective selection probability as their sampling weight to adjust for the use of the combined sample.
[2] This information is not available for the cohorts born in 1930 and afterwards.

marriage ban was formally written into a law called *Military Marriage Ordinance* (MMO) in 1952.[3] The MMO forbad most of the *active* military personnel to get married except for military officers and technician sergeants.[4] However, in August 1959, it was largely relaxed by restricting the ban to only male soldiers of age under 25, female soldiers under 20, and all soldiers who serve less than three years.[5] This relaxation essentially made the MMO non-binding for most of the immigrant soldiers, who were already older than 25 in 1959 and had served more than three years. In other words, they were finally allowed to get married roughly ten years after they came to Taiwan. In 1974, the MMO was further restricted to only soldiers currently involved in combats and students in military academies. In 2005, it was completely repealed.

The effect of the MMO and its 1959 relaxation on the immigrant soldiers can be detected in the sample. The upper left panel in Figure 3 shows the year of first marriage for the mainland-born soldiers, i.e. the immigrant soldiers.[6] The distribution clearly exhibits that there were much fewer marriages in the 1950s. Except for military officers and technician sergeants, the few immigrant soldiers who got married in the 1950s should be those who were discharged or retired from the military, so that they were not subject to the MMO. On the other hand, the bounce-back in marriages in the 1960s was also consistent with the relaxation in 1959. In stark contrast, such pattern cannot be found among either the mainland-born women or the Taiwanese men and women.

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[3] Note that the ban was *de facto* effective even before the law was enacted.
[4] Of course, they could get married, if they were discharged or retired from the military.
[5] In 1957, a minor amendment of the MMO allowed some soldiers with special needs to get married with the approval from the Ministry of Defense.
[6] As of 1996, about 16% of the mainland-born men had never been married and thus are not included in Figure 3.

For the Taiwanese men, military service became compulsory for them in the mid-1950s.[7] Most Taiwanese men served in their early twenties for 2 years in the army or 3 years in the air force or the navy. In principle, they were subject to the MMO during their service. However, unlike the mainland-born soldiers, they served for a much shorter period and generally remained socially connected. Therefore, they could still compete in the marriage market even when they served in the military. This can explain why we do not find an unusual decrease in marriages in the 1950s in the upper right panel in Figure 3.

Another noteworthy observation in Figure 3 is that the last marriage of the mainland-born soldiers occurred in 1990, while most of the Taiwanese men had been married by 1980. This suggests that the marriages of the mainland-born soldiers had been significantly delayed by the MMO. Besides, the mainland-born soldiers who got married during the 1980s probably married much younger women, as very few women in the sample got married during that decade (see the bottom two panels in Figure 3).

Figure 4 plots their age at first marriage. Most of the women got married between 15 and 30. For the Taiwanese men, the age ranges from 15 to 40. The mainland-born soldiers are the most special group, as their age ranges from 15 to 60. This suggests that older mainland-born men were also competing with younger men in the marriage market.

The main lesson learned from this section is that the MMO delayed the marriage of most immigrant soldiers to the 1960s and later, while the Taiwanese men were not practically affected.

4. The Censored Official Population Data

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[7] The *Conscription Law* was first enacted in 1933 when the Nationalist government was still in mainland China. It went through several major revisions later and the modern version of the *Conscription Law* that has 54 articles was passed in 1954 when the Nationalist government had moved to Taiwan and the law was applied to Taiwanese men. Another legal document called *the Conscription Regulations* pursuant to the *Conscription Law* was issued in 1956 in order to provide detailed regulations of conscription.

The government in Taiwan collects its population data mainly through an island-wide civilian household registration system.[8] According to the *Household Registration Law*, every civilian citizen has to register to the local government about their birth, death, marriage, divorce, education, migration etc. The data are then reported from the lowest township-level administration all the way up to the central government.[9]

However, active military personnel were generally excluded from the civilian registration system until 1969. Due to this, the immigrant soldiers had been missing in the official population data since they came to Taiwan until they were discharged from the military or got married (Lin 2002). This exclusion was changed by an executive order—*Household Registration Act for the Armed Forces*—issued in November 1968. The order required all active military personnel to register to the local government. It is since then that the immigrant soldiers started to appear in the official population data. The official population data are usually annual data; hence the first entry of the immigrant soldiers into the official population data was in 1969.

On the other hand, Taiwanese men had to remove their civilian registration once they were drafted and re-register after they were discharged from the military. Hence, since the mid-1950s, Taiwanese men in their early 20s were also missing in the official population data for 2-3 years of their service time. However, one important difference is that the active Taiwanese soldiers started to appear in the official population data in 1965, 4 years earlier than the immigrant soldiers. I describe this in more details in the following.

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[8] Another source of population data is the census. However, the census is usually conducted in every ten years and thus cannot be used to calculate the year-to-year sex ratios.

[9] Prior to 1971, the official population data—both the national-level and county-level—were published by the Department of Civil Affairs under the Taiwan Provincial Government. The task was then transferred to the Department of Household Registration under the Ministry of Interior. Before 1965, the official population statistics book was called *Household Registration Statistics of Taiwan*, which was published every few years since 1946. Yet, since 1965, its title has been changed to *Taiwan Demographic Fact Book*, which has been published every year.

While it is well-known that the immigrant soldiers started to be included in the official population data in 1969, it is less-known that the Taiwanese soldiers actually had been *added back* to the official population 4 years earlier. This addition is documented in the introduction of the 1965 *Taiwan Demographic Fact Book*—the official population statistics book—published in October 1966. The introduction states that "*Population in this volume refers to the "registered population" in the respective administration unit. However, to ensure the accuracy of the vital rates, correction is made for those who actually moved out but have not changed their registration).*"[10] Here, "*those who actually moved out but have not changed their registration*" mainly refer to the conscripted Taiwanese men.[11] Note that the immigrant soldiers never *moved out* their registration. However, it is not clear why Taiwanese men were added back to the official population data earlier than the immigrant soldiers.[12]

In summary, the immigrant soldiers were missing in the official population data before 1969, while the Taiwanese soldiers were missing between 1955 and 1965. In the next section, I illustrate the prime-age populations and sex ratio directly observed in the censored population data to verify the censorship.

5. The *Observed* Prime-age Sex Ratio

Considering the wide range of age at first marriage in Figure 4, I define the prime ages for marriage to be 15 to 49. This range includes 99% of all marriages and 94% of

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[10] However, it is not clear why the government decided to add back the Taiwanese soldiers 4 years before the immigrant soldiers were included in the official population data, since the vital rates cannot be correct if the immigrant soldiers were still excluded.

[11] A few of them may be prisoners, who had to remove their civilian registration. But the number of this group is negligible, compared to the military personnel.

[12] I contacted the Department of Household Registration to inquire about this, but they responded that they do not know the reason, either.

the marriages for the mainland-born men in the sample. The prime-age sex ratio is then defined as the ratio of men to women within this age range time 100.

I acquire the Taiwanese official population data from 1946 to 1990 from the Department of Household Registration under the Ministry of Interior. The original data are annual data at the county level. The 1946-1964 and 1974-1990 data record end-of-year population, while the 1965-1973 data record mid-year population.[13] For consistency purpose, I convert all data into mid-year population. The county-level data are then aggregated to form the Taiwan-level data. I focus on the major island of Taiwan and exclude other small islands such as Pescadores, Quemoy, and Matsu.

Figure 5 plots the Taiwan-level population by sex for nine 5-year age groups. In each group, the solid line represents the male population and the dash line the female. The exclusion of the immigrant soldiers and the Taiwanese soldiers can be easily seen in the figure. Recall that the immigrant soldiers were missing in the official population data until 1969, when they were mostly in their 40s. Their entering into the data can be first seen in the panel for age 40-44, which shows a sudden increase in the male population around 1970 (the circled part). As they age, the same group of people moves on to the subsequent age groups in a cycle of five years. There was another smaller increase in the group of age 45-49 around 1970.

On the other hand, Taiwanese men in their early 20s began to be drafted in the mid-1950s and were missing in the data until 1965. Their part of censoring is illustrated in the panel for age 20-24, which shows a decline since 1955 and a sudden increase in 1965. The downward trend also suggests that the conscription expands over time. However, unlike their immigrant counterparts, the pattern does not pass on to the

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[13] Mid-year population is defined as the average of two consecutive end-of-year populations.

subsequent age groups, because Taiwanese men only missed in the data for 2-3 years in their early twenties.

Moreover, there is almost nothing unusual in the female population across all ages. This should not be surprising, because there were only few female civil war immigrants. Another noteworthy observation in Figure 5 is a cohort of baby-boomers who were born during 1950-1965. This cohort is exemplified in the big rise since 1965 for the group of age 15-19 and moves on to the subsequent age groups with a 5-year delay.

In accordance with the censored male population in Figure 5, the observed sex ratio in Figure 6 shows three unusual kinks. Circle 1 and 2 respectively reflect the removal and added-back of the conscripted Taiwanese soldiers. Circle 3 reflects the entering of the immigrant soldiers. The ratio peaks in 1970, which is about 20 years after the civil war immigrants arrived in Taiwan. However, one would reasonably conjecture that should the military be included, the ratio would have peaked sometime in the 1950s, instead of 1970. Despite the unusual kinks and the timing of the peak, the observed sex ratio did increase from 102 in 1946 to 115 in 1970, still suggesting the significant shock caused by the civil war immigrants.

6. Imputation of the Effective Sex Ratio in the Marriage Market

Based on the previous findings, this section proposes a method to impute the effective sex ratio in the marriage market in the post-war period. I define the effective sex ratio as the ratio of men to women times 100 among the population of age 15-49 who are *relevant* in the marriage market. In particular, I assume the military marriage ban was strictly binding for the immigrant soldiers before 1960. Therefore, they are not included in the effective sex ratio before 1960. On the other hand, I assume Taiwanese soldiers

were not practically affected by the military marriage ban because of their short service time. Thus, they are always included in the effective sex ratio. All soldiers are assumed to be male, so I only impute the male populations. This assumption is justified by the fact that female soldiers are almost negligible in the military. Besides, there is no abnormality observed in the female population in Figure 5.

The imputation involves two parts. The first part is for the immigrant soldiers and the second part is for the Taiwanese soldiers. For the immigrant soldiers, the goal is to impute their numbers between 1960 and 1968 when they were missing in the official population data but relevant in the marriage market. I only impute those who were at least 30 years old in 1960, because as aforementioned most of them were in their 20s or 30s in 1950. This is also confirmed by the fact that increases in the male populations around 1970 appear in the age 40-44 and older groups. Besides, I only impute up to age 49, which is the upper limit of the prime ages that I have defined.

To impute, I mainly utilize the increases in the male population between 1968 and 1969 and between 1969 and 1970. I assume that the two increases were only caused by the entry of the immigrant soldiers, as a result of the executive order in November 1968 that required them to register in the household registration system.[14] Since I use mid-year population data, the increase between the 1968 and the 1969 data only includes the immigrant soldiers who registered between November 1968 and June 1969. Those who registered after June 1969 would be reflected in the difference between 1969 and 1970. I assume that all immigrant soldiers had finished their registration by July 1970. The two

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[14] Another possible cause of the increases is immigration. However, according to the official immigration data, the net immigration for males, i.e. male immigrants minus male emigrants, are only -158 in 1969 and -473 in 1970. Therefore, the increases in the male population in these two years are unlikely to be caused by immigration. Immigration data can be accessed at http://www.ris.gov.tw/version96/population_01_C_07.html.

increases are then adjusted for mortality before adding back to the original male populations across years.

It is helpful to give a concrete example. To impute the immigrant soldiers who were of age 30-34 in 1960, I first calculate two differences in male population. The first one is between the group aged 38-42 in 1968 and the group aged 39-43 in 1969 and the second difference is between the group aged 39-43 in 1969 and the group aged 40-41 in 1970. To add back those who may have died over this period, I adjust the two differences using the average age-sex-specific death rate during 1960-1969. More specifically, the adjustment formula is $\Delta/(1-M)^n$, where Δ is the difference, M is the average age-sex-specific death rate, and n is the number of years of this period. Finally, I add the adjusted differences to the original male population of age 30-34 in 1960. This process is repeated across age groups and years. The appendix provides a step-by-step summary of the imputation procedures. In addition, the original and the imputed male populations are provided in Table A1 and selected age-specific male death rates are listed in Table A2 in the appendix.

The case for the Taiwanese soldiers is relatively easy, as their exclusion only occurs at age 20-24. I impute their number from 1955 to 1964 using a linear projection between 1954 and 1965. I choose linear projection for three reasons. First, their exclusion does not affect other age groups. Second, judging from the panel of age 20-24 in Figure 5, the female population over 1955-1964 appears to be linear. It is thus reasonable to assume that the male population over this period, if they were included, should also be linear. Third, unlike the case of the immigrant soldiers, Taiwanese soldiers appeared in the age group of 20-24 in 1965 are not the same groups of soldiers in the previous years,

because Taiwanese soldiers only served for 2-3 years. This prevents me from adopting the same method as for the immigrant soldiers. A step-by-step summary for the Taiwanese soldiers is also provided in the appendix.

The imputed populations are illustrated in Figure 7. For the Taiwanese soldiers, the male population in the age 20-24 group is now lifted up to parallel to its female counterpart. For the immigrant soldiers, there is an increase in the male population of the age 30-34 group in 1960 and it is passed on to subsequent age groups every five years.

To check on how close my imputation is to the true population, I use the 1966 census data, which include all civilian and non-civilian residents in Taiwan and should be very close to the true population in 1966. Note that the 1966 census data are different from the official population data in 1966, which were collected from the household registration system and did not include the immigrant soldiers. Figure 8 compares the official population data, the census data and my imputation for the 1966 population. The top panel shows that my imputation of male population is very close to the census data for age 30-49, while the official population data for this age range are much smaller. The bottom panel, on the other hand, shows that there is no difference in female population between the census data and the official population data, and I do not impute the female population. This cross-sectional comparison shows that my imputation is very close to the true population.

After imputing the populations, I calculate the prime-age (15-49) effective sex ratio, which is presented in Figure 9. The effective sex ratio first gradually rises from 102 in 1946 and then has a dramatic jump from 110 in 1959 to the peak of 119 in 1961. It remains at the plateau for the first half of the 1960s and then gradually declines in the

second half of the 1960s. The high effective sex ratio suggests that the marriage squeeze was very intense in the 1960s. However, one can imagine that were there no marriage ban, the effective sex ratio would have peaked in the 1950s and so would the intensity of the marriage competition.

For comparison, I also plot the observed sex ratio in Figure 8. As shown, the effective sex ratio is much higher than the observed sex ratio from 1955 to 1970, suggesting that using the observed sex ratio can seriously underestimate the marriage squeeze. Moreover, there is a 10-year-distance between the peaks of the two ratios. The effective sex ratio peaks in 1960, while the observed sex ratio peaks in 1970. This is mainly caused by the exclusion of the military from the household registration system.

7. Discussions and Conclusions

In this paper, I first show that using the censored official population data in Taiwan to calculate the prime-age sex ratio can substantially underestimate the intensity of the marriage squeeze in the post-war period (1955-1970), which was presumably resulted by the great influx of male-dominant civil war immigrants—especially male soldiers—from mainland China around 1950. In addition to the data censoring problem, the military marriage ban in the 1950s also plays a significant role in the marriage market by holding off the immigrant soldiers from entering the marriage market until 1960. I thus propose a method that addresses both issues of the data censoring and the military marriage ban to impute the effective sex ratio in the marriage market.

My imputed effective sex ratio suggests that the marriage market competition was most intense during 1960-1965, when on average every 120 men were competing for

only 100 women among the age group of 15-49. The intensity then started to decline as the immigrant soldiers gradually aged out of this group.

In principle, my imputation method can be applied to calculate the county-level sex ratio. However, one has to further consider cross-county migration. This is not an issue for the Taiwan-level sex ratio, because the migration from one county to another does not change the aggregate population. Another caveat for using county-level sex ratio to measure the county-level marriage squeeze is that some people may live in a different county than their registered county. In Taiwan, the law does not require people to register in the same county where they currently live, even though the official population data are collected through household registration. Therefore, if cross-county migration is significant, county-level sex ratio based on the household registration data can be biased.

One last thing is worth pointing out. In order to investigate the effect of sex ratio on women and children in Taiwan, Francis (2011) also imputes the effective sex ratio in the post-war period. However, we differ in two major aspects. First and foremost, Francis does not include the immigrant soldiers in his sex ratio, because he argues that "the government socially isolated mainlanders in the military, not permitting them to marry…." This statement is only true for the period prior to 1960. As I have discussed, most of the immigrant soldiers were free to get married after 1959. Second, Francis defines the prime ages to be 15-39, while mine are 15-49. The wider age range that I choose is based on the fact that the entry of the immigrant soldiers into the marriage market was delayed by the MMO, and the age range of first marriages for the immigrant soldiers is also wider.

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Appendix: Imputation Procedures

This appendix describes the details of imputing for the immigrant soldiers and the Taiwanese soldiers step by step.

A.1. Immigrant Soldiers

Step 1. *Calculate the difference in male populations between* 1968-1969 *and* 1969-1970

Since I use mid-year population data, the increase in male population between 1968 and 1969 represents the increase between mid-1968 and mid-1969. Likewise, the increase between 1969 and 1970 represents the increase between mid-1969 and mid-1970. I assume these two differences are mainly resulted by the registration of the immigrant soldiers starting in November 1968. I also assume their registration had been completed by mid-1970.

As an example, to impute the number of the missing immigrant soldiers of age 30-34 in 1960, I use the male population of age 38-42 in 1968, 39-43 in 1969 and 40-44 in 1970. For 1965-1969, the data are aggregated in 5-year-age groups. Hence, I have to break them down into single ages using the distribution of single ages observed from other years.

Step 2. *Calculate the average male age-specific death rates*

I adjust the two differences in Step 1 with age-specific death rates for men. I acquire the death rates from the Department of Household Registration under the Ministry of Interior. The death rates are also in 5-year-age groups. Without any more detailed information, I use the average death rates across years. For example, I calculate the average death rate of the group 30-34, 35-39, and 40-44 from 1960 to 1969 in order to adjust the difference between 1969 and 1970 by the following formula

$\frac{\Delta^{1969-1970}}{(1-M)^{10}}$, where $\Delta^{1969-1970}$ is the difference between 1969 and 1970; M is the average death rate.

Note that the death rates are civilian death rates. I assume that the death rates for the immigrant soldiers are similar to the civilian death rates, since there were no combats in Taiwan over this period.

Step 3. *Add the imputed immigrant soldiers to the original male populations*

As the last step, I add the adjusted differences to the original male population in 1960.

For the immigrant soldiers, I impute for the group of age 30-34 from 1960-1964, the group of age 35-39, 40-44 and 45-49 from 1960-1969. This choice is based on the observation in Figure 5 that the increases first appear in the group 40-44 around 1970. When impute backwardly, these are the age-year cells that are affected.

A.2. Taiwanese Soldiers

To impute the Taiwanese soldiers, I simply fit a linear projection between 1954 and 1965 for the age group 20-24. As mentioned, Taiwanese soldiers mostly serve in their early twenties for 2-3 years, so they do not affect other age groups. Meanwhile, men and women of this age group parallel to each other except for the period 1955-1964 and the women population appears to be linear over this period. Therefore, it is reasonable to assume that the men population should also be linear, were the Taiwanese soldiers not excluded.

Table A1 provides the original male population and the imputed male population. Table A2 provides the selected age-specific death rates for men.

Table A1. Original and imputed male population

Panel A: Original male population

Year	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1954	452424	387094	336057	294732	245574	224156	177689
1955	455418	372131	341429	300044	248523	230274	184169
1956	468884	343386	350438	311901	264965	240760	194533
1957	487289	330528	356309	329198	287066	251431	211113
1958	494518	332103	350018	345002	301533	255260	225535
1959	498951	333404	362910	363701	317093	261565	239345
1960	490216	319764	393591	380765	334210	271681	249802
1961	475628	311953	412713	394666	349223	287425	257073
1962	475454	314515	422474	405221	362245	306238	260641
1963	493054	316677	432372	413313	378196	320308	262881
1964	526901	320237	441571	419699	397268	333519	268257
1965	584158	495360	460627	427486	417389	352701	279138
1966	658998	481063	473282	429673	430472	369174	295181
1967	732117	481603	481418	432331	438191	383816	311943
1968	785175	496798	487740	438150	442752	403706	327194
1969	832331	523284	490685	445886	454745	452692	360750
1970	872038	574687	481767	456059	461030	501243	403240

Panel B: Imputed male population (shaded cells)

Year	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1954	452424	387094	336057	294732	245574	224156	177689
1955	455418	396936	341429	300044	248523	230274	184169
1956	468884	406779	350438	311901	264965	240760	194533
1957	487289	416621	356309	329198	287066	251431	211113
1958	494518	426463	350018	345002	301533	255260	225535
1959	498951	436306	362910	363701	317093	261565	239345
1960	490216	446148	393591	466529	396107	269496	269300
1961	475628	455991	412713	469778	406041	301936	274106
1962	475454	465833	422474	462839	413905	336750	270158
1963	493054	475675	432372	455109	433127	368297	274407
1964	526901	485518	441571	448827	464309	390376	272546
1965	584158	495360	460627	427486	501664	413127	277026
1966	658998	481063	473282	429673	504293	424626	309178
1967	732117	481603	481418	432331	496657	436577	344216
1968	785175	496798	487740	438150	483944	457538	373787
1969	832331	523284	490685	445886	472995	478013	389586
1970	872038	574687	481767	456059	461030	501243	403240

Notes: original male population data acquired from Department of Household Registration, Ministry of Interior; original data are at the county-level; reported numbers in this table are at the national-level, which

are directly aggregated from the county-level data; small islands such as Pescadores, Quemoy, and Matsu Islands are not included.

Table A2. Age-specific death rates for male (‰)				
Year	30-34	35-39	40-44	45-49
1960	3.02	4.06	5.82	7.74
1961	2.86	3.75	5.53	7.76
1962	2.92	3.92	5.10	7.54
1963	2.81	3.54	5.26	7.95
1964	2.62	3.74	5.13	7.71
1965	2.52	3.37	4.80	7.44
1966	2.55	3.43	4.89	7.36
1967	2.53	3.45	4.89	7.51
1968	2.57	3.52	5.02	7.21
1969	2.50	3.31	4.48	6.89

Source: Department of Household Registration, Ministry of Interior; data accessed at http://www.ris.gov.tw/version96/population_01_C_04.html ; small islands such as Pescadores, Quemoy, and Matsu Islands are not included.
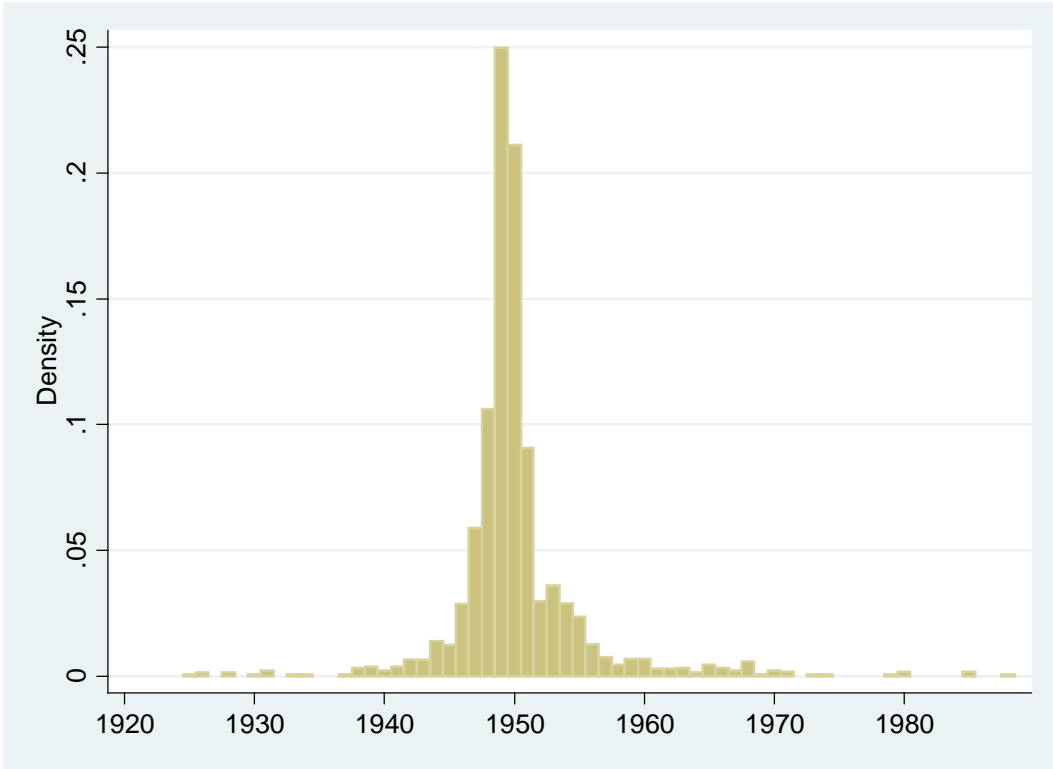
Figure 1. Year of arrival in Taiwan for those born in mainland China
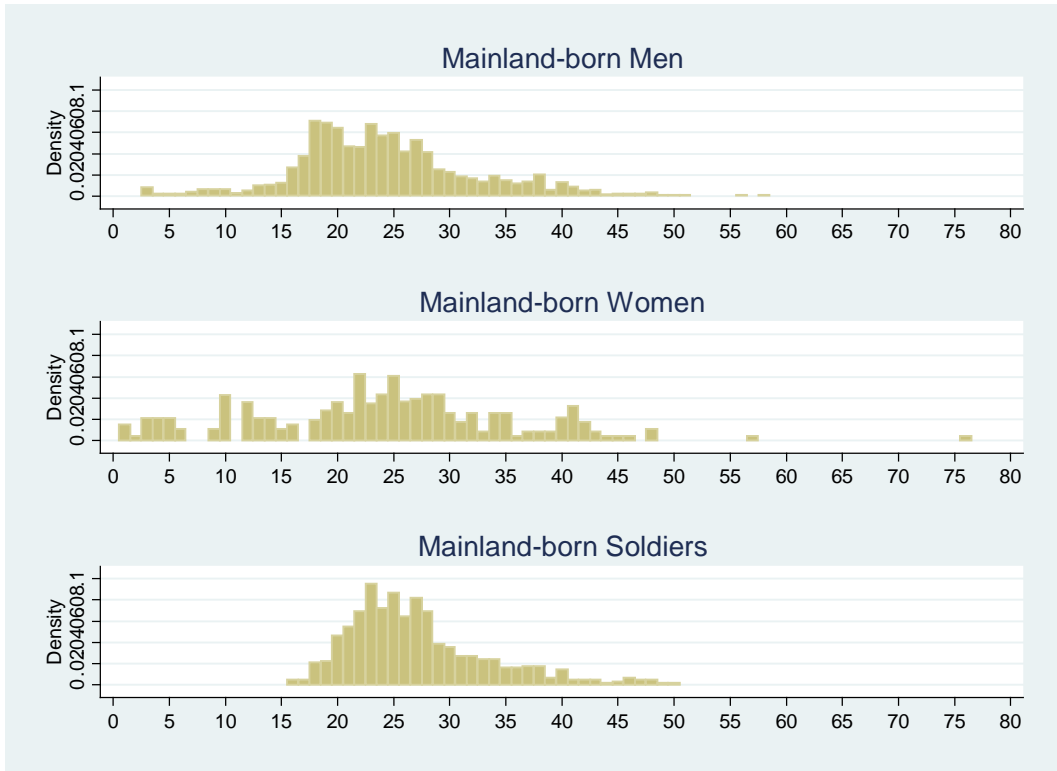
Figure 2. Age of arrival in Taiwan for those born in mainland China

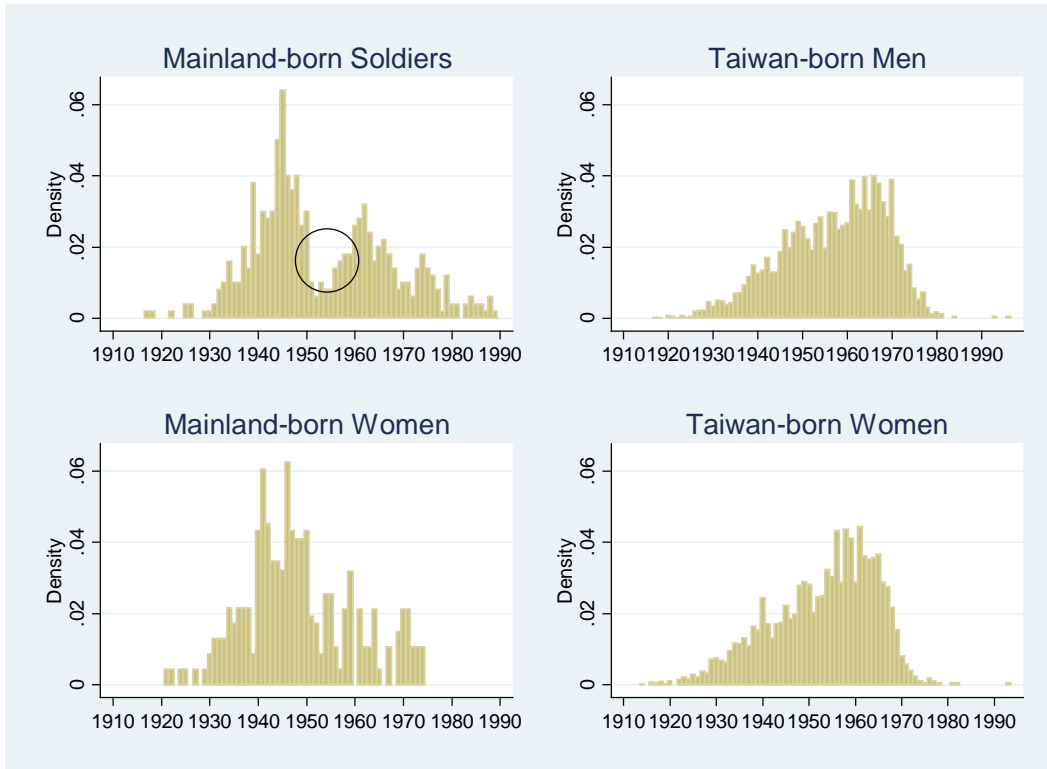Note: mainland-born soldiers refer to the cohorts born before 1930

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Figure 3. Year of first marriage

Notes: about 16% of the mainland-born men never got married; for the other three groups, the percentage is less than 2%; mainland-born soldiers refer to the cohorts born before 1930.
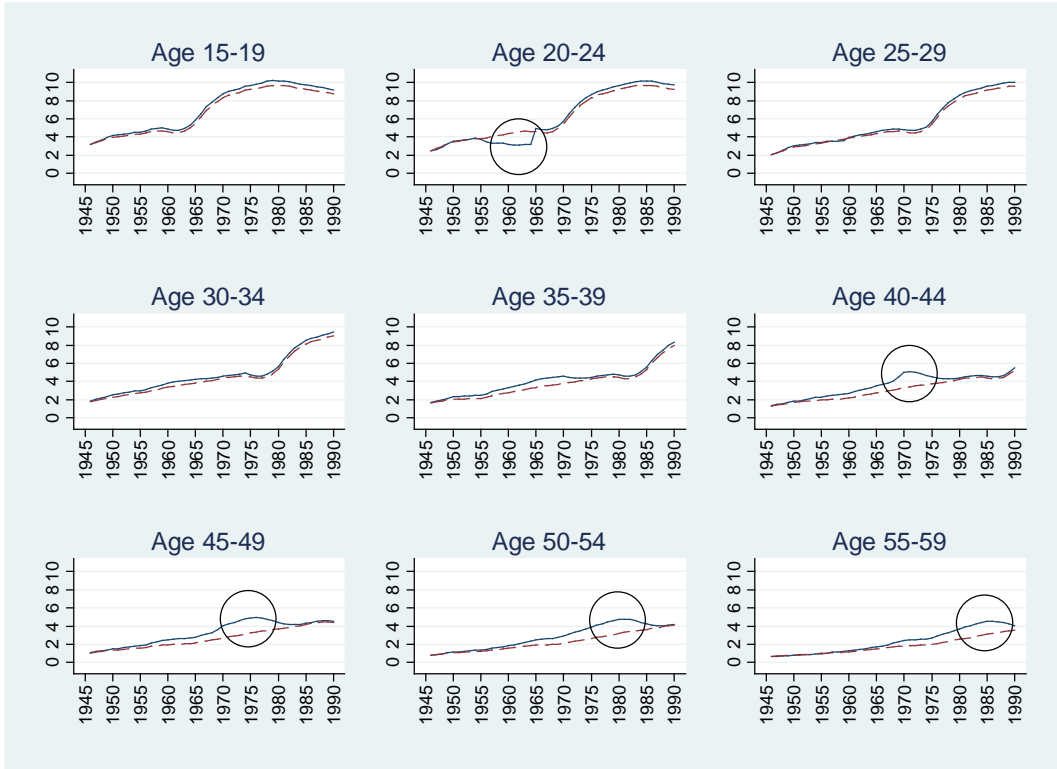
Figure 4. Age at first marriage

Notes: about 16% of the mainland-born men never got married; for the other three groups, the percentage is less than 2%; mainland-born soldiers refer to the cohorts born before 1930.

Figure 5. Age-specific population by sex: 1946-1990

Notes: the unit is 100,000 people; solid line indicates men; dash line indicates women
Data source: *Household Registration Statistics of Taiwan* (1946-1964); *Taiwan Demographic Fact Book* (1964-1973); *County-level end-of-year population by sex and age* (1974-1990), Department of Household Registration, Ministry of Interior, electronic file assessed at
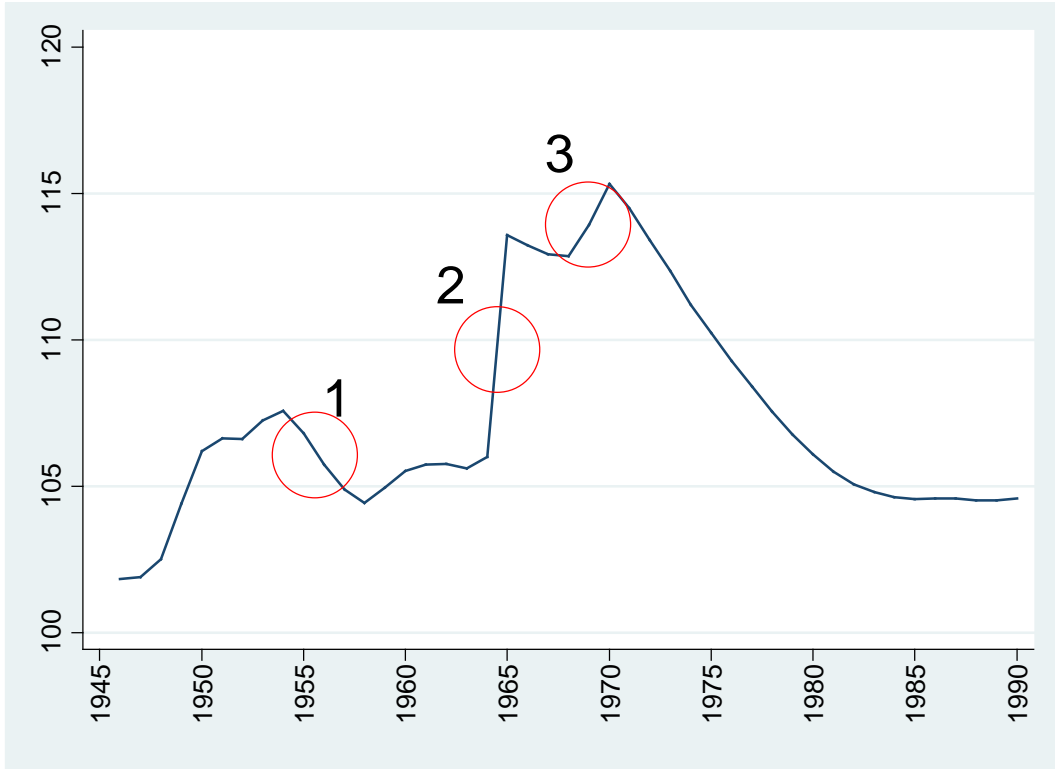http://www.ris.gov.tw/version96/population_01_C_02.html

Figure 6. Observed prime-age (15-49) sex ratio: 1946-1990

Data source: *Household Registration Statistics of Taiwan* (1946-1964); *Taiwan Demographic Fact Book* (1964-1973); *County-level end-of-year population by sex and age* (1974-1990), Department of Household Registration, Ministry of Interior, electronic file assessed at http://www.ris.gov.tw/version96/population_01_C_02.html
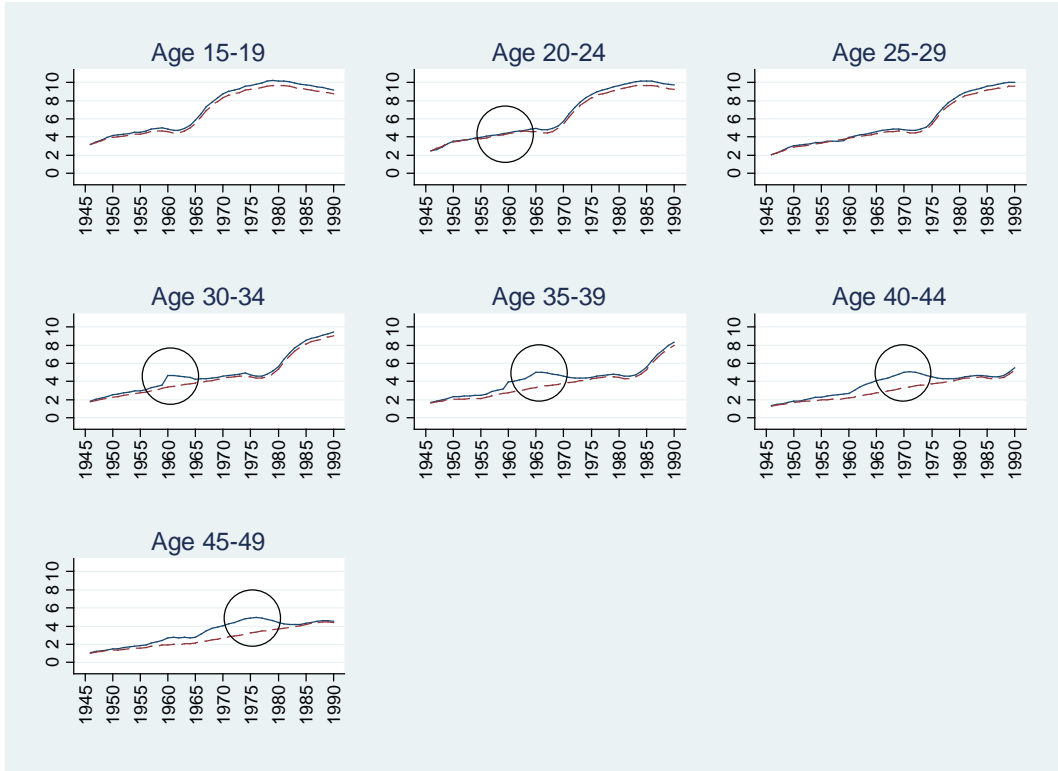
Figure 7. Imputed age-specific population by sex: 1946-1990

Notes: the unit is 100,000 people; solid line indicates men; dash line indicates women
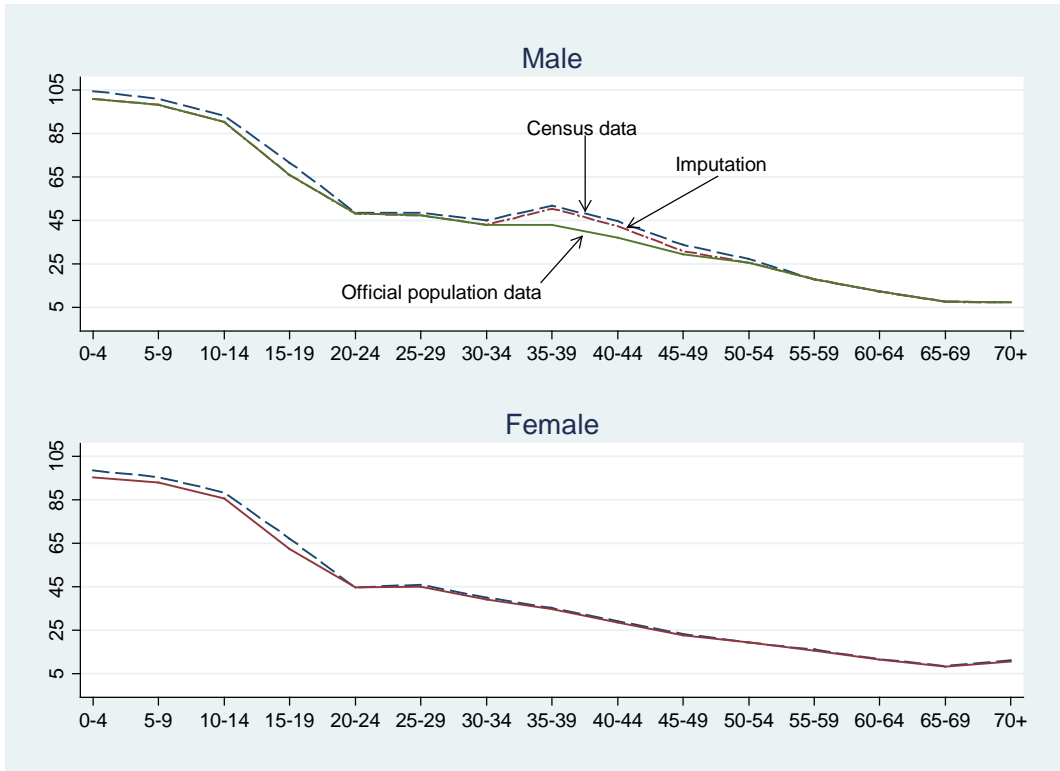
Figure 8. Comparison of official population data, census data and imputation in 1966 by sex

Notes: dash line indicates census data; solid line indicates official population data; dash-dot line indicates imputation; the unit is 10,000 people.
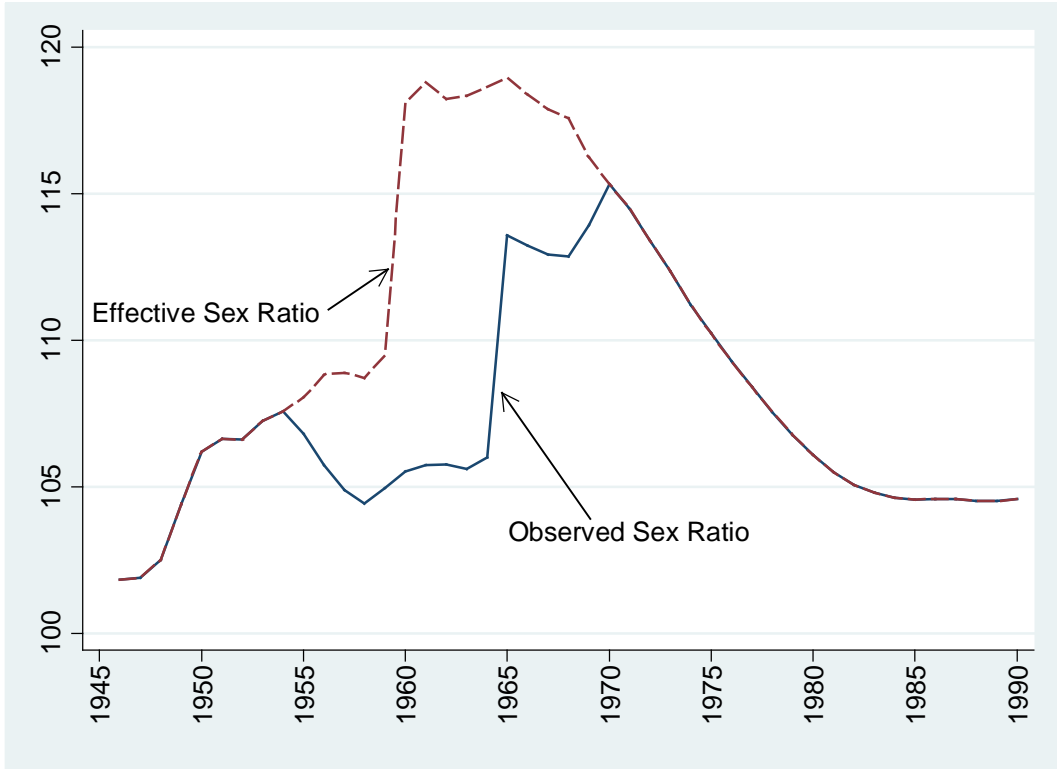
Figure 9. Effective prime-age sex ratio versus observed prime-age sex ratio