Chapter 9
Effects of a male-female imbalance

In this chapter we examine the effect on suicide rates of the fact of being deprived of family ties with spouse and children. It is known at least since the work of Emile Durkheim that unmarried people have a higher suicide rate than married people. It is our objective in the present and subsequent chapters to identify and test the various implications of this effect.

In normal conditions, it has little incidence on the total suicide rate because in most societies, unmarried people are a small minority; consequently, their higher suicide rate has only a small impact on total suicide rates. To be more specific, let us consider a population A of 100,000 people for which the suicide rate is 15 per 10^5 and which comprises only married people (for the sake of simplicity we suppose that there are no children). In such a population there are $n_A = 15$ suicides annually. How is this number modified in a population B similar to A in all respects except that it comprises 5% unmarried people. If we assume that the suicide rate of unmarried people is $15 \times 2 = 30$, the annual number of suicides will be: $n_B = (15/10^5) \times 0.95 10^5 + (30/10^5) \times 0.05 10^5 = 15.75$ which represents a relative increase of $(n_B - n_A)/n_A = 5\%$. As can be expected (and will be seen in more detail subsequently) a change of this magnitude is likely to be hidden by the background noise of suicide rates. If we consider a third population C which is identical to A and B except for the fact that it comprises 50% unmarried people, we get: $n_C = (15/10^5) \times 0.5 10^5 + (30/10^5) \times 0.5 10^5 = 22.50$ and $(n_C - n_A)/n_A = 50\%$. This calculation shows that a group of unmarried people will have an observable effect on suicide rates only if it represents about 50% of the population. This leads us to search for populations in which there is a high proportion of unmarried people. One can think of two mechanisms. (i) In populations characterized by strong gender imbalances some men (or women) will not be able to get married. This effect will be examined in the present chapter. (ii) For some reason, young people may postpone their marriage which will increase the suicide rate in young age groups. This effect will be examined in the next chapter.

After having reviewed the statistical evidence about increased suicide rates among unmarried people, we build a simple model based on this evidence which provides analytical formulas expressing suicide rates as a function of the males to females ratio r. In the rest of the chapter we set up quasi-experiments to confront these predictions with actual observations. Finally, once we have been able to convince ourselves that these formulas provide a fairly correct description, we discuss some of their possible implications, for instance the effect on suicides of the death of young males during major wars.

1 Suicide rates of unmarried versus married people

If, as implied by the network representation, the phenomenon of suicide reflects the sparseness and weakness of the ties which link up individuals with their society, then the lack of the marital bond should have a major and fairly universal effect on suicide rates. Table 9.1 summarizes the evidence for four different countries and for time intervals which cover more than one century. On average, the suicide rate for unmarried men is 2.4 times higher than for married men; for women the ratio is 1.9. Subsequently, these ratios will be denoted by k_m and k_f respectively.

An objection may be raised which we must discuss. Suicide rates are known to be age-dependent with higher rates in older age. As, in addition, the mean ages of single and married people are not the same, one may wonder if the ratios measured in Table 9.1 are not statistical artifacts. Fig. 9.1 answers this question. It shows that in every age group the suicide rates of unmarried people are higher than those of married people. In addition, we see that the ratio is largest for the age interval corresponding to the family building period of life, namely 30-45 years. During this period, married people have also close ties with their children.

One century ago, a substantial proportion of the population was living and working on farms. It was a way of life which implied fairly different roles for men and women. For instance, unmarried women were likely to stay on the farm with their parents at least if the farm was big enough to provide a living for all. On the contrary, young men were supposed to get married and to set up their own farms. However, in the course of time there was a gradual population shift to the secondary and tertiary sectors coupled with an increasing female employment rate. Under such conditions one would expect the lives and social networks of unmarried females and males to become more similar. This hypothesis can be tested statistically. If one computes the suicide rates of unmarried males and females one observes that there is a convergence process in which the rate of unmarried males strongly decreases while the rate of unmarried females increases slightly. The convergence documented in Table 9.2 suggests that over the past century the social networks of males and females have become more similar. Because these people are deprived of marital ties, which is normally the predominant factor, these rates enable us to probe the second circle of social ties. This convergence is less visible for married people because in this case it is the permanence of domestic ties which is the dominant factor.

> In a more general way, we can retain the idea that if one wishes to observe the effect of changes which occur outside of the family unit, it is a good strategy to study how they affect the suicide rates of unmarried people (for instance in the age group 15-24) rather than the rates in the general population in which married people are predominant.

2 Suicide rate in a population with a gender imbalance

We consider a population in which the male and female populations which we denote by M and F are not equal: $M/F = r \neq 1$. What is the effect of this imbalance on the suicide rate of males (t_m), females (t_f) and on the total suicide rate (t)? We denote by $\bar{t}_m, \bar{t}_f, \bar{t}$ the same rates in the case when $r = 1$. From the previous section we know that there will be an increased suicide rate for the men and women who remain single. Throughout this chapter we assume that the male-female imbalance is the only limiting factor in the number of marriages; such an assumption is acceptable when r is substantially different from 1, say $r > 1.5$, because in this case the number of unmarried people due to the imbalance is notably larger than the number of people who do not get married for other reasons[1].

Using a simple argument which is detailed in Appendix A, we find:

$$t_m = \begin{cases} \bar{t}_m & \text{if } r \leq 1 \\ (1/r)\bar{t}_m + (1 - (1/r))\, k_m \bar{t}_m & \text{if } r \geq 1 \end{cases} \tag{9.1}$$

Let us see how this expression can be interpreted. When $r \leq 1$ all men are married and it is therefore normal that their suicide rate is given by $\bar{t}_m$; when $r \geq 1$, t_m comprises two terms: (i) the term $(1/r)\bar{t}_m$ describes the suicides of the M men who are married (ii) the term $(1 - 1/r)k_m\bar{t}_m$ describes the suicides of the $M - F$ men how are unmarried; it is natural that for these men we have to use the suicide rate $k_m\bar{t}_m$ which characterizes unmarried people.

There are similar expressions for t_f and t (see Appendix A):

$$t_f = \begin{cases} r\bar{t}_f + (1 - r)\, k_f \bar{t}_f & \text{if } r \leq 1 \\ \bar{t}_f & \text{if } r \geq 1 \end{cases} \tag{9.2}$$

$$t = \begin{cases} [2r/(r+1)]\, \bar{t} + [(1-r)/(1+r)]\, k_f \bar{t}_f & \text{if } r \leq 1 \\ [2/(r+1)]\, \bar{t} + [(r-1)/(r+1)]\, k_m \bar{t}_m & \text{if } r \geq 1 \end{cases} \tag{9.3}$$

How many parameters do we have in this model? It can be noted that: $\bar{t} = (\bar{t}_m + \bar{t}_f)/2$, as a result there are 5 parameters: $r, k_m, \bar{t}_m, k_f, \bar{t}_f$. Naturally, these parameters

[1]In this chapter we consider mainly data for periods prior to 1960, a time when divorce rates were less than 3%. This is why the incidence of divorce can be neglected. It will be taken into account in the next chapter.

are not free parameters. In any population for which the male and female populations are known, r is determined. Furthermore, k_m and k_f must take values which are consistent with those in Table 9.1. Finally, if the same population can be observed not only for $r \neq 1$ but also for r close to 1, this observation will give estimates for $\overline{t}_m$ and $\overline{t}_f$. In such a case there are no free parameters in the model.

The formulas (9.1-3) are illustrated in the graph of Fig. 9.2. Let us for instance consider the section $r \leq 1$ of the middle curve of the total suicide rate; why is it an horizontal line? As r becomes smaller, there are more and more women in the population and this has two opposite effects (i) As men are replaced by women, the suicide rate is reduced because women have a smaller rate than men (ii) More and more women remain unmarried and these women have an inflated suicide rate with respect to married women. When these effects are of same magnitude they cancel each other with the result that the curve is horizontal. Such a cancellation occurs when $\overline{t}_m/\overline{t}_f = 2k_f - 1$.

In the next section we examine how the model described by formulas (9,1-3) can be tested.

3 Designing the experiment

In a previous chapter we emphasized that one of the main difficulties in the social sciences is the high level of "noise". By this term we understand the influence of all factors apart from the effect that one plans to observe. More precisely, if the signal that one tries to identify has an amplitude which is of same magnitude as (or smaller than) the standard deviation of the noise, one is in a situation in which it is difficult to draw any clear conclusion. Thus, the main requirement is to find situations for which the signal is the strongest possible. In order to illustrate this important (but often overlooked) point we first describe two experiments which were *not* successful. Nevertheless, they are probably not without interest because they show that it is only by a process of trial $\longrightarrow$ failure $\longrightarrow$ improvement that it is possible to progressively enhance the signal to noise ratio.

3.1 An unsuccessful experiment

We will try to test formula (9-A,3) for the ratio t_m/t_f. This ratio has the advantage of depending on only 3 parameters (apart from r). For this test we need a database which gives (i) Suicide rates by gender (ii) male and female population for determining the ratio $r = M/F$. WONDER is a database created and maintained by the Center for Diseases Control of the American Department of Health. This database in fact gives mortality rates for many causes of death; in the ICD-9 classification which was in use in the 1980s the code for death by suicide was 950-959. WONDER gives suicide data nationally, but also at state and county level. It could seem therefore that we are in a good position to carry out this investigation. If one remembers that there are 3,000 counties in the U.S. it is clear that we have a huge amount of data at our disposal. Moreover, the fact that the database covers more than 20 years gives us the possibility to carry out longitudinal (i.e. in the course of time) as well as cross-sectional (i.e.across states or counties) analysis. Because r does not change markedly over the 20 years covered by the data base it makes sense to try a cross-sectional analysis; because the number of suicides in many small counties would be too small, we make the cross-sectional analysis at state level. In the hope of reducing the dispersion, we ask WONDER to perform averages over the four years 1979-1983. The main advantage of summing up the suicides over 4 years is to increase the number of suicides in states which have a small population (New Hampshire, Rhode Island, etc.) and therefore to reduce statistical fluctuations.

Fig. 9.3 shows the results of the investigation for the 50 states and the District of Columbia. The points in the scatter plot are contained within a narrow interval $r \in (0.85, 1.15)$ but they have a great vertical dispersion in rate ratios. The coefficient of correlation turns out to equal to 0.20, which is a low and in fact nonsignificant correlation: the confidence interval for probability 0.95 is (-0.08,0.45). The thin line shows the theoretical curve given by the expression (9-A,4); the fact that it crosses the center of the scatter plot has been obtained by choosing the parameter $\gamma = \bar{t}_m/\bar{t}_f$ equal to 4 and k_m, k_f equal to 3.4 and 1.8 respectively. Unfortunately, the relationship that one wishes to observe is drowned in the background noise. Obviously, our first attempt failed miserably; it is of interest to understand why.

The main hurdle in the previous attempt is the fact that for 90% of the states r is comprised between 0.90 and 1.00. Remember in this respect that the effect is weaker for $r < 1$ than for $r > 1$; there are only 5 states for which r is larger than one, and even for these r is very close to 1. As a result the effect that we wish to observe is very weak. In addition, what makes the scatter plot of little usefulness is the huge dispersion. How can it be explained, what are the dispersion factors? The ethnic composition of the population is one factor of dispersion because Black people have suicide rates which are about one half of the rates of White people. This is why the suicide rate in Alabama is smaller than in Vermont. Population density, mean age of population are other factors of dispersion. In fact, it is precisely for this reason that we analyzed the rate ratio t_m/t_f rather than the rates themselves. Yet, even for the ratios the dispersion is too large. We can try to reduce it by considering a sample of states which is more homogeneous. For this purpose we restrict ourselves to states whose density of population is greater than 10 people par square kilometer; to reduce ethnic variability we focus on White people. In addition we restrict ourselves to a specific age interval, namely 20-45 years. All these constraints will of course diminish the number of suicides; to keep it nevertheless at an acceptable level we asked WONDER to sum up the 20 years from 1979 to 1998. As a result of these changes the dispersion of the rate ratio was indeed diminished to $\sigma = 0.45$ down from $\sigma = 0.67$ in the previous case. In spite of this (small) improvement the relationship between r and t_m/t_f remains invisible. If we wish to progress we need to make drastic changes.

3.2 Possible options

The main requirement is to increase the interval of variation of the sex ratio r. How can we do that? There are several options.

1) One may try to focus on groups of immigrants because it is well known that in such groups there are usually more men than women. This should at least enable us to explore the region $r > 1$.

2) Because men have a shorter life time than women, there are more women than men in populations of elderly people. This may enable us to explore the region $r < 1$.

3) In some social groups, for instance Roman Catholic priests, there is a high gender imbalance. Can we use such groups as testing grounds?

4) As some wars provoke a drastic reduction in the male population, the postwar periods should offer a good opportunity to explore the region $r > 1$. For instance, after the War of the Triple Alliance (1864-1870) which opposed Paraguay to Argentina, Brazil and Uruguay, the Paraguayan population which numbered 500,000 before the war, was reduced to about 220,000 of which only 30,000 were males, a situation which corresponds to a gender ratio $r = 0.16$. We come back to this point at the end of the chapter.

Which of the previous options are the most promising? A basic requirement is the *ceteris paribus* condition by which we mean that with the exception of the gender ratio, all other variables should remain unchanged. This requirement is hardly fulfilled in the third option. Indeed, as a social group, Roman Catholic priests differ from the rest of the population in many respects. (i) They may have close connections with other priests for instance with those with whom they share housing. (ii) They are the result of a process of social selection based on the fact that they decided to become priests. In short, it would be questionable to claim that priests are similar to the rest of the population in all other respects except their gender ratio. With respect to suicide rates, any comparison between priests and the general population would therefore be meaningless. In contrast the experiment described in option 1 does not have the same problem for in this case we do not have to compare a group of immigrants with the rest of the population; rather we can make comparisons for the same group at different dates, provided that the sex ratio changes in the course of time. For instance, Chinese immigrants in the United States (excluding Hawaii) had a sex ratio of 14 in 1910 and 1.90 in 1950. A possible objection could be raised: are the Chinese immigrants of 1910 really identical to those of 1950. Naturally, it is difficult to answer this question *a priori*; it is rather an assumption which is justified afterward by observing that the comparison works.

In the next section, we examine more closely the evidence regarding groups of immigrants.

4 Suicide rates as a function of sex ratio in groups of immigrants

According to census reports the sex ratio of Chinese immigrants reached a maximum of $M/F = 27$ in 1890 and then decreased steadily eventually reaching a quasi-equilibrium level of 1.02 in 1970. However, the annual volumes of the *Mortality Statistics of the United States* began to report suicide data for the Chinese population in 1923 only[2]. At that time, the sex ratio has already dropped to 5.9. It should be recalled that due to various anti-miscegenation laws, Asian immigrants could not marry white women even if they wished. Moreover, because of restrictive immigration laws, few Asian women could join them. This explains why the gender ratio decreased fairly slowly. In response to this situation, Asian immigrants created a system by which bachelors were adopted as uncles into existing families whose women functioned as surrogate mothers, sisters and aunts to those men (CAPAA 2001). Thanks to the steady decrease of the gender ratio between 1923 and 1970 we have a

[2]High sex ratios among immigrant groups whether in Australia, Saudi Arabia or other countries are fairly common; however, specific suicide data are available in very few cases only. Any other documented minority case apart from those that we study in this chapter would be of great interest.

spectrum of situations characterized by a broad range of sex ratios. This is precisely what we need. Moreover, all these cases are in the region $r > 1$ where the effect is strongest. There is a last requirement that must be checked: are the populations large enough to produce a substantial number of suicides? Table 9.3 summarizes the populations of the three groups under consideration. With a population of only 28,700 the Chinese immigrants in Hawaii are the smallest group. A suicide rate of the order of 30 per 100,000 implies that there are about $30 \times 0.28 = 8$ suicides a year. With such small numbers the volatility would be fairly large. This is confirmed by the numbers of suicides observed for instance from 1936 to 1940, namely 2,7,9,9,5 which gives a coefficient of variation σ/m as large as 46%. In order to reduce the statistical fluctuations we summed up the suicides over 5-year periods. The choice of this 5-year interval is a compromise between two opposite requirements: reducing the fluctuations but nevertheless keeping enough separate points.

We consider three cases:

- Chinese and Japanese immigrants in continental America, 1923-1960.
- Chinese and Japanese immigrants in Hawaii, 1916-1950.
- White immigrants in Alaska, 1945-1990.

It is natural to consider the immigrants in Hawaii and in the continental part of the United States as two separate cases because the social environments were fairly different. On the continent the Chinese and Japanese communities were in contact with a population which was overwhelmingly of European descent. On the contrary, in Hawaii, people of European descent were a small and diverse group. In 1920 it totaled 21% of the population of Hawaii and comprised many people from Portuguese or Spanish origin who came to Hawaii before it became an American possession. In spite of these different social environments the two cases follow the same rule as far as suicide rates are concerned; this illustrates the robustness of the dependence between suicide rates and sex ratio.

Total suicide rates are shown in Fig. 9.4 a,b; male and female rates are shown in Fig. 9.4c for the Japanese population. We did not represent the male and female rates for the Chinese population because of the fact that the high sex ratio implies that the female population is too small to produce significant numbers of suicides which results in high statistical fluctuations. Moreover, and for the same reason, the male suicide rate is almost identical to the total suicide rate.

In the three graphs of Fig. 9.4 a,b,c the thin line represents the suicide rates as defined by the theoretical formulas given earlier. The set of parameters is the same for the three graphs, namely:

$$\overline{t}_m = 18, \quad \overline{t}_f = 10, \quad k_m = 4.19, \quad k_f = 1.9 \tag{9.4}$$

The values of k_m and k_f are consistent with the evidence presented in Table 9.1, except for the fact that k_m is somewhat higher than would have been expected. The values of $\overline{t}_m$ and $\overline{t}_f$ are determined by the magnitude of the suicide rates in the vicinity of $r = 1$. Thus, we implicitly assume that these parameters did not substantially change in the course of several decades.

As Fig. 9.4d refers to the White minority of Alaska, it is natural to use another set of parameters, namely:

$$\overline{t} = 8, \quad \overline{t}_m = 21, \quad k_m = 2.9 \tag{9.5}$$

The value $\overline{t} = 8$ should be compared with the previous value $\overline{t} = (1/2)(\overline{t}_m + \overline{t}_f) = 9$. As can be seen, except for k_m the two sets of parameters (9.4) and (9.5) are not very different.

5 Cross-sectional analysis

Our previous attempts in cross-sectional analysis failed because the sex ratio was confined in a narrow interval around $r = 1$. In the light of the previous section one may wonder if the situation can be improved by using data from the early twentieth century, when immigrant groups, particularly in the West, were still characterized by sex ratios notably different from 1. One obstacle for the realization of this plan is the fact that at the beginning of the twentieth century the death registration area comprised only 14 states. Fortunately, the registration area also comprised a number of registration cities in states which were not globally registration states. For instance, in spite of the fact that Nebraska did not belong to the registration area in 1906, its two cities of Lincoln and Omaha were registration cities. Piecing together these data, we get the graph in Fig. 9.5. There are only 5 points whose gender ratios are significantly different from 1. In other words, even in this improved form, cross-sectional analysis is less satisfactory than longitudinal analysis.

6 Male - female imbalance induced by war

The death of millions of soldiers on the battlefields of World War I and II created situations marked by substantial male-female imbalances in several countries. This is illustrated in Fig. 9.6 a,b by the cases of France after World War I and Japan after World War II. In contrast to previous cases, the imbalance does not concern the whole population but only specific age groups. In both cases, there are age groups characterized by sex ratios under 0.80.

Under the assumption (that we make for the sake of simplicity) that the average marriage age is the approximately the same for men and women, the female age group that should be the most affected by the war is the group of women who are of same age as the soldiers who died on the battlefields. As the later mainly belongs to the group of men who were 20-24 year old during the war, one expects the effect to be largest for women in the same age group; we denote it by $a = (20, 24)$ and will refer to it as the war age group. If we denote by $M(a)$ and $F(a)$ the male and female populations of a, we can apply to these variables the argument used previously. One gets:

$$t_f(a)/\overline{t}_f = 1 + \epsilon(k_f - 1) \tag{9.6}$$

where $t_f(a)$ is the female suicide rate in age group a, $\bar{t}_f$ is the female suicide rate in the equilibrium situation $r = 1$ and $\epsilon = 1 - r(a)$ with $r(a)$ denoting the sex ratio in age group a. Formula (9.6) will enable us to estimate the magnitude of this effect in different cases.

France after World War I Fig. 9.6a gives $r(a) = 0.80$, for k_f we take the value given in table 9.1: $k_f = 1.8$; replacing in (9.6) gives: $t_f(a)/\bar{t}_f = 1 + 0.2 \times 0.8 = 1.16$.

Paraguay after the Triple Alliance War In this case $\epsilon = 0.84$, if we assume the same value of k_f as in the previous case we get: $t_f(a)/\bar{t}_f = 1 + 0.84 \times 0.8 = 1.67$. This second effect would certainly be large enough to be observable; unfortunately, so far we were not able to find statistical data for this case. The first effect is fairly small. Moreover, there are several side effects which complicate the detection.

1) We do not know the magnitude of the delay between the war and the occurrence of the excess-suicides. Even though their age group has been depleted, the women of the war age group may entertain the hope of finding a husband in another age group. Therefore their possible suicide may occur several years after the war.

2) In addition to the male-female imbalance, there may also be female suicide induced by the death of soldiers who were already married or engaged. These suicides may occur soon after the war or perhaps even during the war; in truth, once again we do not know the time lag between link severance and suicide.

3) In addition to the two previous effects it is likely that the deaths of young males will result in increased suicide rates in the group of their parents. The incidence of the loss of a son has been little studied because this condition is not reported on death certificates. Such an effect should be expected on account of the general rule that the severance of a link results in greater suicide rates.

4) Still another effect should be mentioned which does not play a role in World War I but may play a great role in World War II. During 1940-1943, there were about one million French prisoners of war in Germany. Moreover, in many occupied countries nationals were asked to work in Germany for periods of one or two

years. In both cases, the suicides occurring among these populations may not have been recorded in their country of origin. As a result suicide rates may have been underestimated during the time of the war.

In this chapter we discussed the increase in suicide rates due to the impossibility of establishing marital bonds. In the next chapter, we investigate the effects on suicides of cracks that may occur in marital bonds.

A Appendix A: Suicide rate in a population with a sex ratio $r \neq 1$

In this appendix we establish the formulas for the male, female and total suicide rates. M and F denote the populations of males and females respectively.

First we consider the case where there are more males than females. The F men who are able to get married give rise to a number of suicides equal to: $Ft_m(r, \text{married})$ where $t_m(r, \text{married})$ denotes the suicide rate of married males in a population whose sex ratio is r. $t_m(r, \text{married})$ is not necessarily equal to $\bar{t}_m$, the rate in a balanced male/female population because it cannot be excluded that the suicide rate of men is affected by the sex ratio prevailing in the society. However, for the sake of simplicity and because of the lack of empirical data, we will assume that for $r > 1$: $t_m(r, \text{married}) = \bar{t}_m$.

The number of unmarried men is $M - F$. The suicide rate in this subgroup is $k_m t_m(r, \text{married}) = k_m \bar{t}_m$. As a result the total number of male suicides is: $s_m = F\bar{t}_m + (M - F)k_m\bar{t}_m$ and the suicide rate $t_m = s_m/M$ becomes:

$$t_m = (F/M)\bar{t}_m + (1 - F/M)k_m\bar{t}_m = (1/r)\bar{t}_m + (1 - 1/r)k_m\bar{t}_m$$

If there are more females than males, all males are married and their suicide rate is equal to $t_m(r, \text{married})$; as in case $r > 1$, we assume that this rate is equal to $\bar{t}_m$. This leads to the result:

$$t_m = \begin{cases} \bar{t}_m & \text{if } r \leq 1 \\ (1/r)\bar{t}_m + (1 - 1/r)\, k_m\bar{t}_m & \text{if } r \geq 1 \end{cases} \tag{9-A.1}$$

For females, a similar reasoning leads to:

$$t_f = \begin{cases} r\bar{t}_f + (1 - r)\, k_f\bar{t}_f & \text{if } r \leq 1 \\ \bar{t}_f & \text{if } r \geq 1 \end{cases} \tag{9-A.2}$$

We now use these expressions to compute the total suicide rate t:

$$t = \frac{Mt_m + Ft_f}{M + F} = \frac{rt_m + t_f}{r + 1}$$

Suppose that $r \geq 1$; replacing t_m and t_f by their expressions we get:

$$t = \frac{1}{r+1}(\bar{t}_m + \bar{t}_f) + \frac{r-1}{r+1}k_m\bar{t}_m$$

We introduce the total suicide rate $\overline{t}$ in a balanced population: $\overline{t} = (\overline{t}_m + \overline{t}_f)/2$, thus:

$$t = \frac{2}{r+1}\overline{t} + \frac{r-1}{r+1}k_m\overline{t}_m \quad r \geq 1 \tag{9-A.3a}$$

A similar calculation in the case $r \leq 1$ leads to:

$$t = \frac{2r}{1+r}\overline{t} + \frac{1-r}{1+r}k_f\overline{t}_f \quad r \leq 1 \tag{9-A.3b}$$

Finally, we write the expression for the ratio t_m/t_f which depends only on the ratio $\overline{t}_m/\overline{t}_f$ that we denote by γ:

$$t_m/t_f = \begin{cases} \dfrac{1}{r+(1-r)k_f}\,\gamma & \text{if } r \leq 1 \\ [1/r + (1-1/r)k_m]\,\gamma & \text{if } r \geq 1 \end{cases}, \quad \gamma = \overline{t}_m/\overline{t}_f \tag{9-A.4}$$

Apart from r which can be estimated from the population data, the ratio t_m/t_f depends only on 3 parameters: k_m, k_f and γ; the other side of the coin is that (except for large populations) the number of female suicides is fairly small which results in great fluctuations of t_f and in large error bars for the ratio t_m/t_f.

Table 9.1 Influence of family ties on suicide rates

	Time interval	Country	Males	Females
			Ratio of suicide rates: unmarried/married	Ratio of suicide rates: unmarried/married
1	1889 – 1891	France	2.80 ± 0.23	1.56 ± 0.43
2	1881 – 1890	Switzerland	1.66 ± 0.24	1.34 ± 0.41
3	1911 – 1920	Norway	2.56 ± 0.83	2.18 ± 1.21
4	1968 – 1978	France	2.69 ± 0.66	2.24 ± 1.10
5	1970 – 1985	Norway		1.78 ± 0.24
6	1981 – 1993	France	2.34 ± 0.33	2.15 ± 0.91
7	1982 – 1996	Britain	1.44 ± 0.12	1.27 ± 0.20
8	1990 – 1992	Queensland	2.67 ± 1.20	2.11 ± 1.60
9	1998 – 1998	Australia	2.21	2.00
		Average	2.30 ± 0.24	1.85 ± 0.32

Notes: In most cases (except 9) detailed data by age interval were available. We computed the ratios of the suicide rates in each age interval and then the average m and the standard deviation σ of the ratios. The results in the table are given in the form $m \pm \sigma$. It should be noted that the category “married” includes both “married without children” and “married with children”; consequently, the reduced suicide rates for “married” should not be attributed solely to marriage but to the combined effect of being married and having children. It can be noted that the figures for Britain and Switzerland are curiously out of range.
Sources: 1: Durkheim (1897); 2: Halbwachs (1930); 3: Statistiske Centralbyrå (1926, table 22); 4: Besnard (1997); 5: Høyer et al. (1993); 6: Besnard (1997); 7: Kelly and Bunting (1998, Fig. 4); 8: Cantor et al. (1995); 9: Steenkamp et al. (2000).

Table 9.2 Suicide rates of unmarried people: male vs. female

	$1889-1891$	$1968-1973$	$1979-1983$	$1989-1993$
Unmarried males, 30-59 y.	101	65.4	76.5	65.8
Unmarried females, 30-59 y.	16.7	17.2	24.0	23.1
Ratio M/F	6.0	3.8	3.2	2.8

Notes: The table shows that over the past century suicide rates of unmarried males and females have become closer. There was a similar, albeit slower, trend for the rates of married men versus married women: for the 30-59 age interval the ratio decreased from 3.20 in 1889-1891, to 2.45 in 1989-1991.
Source: Besnard (1997).

Table 9.3 Population and sex ratio of immigrant groups in the United States, 1940

	Continental U.S. Population $[10^3]$	M/F	Hawaii Population $[10^3]$	M/F	Alaska Population $[10^3]$	M/F
Chinese	77.5	2.9	28.7	1.3		
Japanese	127	1.3	158	1.2		
Filipinos			52.6	3.5		
Whites					40	2.0

Sources: Census of the United States 1940, Vol.I and Vol. II; Nordyke (1989).

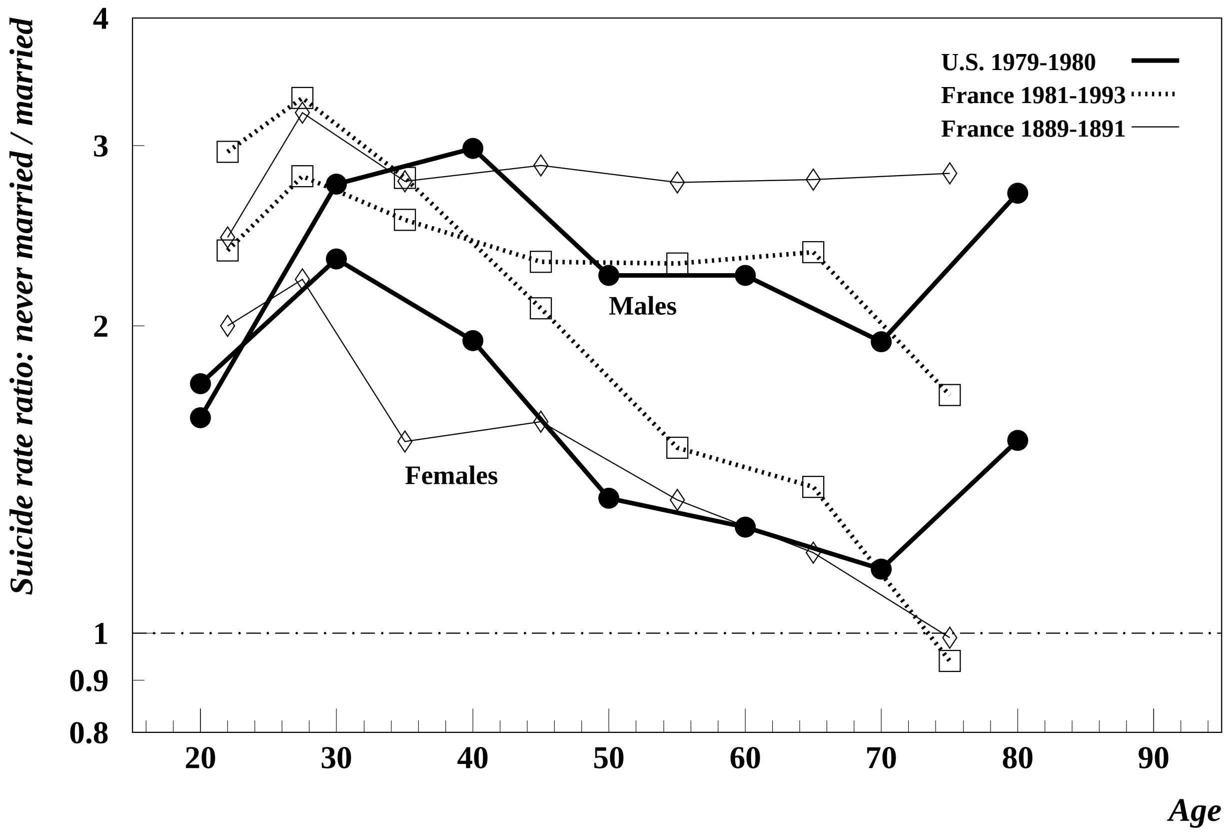

Fig. 9.1 Ratio of suicide rates: unmarried/married All ratios in all age groups (under 75) are higher than 1 which means that the suicide rates of unmarried people are higher than the suicide rates of married people not only globally, but also in each age group. Moreover, in a general way, the ratio is higher for males than for females; the only exceptions are the first three points of the curve for France 1981-1993. For both men and women the ratio is largest during the age interval 30-45. *Sources: United States: Vital Statistics of the United States, 1979 and 1980, Vol. 2, Part I, section 1, p. 323; population of age groups: Statistical Abstract of the United States (1981, p. 38); France: 1981-1993: Besnard (1997); France 1889-1891: Durkheim (1897, table 21).*

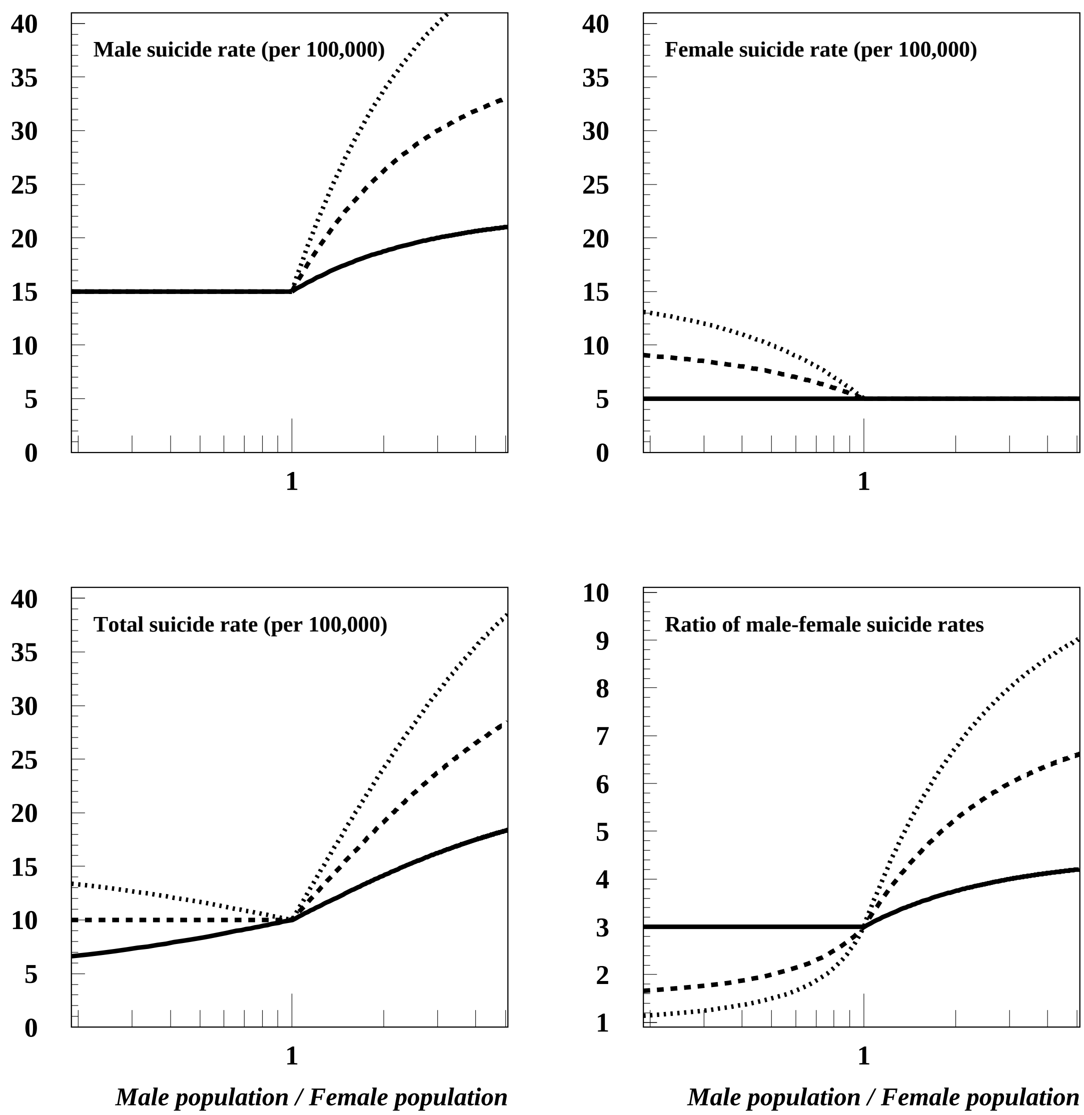

Fig. 9.2 Suicide rate as a function of sex ratio. The graphs shows the suicide rates given by formulas (9.1-3). All curves correspond to $\overline{t}_m = 15,\ \overline{t}_f = 5$, but to different values of the coefficients k_m and k_f; for the lowest curves: $k_m = 1.5,\ k_f = 1.0$, for the middle curve: $k_m = 2.5,\ k_f = 2.0$, for the upper curves: $k_m = 3.5,\ k_f = 3.0$

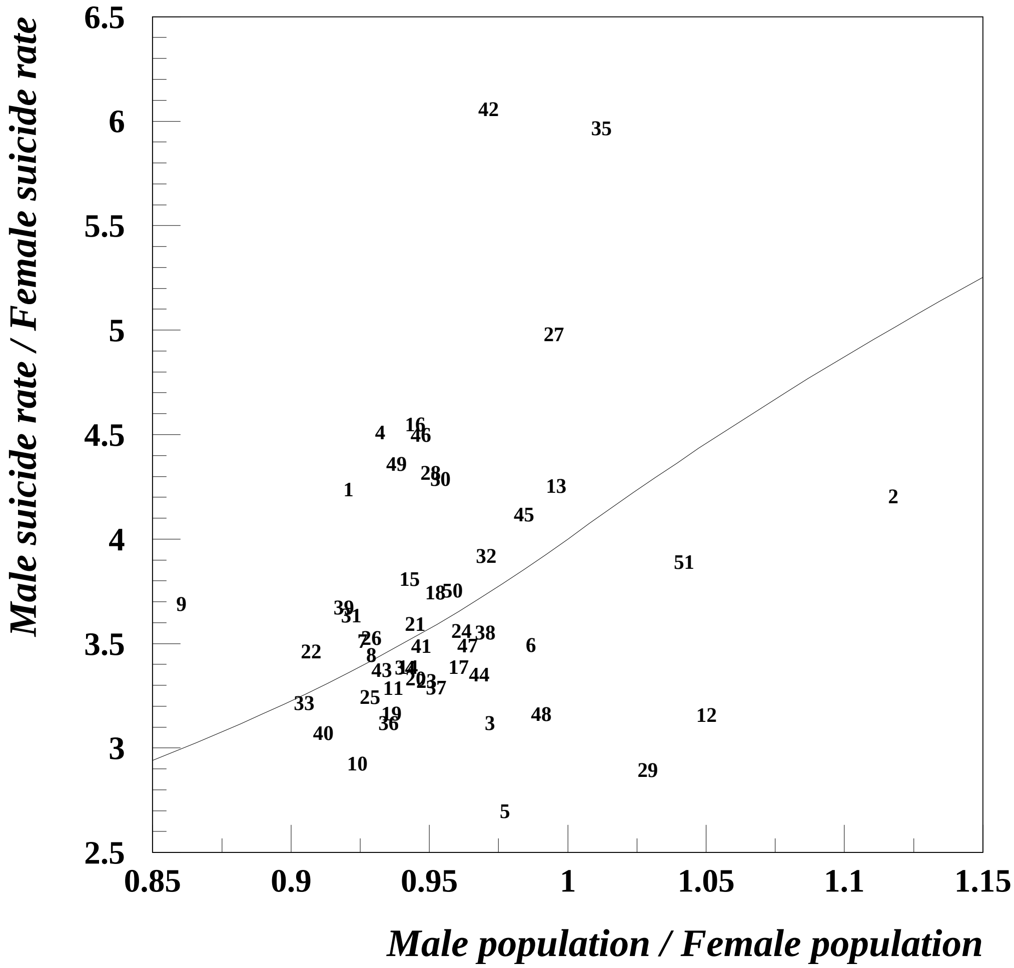

Fig. 9.3 A failed attempt to test formula (9-A,4) Formula (9-A,4) gives the ratio of the male to female suicide rates as function of the sex ratio r for 50 American states and the District of Columbia (label 17). The three parameters of (9-A,4) have been chosen in such a way that the thin line crosses the center of the scatter plot, namely $\overline{t}_m/\overline{t}_f = 4.0,\ k_m = 3.4,\ k_f = 1.9$. However, the dispersion of the data points is too large to allow any clear conclusion. *Sources: WONDER data base (website of the Center for Diseases Control)*

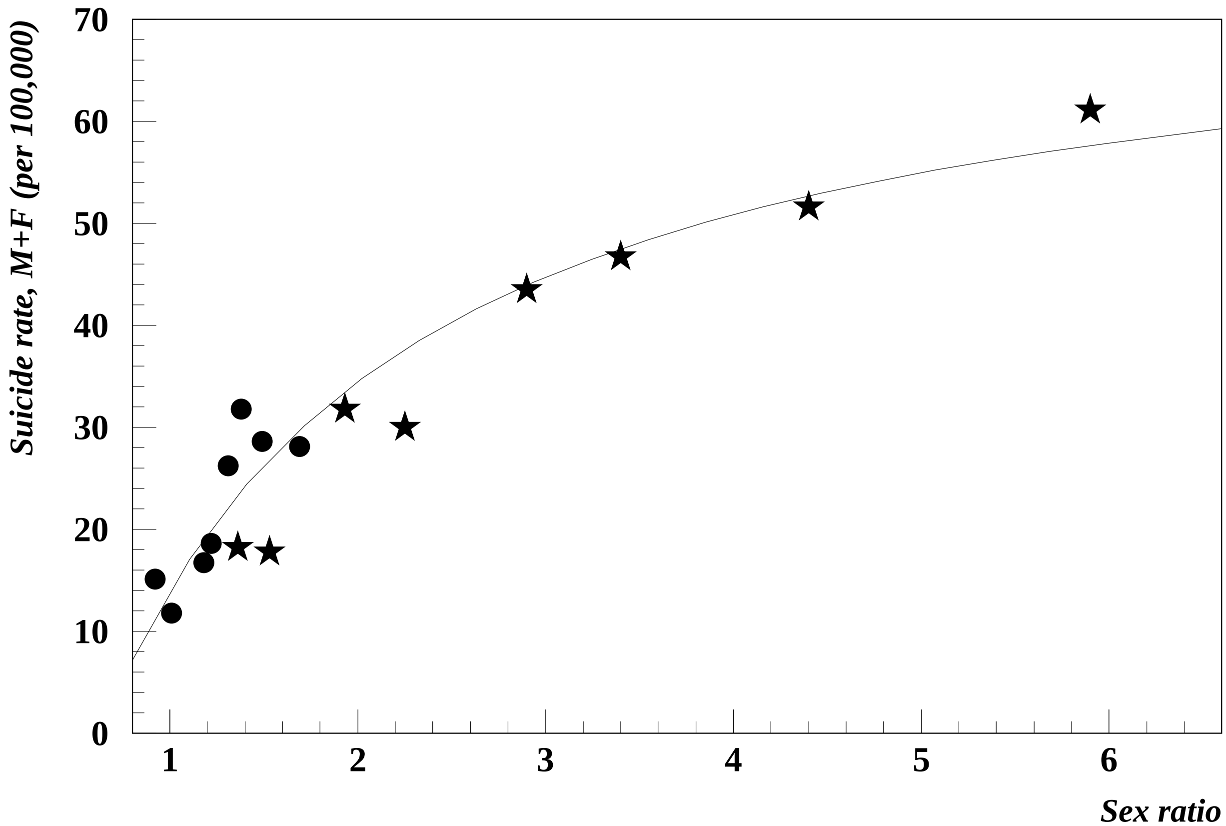

Fig. 9.4 a Suicide rates in the Chinese and Japanese community of the Unites States. The graph shows the (total) suicide rates of people of Chinese (stars) and Japanese (black dots) descent established in the continental part of the U.S. as a function of the sex ratio of these communities. The star on the right-hand side corresponds to 1923-1924; in subsequent years the sex ratio of the Chinese community decreased steadily. The thin line corresponds to formula (9.3) with the following parameters: $\overline{t} = 14,\ \overline{t}_m = 18,\ \overline{t}_f = 10,\ k_m = 4.19,\ k_f = 1.9$ (only $\overline{t}, \overline{t}_m$ and k_m are needed here). *Sources: Mortality Statistics of the United States and Vital Statistics of the United States, various volumes; all volumes are available online on the website of the National Center for Health Statistics.*

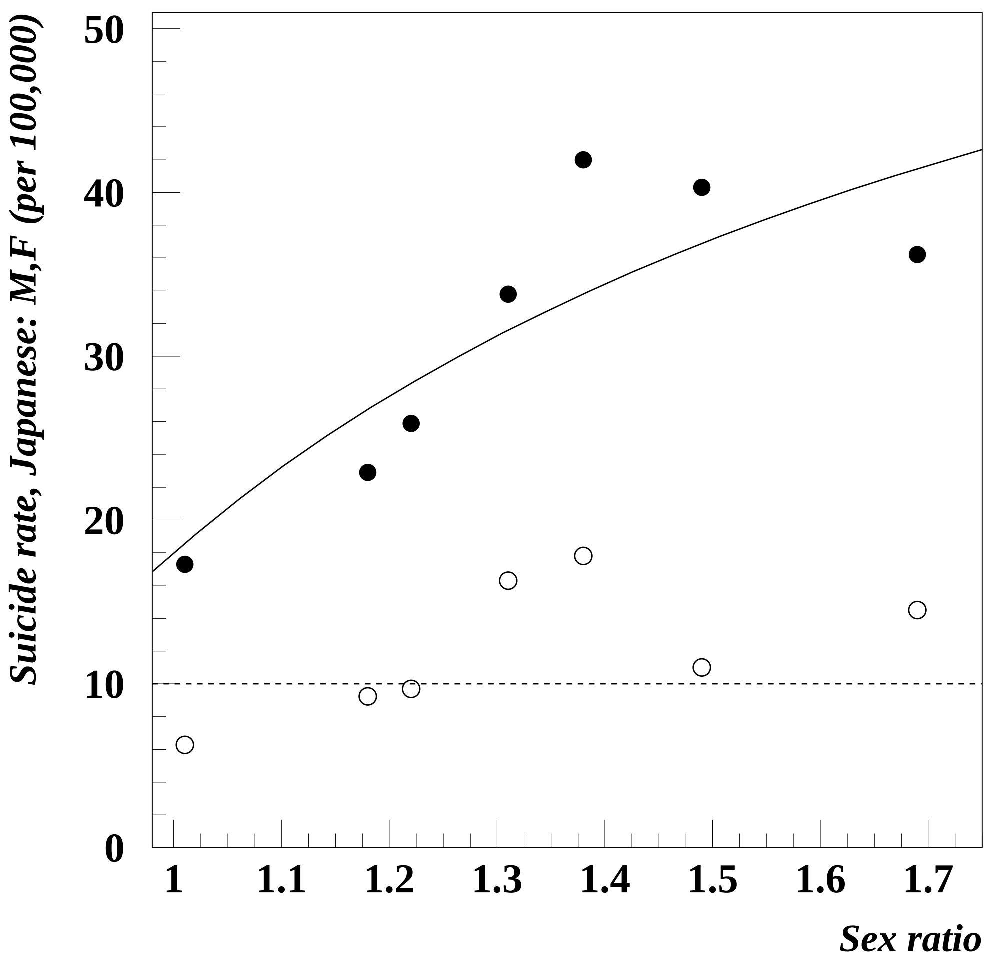

Fig. 9.4 b Male and female suicide rates in the Japanese community of the United States. The heavy dots correspond to males, the light dots correspond to females. The data cover the period 1923 (highest sex ratio) to 1955 (lowest sex ratio). The thin lines correspond to formulas (9.1) and (9.2) with the same set of parameters as in the previous graph. In the region $r > 1$ the theoretical curve for the female suicide rate is an horizontal line. In the 1920 the suicide rates of Japanese males and females in Japan were 24 and 15 per 100,000 respectively. *Sources: Same as for Fig. 9.4a.*

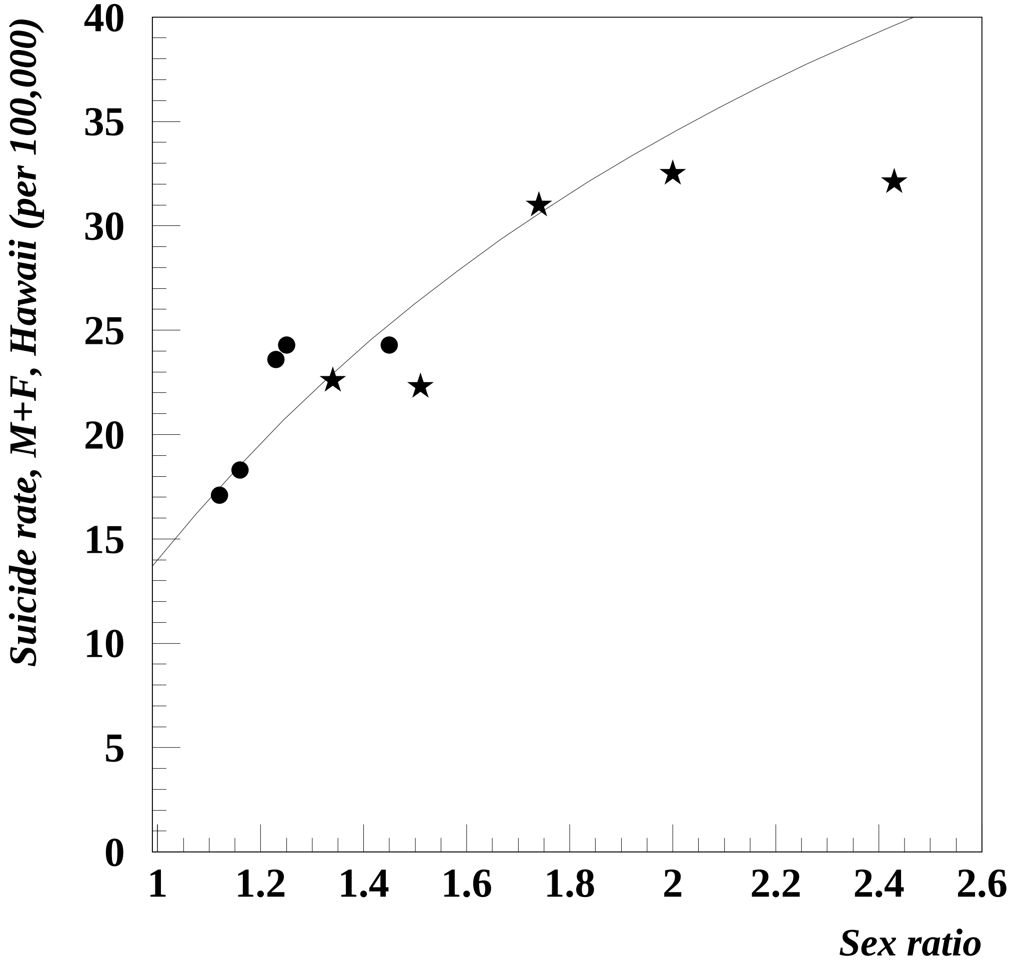

Fig. 9.4 c Suicide rates in the Chinese and Japanese community of the Unites States. This graph is similar to Fig. 9.4a but for the Chinese and Japanese communities in Hawaii. The thin line corresponds to formula (9.3) with the same set of parameters. *Sources: Same as for Fig. 9.4a.*

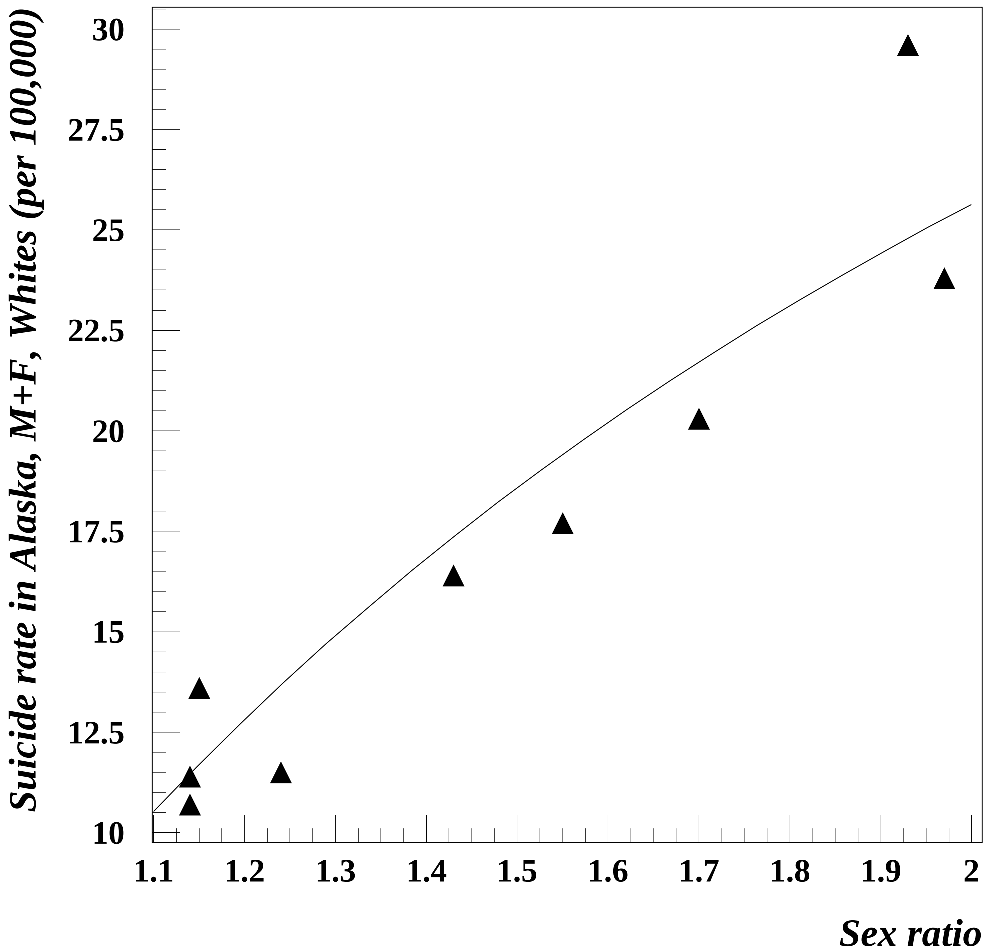

Fig. 9.4 d Suicide rates of White people established in Alaska The graph shows the (total) suicide rates of white people established in Alaska as a function of the sex ratio of this community. The sex ratio decreased steadily in the course of time. The data cover the period 1945 (highest sex ratio) to 1981 (lowest sex ratio). In 1945 the average American suicide rate was 11.5, in 1981 it was equal to 12. Thus, when the sex ratio was equal to 2 the suicide rate of Whites in Alaska was twice the American rate; once the sex ratio has dropped to 1.1 the suicide rate of Whites in Alaska is almost at the same level as in the rest of the U.S. The thin line corresponds to formula (9.3) with $\overline{t} = 8,\ \overline{t}_m = 21,\ k_m = 2.9$. *Sources: Same as for Fig. 9.4a.*

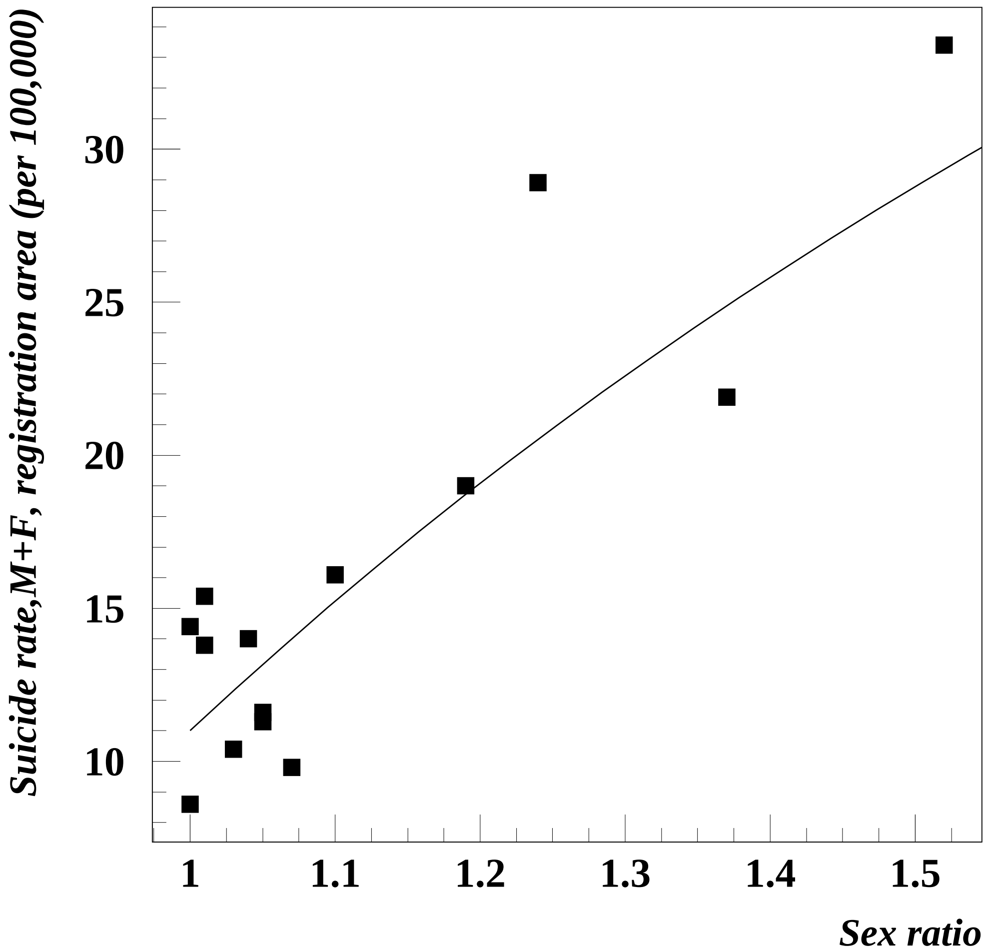

Fig. 9.5 Cross-sectional analysis for suicide rates as a function of sex ratio. The graph is for U.S. states or cities in 1906. Each square corresponds to a state or a city belonging to the death registration area. The places with the highest sex ratio are mainly located in the West. The thin line corresponds to formula (9.3) with parameters: $\bar{t} = 11,\ \bar{t}_m = 27,\ k_m = 3.7$. No clear conclusion can be drawn because the dispersion is too large. *Sources: Same as for Fig. 9.4a.*

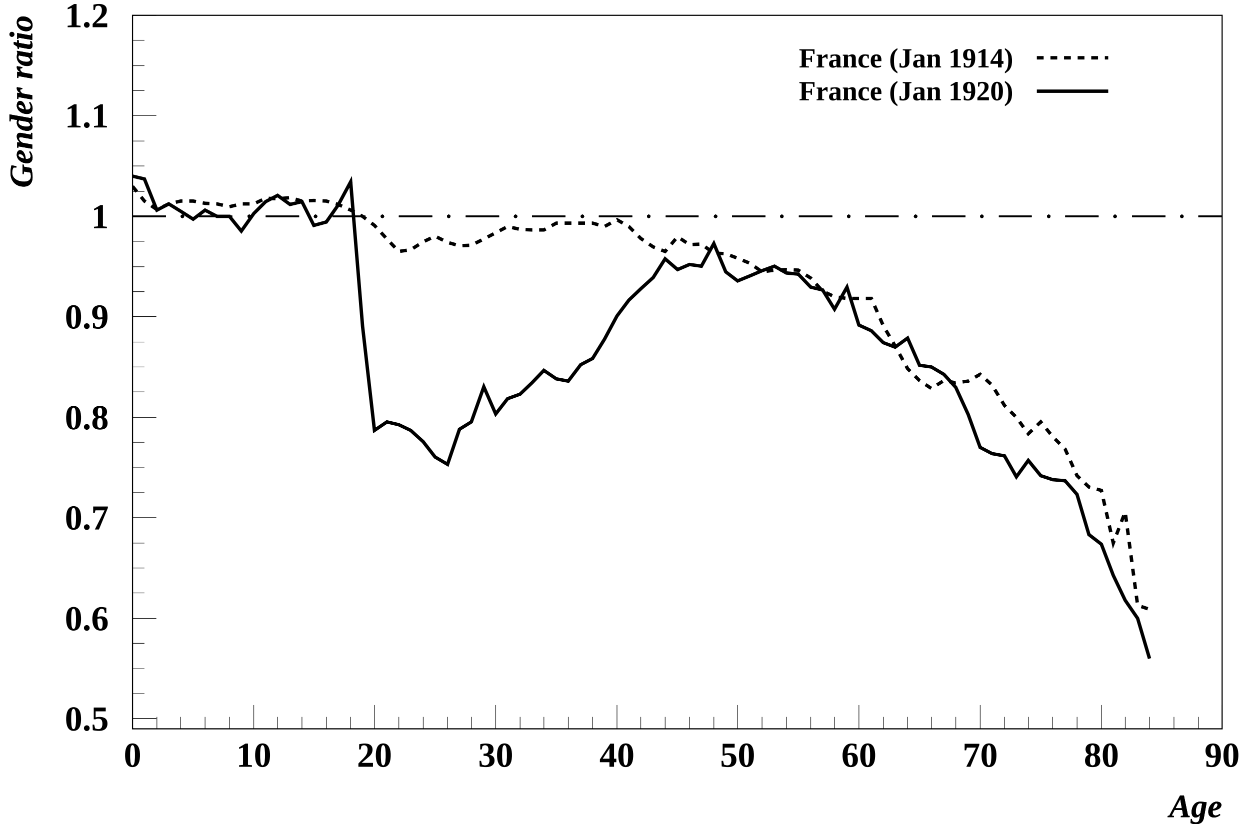

Fig. 9.6 a Gender ratio in the French population as a function of age. The graph shows the gender ratio before and after World War I. For the people who are 25 year old in 1920 the sex ratio is 0.78. *Source: Daguet (1995)*

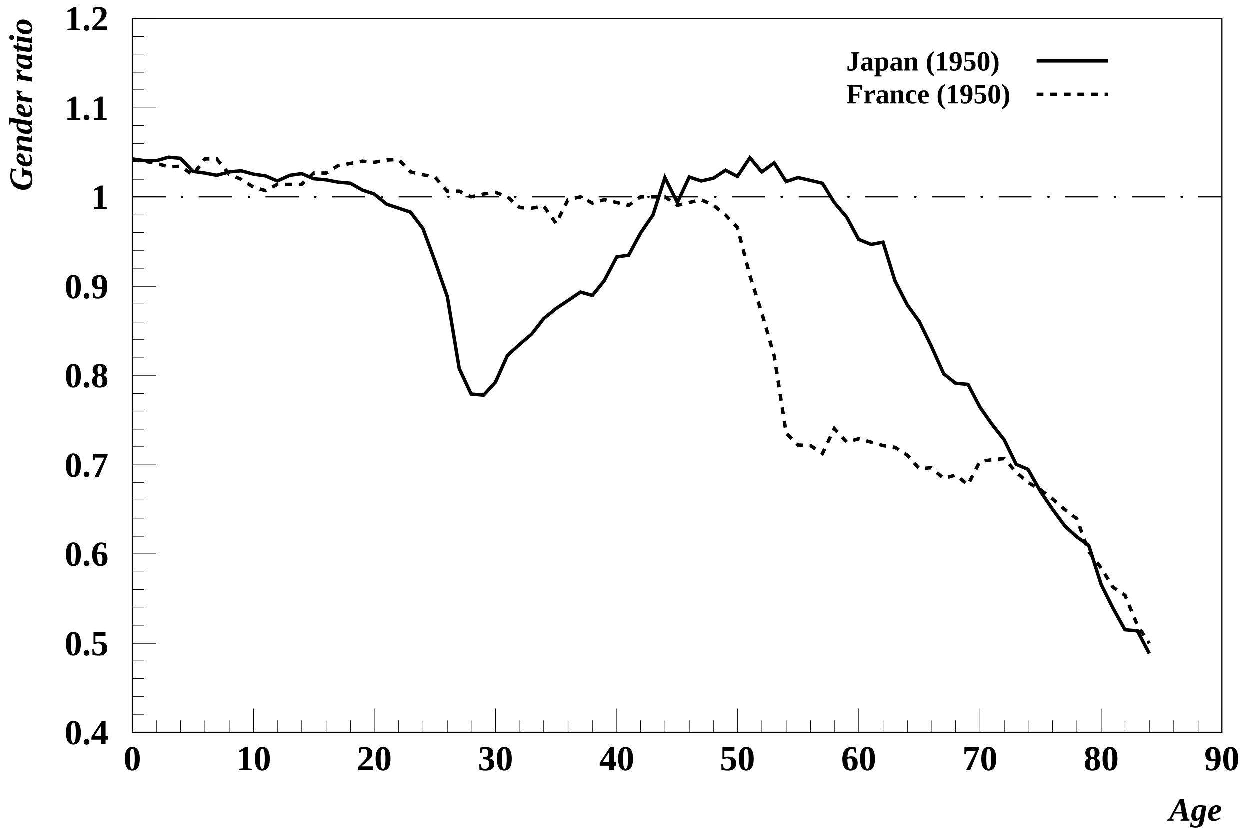

Fig. 9.6 b Comparison of the French and Japanese gender ratio in 1950. The trough for French people over 50 correspond to the First World War; with respect to the previous graph the trough became deeper because men have a shorter life expectancy than women. The trough for Japanese people between age 22 and 42 correspond to the Second World War *Sources: For France, same source as Fig. 9.6a; for Japan: website of the Ministry for Internal Affairs and Communication: http://www.stat.go.jp/english/data/chouki/02.htm*