INDIRECT METHODS OF ESTIMATING ADULT MORTALITY LEVELS

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Kenneth Hailey Hill

London School of Hygiene and Tropical Medicine

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ABSTRACT OF THESIS

Many countries, particularly in the developing world, have inadequate vital registration systems, and data collected by population censuses in these countries often contain serious and predictable biases. Direct methods of measuring mortality are useless in such situations, so indirect methods have been developed instead. The two best known indirect methods, namely estimating childhood mortality from the proportion dead among children ever borne by women of known age, and estimating adult mortality from reports of orphanhood by age, are discussed. Various shortcomings of the orphanhood method are noted, particularly in its application to estimating adult male mortality.
To avoid these, two different approaches are suggested, developed and tested. One is to limit the analysis of orphanhood to reports of the eldest surviving child of each parent only, and the other is to analyse proportions widowed of first spouse.

It is not difficult to develop a method of analysis for estimating mortality from reports of firstborn children, but using reports of eldest surviving children is more complicated. Allowance has to be made for deaths among firstborn children, and their replacement by second or higher order children. A simple model was developed to work out the birth order composition of eldest surviving children at various ages. The method of analysis so developed has certain advantages over the original orphanhood method, but is found to be very sensitive to changes in the level and age pattern of mortality.

The method of analysis developed for widowhood data is much simpler. The only complication is the need for two marriage distributions,

male and female, the one to calculate the probability of being widowed for a given exposure to risk, and the other to work out the exposure to risk of a particular age group of respondents. The method proves to be robust to changes in mortality and to deviations from the other crucial assumptions on which it is based.

Both methods are applied to suitable data collected by a sample survey in Honduras. The data and the results are critically examined to assess both the possibility of collecting the required data and the success of the methods themselves. The conclusion is drawn that the widowhood method is promising, but the orphanhood of eldest surviving children method is disappointing. More applications are needed, though, to establish whether either or both of these methods are worthy of a place amongst the standard techniques for estimating population parameters in countries having defective or incomplete data.

CONTENTS

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CHAPTER ONE

The Need for Indirect Approaches in the Measurement of Adult Mortality

1.1 Introduction

The direct measurement of adult mortality requires a knowledge of two types of information about the population. First, it is necessary to know how many deaths occur, by age and sex, over some period of time. Second, it is necessary to know the population exposed to risk of dying, again by age and sex, for the same period; this is usually approximated by the mid period population. From these two types of information, age specific mortality rates can be calculated, and a conventional life table constructed.

In those countries which have virtually complete and reliable death registration systems and regular censuses free from major distortions, the information required to consctruct conventional indices of mortality is directly available. However, few areas outside the developed world are able to collect such information. Efforts to introduce or improve vital registration systems to collect information of the required accuracy within the restricted budgets available have generally proved unsuccessful. Indeed, in some places, for instance India, or the province of Buganda in Uganda, registration of births and deaths seems to have become less complete over the last 20 or 30 years. Efforts to reduce omissions from censuses seem to have been more successful, though progress with reducing certain typical errors, such as age misreporting, has been very slow. It seems likely that such errors will only be reduced by the spread of education, and a substantial improvement in data quality will be a long time coming.

Various attempts have been made to adapt developed country techniques to the estimation of mortality levels in statistically underdeveloped regions. The most important of these modifications will now be discussed briefly, to show why the need exists for indirect approaches.

1.2 Census and Survey Questions

Extra census questions that attempt to measure mortality directly have an obvious appeal. One part of the information needed, the base population, is being collected anyway, and there are no problems of sample size or bias. The approach most frequently used has been a household question, enquiring how many deaths occured in the household during some reference period such as a year. This was recommended for inclusion in the 1970 round of censuses by the United Nations (United Nations: 1967a). It has also been fairly widely used in demographic sample surveys.

This approach does have advantages. It is cheap, if the census is being held anyway, since the question is brief and easy to put, and is only answered by each household head, not by each individual. The analysis is also completely standard, and no complicated tabulations are needed. The disadvantages are considerable however. No information will be available for deaths by age, unless the age at death of each deceased is collected, and this seems unlikely in countries where respondents cannot report their own ages with any semblance of accuracy. Thus the best that the method can provide is a crude death rate. There are reasons to doubt whether it can even do that satisfactorily, however. It is well known that reference periods always cause problems, this being particularly so in statistically underdeveloped countries (Brass et al.; 1968). Thus the deaths reported may have occurred on average over a period of 14 months or 10 months before the survey, causing a substantial upward or downward bias in the estimate of the death rate.

Attempts have been made to get round this problem by using the period since some event rather than a calendar period, but this has never proved very successful. To be suitable, such an event needs to be an unambiguous point in time, to be very well known throughout the area, and to have occurred a suitable length of time before the survey. Not many events fulfil these criteria, and even if a suitable event could be found, it is doubtful if it would solve all problems. The problem with reference periods seems to be not just not knowing what a year is, but being unable to relate events in the past to one another. It is not possible to apply a reference period correction like that used in fertility analysis (Brass et al.; 1968). There is no doubt that deaths are omitted altogether and that the omissions are age selective, deaths amongst young children and the elderly being more likely to be left out. Using the household as the unit of enquiry leads to problems too. The household is a rather vague concept, and the usual definition of it as being a group of people who usually cook and eat together allows some scope for interpretation. Nor is the household a permanent group; members leave and join, and sometimes the whole group may disintegrate, especially if the head of the household dies; households of a single person obviously disappear if the person dies. All these ambiguities could be associated with under-reporting or over-reporting of deaths, and it is hard to see how such uncertain data can be of any use to the analyst. The results of such a question have sometimes been so bad that the information was simply abandoned without any detailed analysis being made of it (Uganda Protectorate; 1962).

Direct retrospective questions about deaths have not proved a satisfactory way of estimating the level of mortality in developing countries. The omissions and distortions are too substantial for the information to be of any value by itself, and the errors are too age selective for any correction technique to work.

1.3 Multi-Round Surveys

Multi-round surveys can provide a direct estimate of mortality by repeated enumerations of the same area. Each individual is identified at each round, and the reasons for any individual being absent are probed. The age of an individual who has died will be available from the previous round, and the population at risk will be enumerated at each round, so all the information required for calculating age specific rates should be available. Recording infant deaths is still a problem, because even if the rounds are only six months apart, a high proportion of those infants who die can be born and die between rounds. The effect of this can be reduced by recording pregnancies, and probing the outcome of pregnancies which fail to result in a live infant on the next round, but experience has shown that infant deaths are in fact always under-reported. This method does experience other difficulties as well. The identification of individuals from one round to the next always presents problems, even with very carefully supervised field work.

Deaths to individuals who move into the area and die between rounds will go unrecorded, and deaths of individuals who move out of the area because they are dying will be excluded. Health service facilities such as hospitals and dispensaries lead to serious sampling problems because of their association with deaths. Enumerations can never be absolutely complete, and old people living alone have a high mortality risk and a high risk of not being enumerated.

Multi-round surveys are likely to produce more satisfactory mortality information than direct questions in a census, but there is strong evidence that mortality in childhood and old age is still underestimated. Such surveys tend to be rather expensive, and are incapable of producing results quickly.

1.4 Dual Record Systems

These surveys, much in vogue over the last decade, combine two supposedly independant data collection systems. A continuous registration of vital events is conducted in each sample area, and at regular intervals, every six months or so, an enumeration and retrospective survey of events is also carried out. Vital events recorded by the two systems are then matched, and the number of events recorded by both systems, or by one system but not the other, are added up. A simple correction, based on the assumption that the probability of an event being omitted from one system is independant of the probability of its omission from the other, is made for the events omitted by both systems.

The dual record system has been tried on a large scale in several countries. Notable examples are the Population Growth Estimation Survey in Pakistan (Report; 1968) and the Turkish Demographic Survey (1970). The method does have very obvious attractions. Two data collection systems are likely to omit fewer events than one, and each system can be set up to collect the sort of information for which it is best suited. Thus a registration system is good for dates, because the registrar will know the Western calendar, whereas an enumeration can probably achieve a better coverage, and provide a base population for calculating rates. Finally, the method incorporates a conjuring trick whereby the number of events not recorded by either collection system can be estimated. This correction, although it is in practice often small, has caught the demographer's imagination, and has much to do with the present popularity of the dual record system.

The system has also come in for a considerable amount of criticism. Collecting all the data twice is very expensive, maintaining independence is almost impossible, and in practice the matching is a severe problem. The assumption on which the Chandrasekar-Deming correction (1949) is based is open to considerable doubt, and the size of the correction is generally small in comparison with the improvement brought about by duplicating the collection systems. In practice, Brass (1971a) has shown that the correction calculated for the Turkish Demographic Survey was much too small to account for all the births omitted. This could have resulted from over matching, as well as from the omission of particular types of births from both surveys.

The use of two data collection systems seems likely to reduce the number of events omitted by a worthwhile amount, though particular types of events are likely to be omitted by both. The improvement that results from maintaining independence and applying the Chandrasekar-Deming correction is small in most cases. The method is more suitable for some societies and cultures than for others, for example more suitable for South East Asia than for Africa. The method is expensive and administratively complex, so its advantages in a particular situation need to be clearly recognisable if it is to be adopted.

1.5 Other Direct Methods

Sample vital registration systems have been introduced in several countries in the last few years. These can probably be justified on the grounds of being a first step towards a national vital registration system. Such a system has substantial long term administrative benefits quite apart from its statistical value. The introduction of such a system probably has to be done in a stepwise fashion, but it is doubtful whether the early days of such a system could provide useful statistical information. If the registration system of a dual record survey is unable to record all events, there is no reason why a sample registration system should be able to, especially as it is common to find friction between the statistical and legal organisers of such a system.

1.6 Conclusion

No entirely satisfactory system has yet been devised for the direct collection of mortality information in developing countries. It seems highly unlikely that there could be such a satisfactory system, given the well known problems of data collection. The spread of education, and the increasing consciousness of time and number will ultimately resolve these data collection problems, but in the meantime there is a place for indirect methods. Such indirect methods measure the mean effect of mortality over a spread of ranges or periods, and are thus not suitable for estimating age specific mortality rates. Indirect methods aim to provide a satisfactory estimate of the overall level of mortality, perhaps divided crudely into child and adult components. A model life table can then be fitted to obtain approximate age specific rates if these are required. If the indirect methods are satisfactory, and the model life table is realistic, the resultant description of mortality will be more satisfactory than could be obtained by any of the direct methods.

The research reported in this thesis was directed towards improving the indirect estimation of adult mortality. Chapter 2 gives a brief review of existing indirect approaches to mortality estimation, and outlines the two developments suggested. Chapters 3 and 4 describe the details of the two developments. Chapter 5 shows the application of the methods to empirical data, and assesses their success. Chapter 6 sums up, and draws general conclusions about the two developments, while Chapter 7 examines the impact on the methods of two important biases.

CHAPTER TWO

Indirect Approaches to Mortality Estimation

2.1 Introduction.

An indirect approach to the estimation of mortality uses as its material the cumulative effect of past deaths on the population rather than the number of deaths over a given period. Several population features are determined by the incidence of mortality, and can thus provide possible methods of estimating the incidence of mortality. The hope is that the information will be easier to collect, and that less sensitive questions will be needed, than with direct questions about deaths. One obvious population parameter affected by the level and age pattern of mortality is the age distribution. It is more affected by the level of fertility, however, and is subject to well known reporting errors, so by itself it is of little value as a measure of mortality. A method of estimating infant and child mortality from proportions dead among children ever borne by women of various age groups has been developed by Brass (1964). This method, and a development of it due to Sullivan (1972), has been widely and apparently successfully used. More recently, a method of estimating adult mortality from proportions orphaned by age has been developed by Brass (Brass and Hill; 1973), and has been used in several African and Latin American countries. Other important indirect methods include the application of quasi-stable age distribution techniques (United Nations; 1967b) and the use of successive census age distributions to calculate survivorship probabilities (Carrier and Hobcraft; 1971). The common feature of all these indirect methods is that estimates derived from them are averages of mortality experience over long periods. The methods themselves involve a further averaging process, so their use is more satisfactory where rates have not been changing rapidly, and they are incapable of estimating rates specific for any other population features, such as education, or social class.

This chapter will give an outline of these indirect methods. A more detailed account of the development and application of the orphanhood analysis will be given, since this is of relevance to the methods developed in subsequent chapters. These methods themselves will be introduced, to show which faults of the existing approaches they are intended to overcome. A more comprehensive survey of indirect techniques in general has been written by Brass (1973).

2.2 Indirect Estimation of Child Mortality.

Women of a given age group will have given birth to children at a range of earlier ages. These children will have been exposed to the risk of dying for a period equal to the difference between the mother's age at their birth and the mother's current age. A proportion of these children will have died, and there will be some age A such that the probability of dying between birth and age A is equal to this proportion. This age A is a mortality weighted average of the exposures to risk, and the exposures to risk are determined by the age pattern of fertility, and, to a lesser extent, by the age distribution of the women within the age group. Brass (1964) calculated values of A using a simple polynomial fertility distribution movable over a range of age locations, together with a standard mortality pattern and a stable age distribution. It was found that the proportions of children dead for mothers in standard five year age groups corresponded very closely to life table probabilities of dying from birth to integer ages I. A series of factors were calculated for converting values of A into estimates of $q_{(I)}$. Indices of the age location of childbearing were given for selecting a suitable set of factors for a given application.

Sullivan (1972) has developed a rather different approach to the analysis of the same information. Using a number of observed fertility distributions and a variety of patterns and levels of mortality from the Coale-Demeny (1966) model life table system, he examined the relationship between A and $q_{(I)}$ in a variety of situations. His conclusion was that the Brass method gave satisfactory estimates, but he proposed a simpler procedure of his own based on his regression equations. In practice, the two systems give very similar results.

This method of estimating childhood mortality is the showpiece of indirect mortality estimation. It has been widely used, and has given plausible estimates in a variety of situations. It has been shown to be robust to age misreporting, and is not too seriously affected by mortality changes since most of the deaths are fairly recent. There are obvious possibilities for bias however. It is possible that neo-natal deaths may be omitted, and a relation between maternal and child mortality would reduce the estimate of mortality. On the other hand, there is the possibility that stillbirths might be included which would lead to an overestimate of mortality. The method seems to work reliably only for $q_{(2)}$ and $q_{(3)}$, based on reports of mothers aged 20 to 24 and 25 to 29; for women older than this, dead children seem often to be selectively omitted. Where the comparison with reasonably reliable registration information has been possible, this indirect method has given similar, though on the whole slightly higher, estimates of childhood mortality. All in all, the evidence suggests that the method gives reasonable estimates under most circumstances.

2.3 Quasi-Stable Age Distributions.

The age distribution of a population is determined more by fertility than by mortality, and by itself it is an unpromising source of information on mortality. Typical patterns of age misreporting, and fairly small deviations from the assumption of stability, can make quite large differences. If additional information on the level of childhood mortality is available, more satisfactory estimates of adult mortality can be achieved by fitting a suitable stable population using proportions under 15 and over 45. The method is still only suitable for use with age distributions free from major systematic distortions under approximately stable conditions. A knowledge of the rate of natural increase can greatly improve the quality of estimates of adult mortality, but since the estimation of the former is often dependent on the latter there is danger of a circular argument. The combination of factors required to make quasi-stable age distribution analysis work seriously restricts its value for estimating the overall level of adult mortality, and it is of little value anyway in estimating childhood mortality.

2.4 Inter-Censal Survival.

If two enumerations are held in a closed population ten years apart, the survivors of any cohort in the first enumeration will make up the age group 10 years older in the second enumeration. The probability of surviving from one age group for 10 years can then be directly calculated. It is straightforward to calculate a life table from this information, but usually the survivorship ratios will be seriously affected by age misreporting and any residual migration effect; the method is also highly sensitive to slight changes in census coverage, the relative effect being greatest for low mortality age groups. It is quite common in practice to find survivorship ratios greater than one for females surviving from 10 to 14 to 20 to 24, or 15 to 19 to 25 to 29. Some smoothing technique is thus needed before a satisfactory life table can be developed. Once again, stable age distributions are used in this smoothing process. With reasonable age reporting and satisfactory elimination of migration, this method can give rather good results for adult mortality, though of course an estimate of childhood mortality has to be available from some other source. The method is only suitable for very large scale enumerations, and is not applicable to sample surveys.

2.5 Information on Orphanhood

It is clear that the incidence of orphanhood is some sort of index of adult mortality. A respondent aged 20 will have had a mother alive at birth. The probability of the mother still being alive will be the probability of surviving from the mother's age at the birth of the respondent, a , to age a + 20 . In a group of respondents aged 20, the proportion orphaned will be determined by the age distribution of the mothers at the births of these respondents, and the level and pattern of mortality.

The first person to investigate the relationship between mortality and ophanhood was Lotka (1931). His interest was in estimating the incidence of orphanhood for a given level of mortality. He showed that in a homogeneous population, the proportion of persons aged a having a surviving father can be approximated as

$$p(a) \quad = \quad \frac{l_{(\bar{t}+a)}}{l_{(\bar{t}-\frac{3}{4})}}$$

where $\bar{t}$ is the mean age of fathers at the birth of their children. Three quarters of a year is subtracted from $\bar{t}$ in the denominator to allow for the fact that children are at risk of paternal orphanhood from conception rather than from birth.

The first person to suggest estimating mortality from information on orphanhood was Henry (1960), who proposed a method of fitting a one parameter model life table to the data. His interest was principally in historical populations, though he noted the possibility of using the method in countries with deficient data.

The method is based on the Lotka approximation already given. The same approximation is also used for maternal orphans, including the adjustment to the denominator. This is included to take account of the risk of the mother dying whilst giving birth to the respondent. In practice, this adjustment is replaced by a factor of 0.99 applied to the mean probability of a parent surviving a given period.

The probability of surviving from any age t to any age $t+a$ is represented as a second order function of t such that

$$\frac{l_{(t+a)}}{l_{(t)}} \quad = \quad S_0 - \alpha t - \beta t^2$$

where S_0, α, and β, are constants. This gives an adequate representation of the change in survival rates with age. If $\bar{S}_a(t)$ is the probability of surviving from age t to age $t+a$, and $\bar{S}(a)$ is its mean, the variance of the age distribution of fatherhood and motherhood in the population being σ^2,

$$\bar{S}(a) = S_0 - \alpha\bar{t} - \beta(\bar{t}^2 + \sigma^2)$$

$$= S_a(\bar{t}) - \beta\sigma^2$$

If P_a is the proportion of respondents aged a who are orphaned, the correction factor in the denominator is now applied, so

$$1-P_a = 0.99\,\bar{S}(a)$$

from which $$1-P_a = 0.99\left[S_a(\bar{t}) - \beta\sigma^2\right]$$

so $$S_a(\bar{t}) = \frac{1-P_a}{0.99} + \beta\sigma^2$$

$S_a(\bar{t})$, the probability of surviving from the mean age of child-bearing for a years, is not determined because β is a function of mortality. However, simply ignoring the term including β gives a satisfactory first approximation for the solution process. Using United Nations (1955) model life tables, Henry calculated values of β for a variety of mortality levels and values of a, together with probabilities of surviving for a years from a range of possible values of $\bar{t}$. There are several life tables which will satisfy the value of $S_a(\bar{t})$, but because of the very strong correlation between mortality rates during adulthood, the different solutions are all very similar.

Henry notes that it has to be assumed that there is no relationship between mortality and fertility, and supports this assumption by the lack of any such connection being found in the historical populations of Geneva and Crulai. He also points out that it is only the married adults whose mortality is estimated, but does not regard this as a serious limitation because the married population represents such a high proportion of the total population. The problem of declining mortality is also touched on, with the comment that the method is at its best when rates are changing slowly, if at all. He recommends that the analysis for developing countries be limited to respondents aged between 15 and 25, to minimise the effects of age misreporting.

This method is not very convenient to apply, and as it stands it is insufficiently flexible to be linked with other mortality information, such as an estimate of childhood mortality. Without lengthy further calculations, the method is inextricably bound up with the United Nations model life table system, which imposes a serious limitation.

A more convenient and flexible method has been developed by Brass (Brass and Hill; 1973). The basic approach is rather different from that of Henry. The relationship between orphanhood and certain life table functions is investigated by means of suitable models. This is done for a range of age groups of respondents, and for a range of age locations of fertility. These model relationships are then assumed to be applicable to real world situations, and are used to convert proportions orphaned into life table functions. The method can then be extended to include any information available on child mortality, and a suitable life table can be developed.

The derivation of the orphanhood model will be described for the sake of convenience in terms of maternal orphanhood; the principles for paternal orphanhood are just the same. A group of respondents aged a are survivors of births that occurred a years ago. If, a years ago, the number of women aged t was $A(t)$, and the probability of having a child at age t was $f(t)$, the number of children born a years ago is given by

$$C(a) = \int_p^q A(t)\, f(t)\, dt$$

where p and q are the earliest and latest ages at which childbearing occurred. The probability of surviving from exact age t to exact age $t+a$ is $l_{(t+a)}/l_{(t)}$, so the proportion of the mothers still surviving will be

$$(2.1) \qquad P(a) = \frac{\int_q^p A(t)\, f(t)\, \frac{l_{(t+a)}}{l_{(t)}}\, dt}{\int_q^p A(t)\, f(t)\, dt}$$

The age distribution of the original women can be represented by a stable population form, such that

$$A(t) = k\, e^{-rt}\, l(t)$$

and this allows equation 2.1 to be rewritten as

$$(2.2) \qquad P(a) = \frac{\int_q^p e^{-rt} f(t)\, l_{(t+a)}\, dt}{\int_q^p e^{-rt} f(t)\, l_{(t)}\, dt}$$

The proportion not orphaned at point values of a can be estimated from equation 2.2 by the use of model fertility and mortality schedules. Brass used a simple polynomial of the form.

$$f(t) = c\,(t-s)\,(s+33-t)^2$$

to represent the fertility distribution, and the General Standard life table (Brass; 1971b) for mortality. Proportions not orphaned by age groups can then be estimated from the point values by the use of suitable age distribution factors.

Life table survivorship probabilities from an arbitrary base age B to age $B+N$ are related to the proportions not orphaned in pairs of age groups centred on age N. Weights are used for this purpose, according to the estimating equation.

$$\frac{l_{(B+N)}}{l_{(B)}} = w(N)\; {}_5P_{N-5} + (1-w(N))\; {}_5P_N$$

Values of w were calculated for N's ranging from 10 to 60, for a variety of age locations of the fertility function. These weights can then be applied to reported proportions not orphaned to estimate the life table survivorship probabilities of the actual population. The relevant set of weights for a particular application is selected by the mean age of childbearing in the stable population. B is fixed at 25, which is a convenient value when applying the method.

The method proposed for estimating adult male mortality from paternal orphanhood is very much the same. A different fertility model, with a range of 60 years, and the second term cubed rather than squared, is used. It has to be remembered that the exposure to risk of paternal orphanhood is the respondent's age plus threequarters of a year. This factor, and the high mortality rates brought in by the length of the fertility function, make it desirable to use an alternative estimating equation, of the form

$$\frac{l_{(B+N+2\frac{3}{4})}}{l_{(B)}} = w(N)\ {}_5P_{N-5} + (1-w(N))\ {}_5P_N$$

It will be noticed that the Brass analysis of maternal orphanhood makes no allowance for the increased mortality risks of childbirth. Any suitable female life table will include this risk, so the only error should be one of timing. With orphanhood data, the risk occurs at the beginning of the period of exposure, and subsequently after each birth interval. With any unbiased period of exposure, the first risk would on average occur after half a birth interval. This should lead to a very slight overestimate of mortality by the orphanhood method, but it would certainly not be equal to an overall increase in exposure of threequarters of a year. Henry's correction would seem to be too large, and the actual correction required seems to be so small that it can be neglected. The net effect of maternal mortality may well be an underestimate of mortality, because of the substantial increase in the probability of the child dying if the mother dies in childbirth. If the child dies, the reports of the mother's death are reduced, in an analysis of orphanhood.

2.6 An Assessment of the All Children Orphanhood Method.

Information on orphanhood has now been collected in a considerable number of Latin American, African and Asian countries. Much of it has been analysed by the Brass weighting technique, and the force of adult mortality relative to child mortality, estimated independently, has been calculated. The mortality estimates derived have been very plausible. The method has not yet been applied to a country with accurate vital statistics, so only a circumstantial justification is possible at the moment. However, the estimates of adult mortality have proved to be very consistent for different age groups of respondents, and to be reasonable in their relation to childhood mortality. This is as good a justification as is available at the moment. Orphanhood amongst young respondents has been regularly under-reported, apparently as a result of the adoption of young orphans, and reports of respondents under 20 have to be regarded with scepticism. It is not clear whether the disappearance of this bias for older respondents merely reflects the swamping of under-reported early orphanhood by rapidly rising rates of orphanhood as age rises, or whether it reflects an actual improvement in reporting. If the former is the case, a small downward bias will remain, whereas if the latter is correct, the adult rates will be more or less right.

The analysis of orphanhood rests on several assumptions, which have already been touched on. First, it is assumed that mortality has been constant for a considerable period. Orphanhood represents the cumulative effect of mortality over a considerable period, and if mortality has been falling, orphanhood will be higher than current rates would account for. Further, if the orphanhood information is combined with an estimate of childhood mortality based on more recent events, the relative force of adult mortality will be exaggerated. This effect is to some extent mitigated by the fact that mortality rates accelerate with age, so that most orphans in any age group have become orphans fairly recently, as a result of fairly recent mortality rates. The effects of declining mortality are investigated by a simple model in Chapter 7, and it is found that this does exaggerate estimates of adult mortality to some extent.

The second assumption is that there must be no relation between mortality experience and number of surviving children. The mortality experience of those with no surviving children will not be represented in orphanhood data, whereas those who have many surviving children will be reported many times over. Strong mortality differentials with marital status have been observed (Klaus and Lilienfield; 1959), mortality being considerably higher for the single, widowed and divorced population than for the married population. These groups are also likely to have had fewer children, so orphanhood would be expected to underestimate overall mortality in the population. Although deaths in childbirth would be expected to inflate mortality levels for high parity women, the mere fact of having had a large number of children implies a reasonable period of survival.

The third assumption is that orphans experience the same mortality risks as the rest of the population. If orphans are more likely to die, which is likely at least in childhood, orphanhood will be under-reported, and mortality underestimated. This could be a contributary factor to the adoption affect amongst young respondents. In most developing countries, deviation from the first assumption will result in adult mortality being overestimated, whereas deviations from the second and third assumptions will lead to an underestimate. It is not clear in which direction the net effect will be, though some experienced authorities in South America believe that orphanhood tends to under-estimate adult mortality on the whole.

The calculation of the weights used for analysing orphanhood rates requires assumptions about fertility and mortality. The model fertility distributions have already been described. The mortality model used was a Brass model life table with an $l_{(2)}$ of 807, an average relationship between child and adult mortality, and an expectation of life at birth of about 43 years. A rate of population growth of two per cent per annum was used, implying a total fertility rate of about six. A large number of trial calculations, using different mortality and fertility levels and patterns, showed that deviations from these assumptions were not an important source of error.

The orphanhood method of estimating adult mortality has proved reasonably successful in practice, and it seems to be robust to variations in fertility and mortality, as well as to reporting errors. No final justification has been possible, however, and doubts remain about the importance of the biases inherent in the method. On the whole more confidence can be placed in estimates of female adult mortality than in estimates of male adult mortality, because of the narrower range of the female fertility distribution, and because of the more satisfactory method of fitting available for the female population. The male fertility distribution shows much more variation, in both shape and range, from one society to another than does the female, and the mean age of male child begetting is considerably higher than the mean age of female childbearing. Both these factors reduce the robustness of the orphanhood method for estimating adult male mortality. New developments will therefore be useful if they are more satisfactory for male mortality estimation, and if they can reduce the effects of the biases mentioned above.

2.7 Orphanhood Reports of Firstborn Children.

The analysis of orphanhood reports of firstborn children would be useful by both the criteria just given. There would only be one respondent per event reported, which would eliminate any bias due to multiple reporting. It would not, however, reduce any bias due to a connection between the mortality of the parent and the child, and the mortality estimate would still only be for parents. This analysis would also provide better estimates of male mortality. The age range of the firstbirth fertility distribution is much smaller than that of the all births distribution. especially for fathers. This will reduce the effect of the non-linearity of the mortality schedule at higher ages, and simplify the problem of changing mortality by reducing the number of cohorts of parents reported on by a given age group of respondents. Such a method is therefore likely to be substantially more satisfactory for the estimation of male adult mortality than the all children method.

First children will of course die, and in fact their infant mortality is higher than that of subsequent children. This will mean that there are fewer and fewer reports as higher age groups of respondents are used. This will not matter if there is no relationship between parent and child mortality, but if there is such a relationship, the resultant bias will be as serious as it is for the all children method.

The main objection to using reports of firstborn children is a practical one. It is likely to be very difficult to collect the necessary information, and the information collected might well be biased in particular ways. In several circumstances, a respondent may well not know whether he or she is a firstborn child. Obvious cases of difficulty will arise when a parent has remarried, or when a firstborn child has died in infancy. There may be some intentional misreporting as well, particularly for males, if there is some desirable status attached to being a firstborn child. Combined with the problem of having fewer and fewer cases, and hence fewer and fewer reports of events, as age of respondent rises, this makes it doubtful whether a method based on firstborn children would be successful.

2.8 Orphanhood Reports of Eldest Surviving Children.

The data collection problems anticipated for firstborn children would be reduced by extending the coverage to eldest surviving children. This would increase the proportion of parents reported for, to the level of the all children method, but would still mean there was only one report per parent. This approach would also reduce the bias resulting from a relation between parent and child mortality, since there would still be one, and only one, report per parent until all the parent's children are dead. On the debit side, the spread of age differences between parents and reporting children will be greater, and reporting errors from lack of knowledge may be more serious. Perhaps the most serious problem, however, is that child mortality will have a substantial impact on the birth order composition of eldest surviving children. Firstborn children will always be the largest single group, followed by secondborn, thirdborn, and so forth, but the actual proportion these groups represent fluctuates dramatically with the level of mortality, and to some extent with the level of fertility also. In a population having a total fertility rate of six, and an $l_{(2)}$ of 900, 87 per cent of the 5 to 9 age group, and 62 per cent of the 55 to 59 age group, are estimated to be firstborn children. In the same population, but an $l_{(2)}$ of 650, the figures are 58 per cent and 25 per cent respectively. These estimates are based on the rather approximate methodology of Chapter 3.

Thus the analysis of orphanhood reports of eldest surviving children has some theoretical and practical advantages, and some theoretical and practical disadvantages, compared with the analysis of reports by firstborn children. On balance, the advantages probably outweigh the disadvantages, and the method seems to be worth examining in more detail. This will be the subject matter of the next chapter.

2.9 Widowhood Reports.

Another population variable clearly partly determined by the level of adult mortality is the incidence of widowhood. Koblenzer and Carrier (1960) have used widowhood information to estimate adult mortality for a tribe in North Boneo, but the numbers studied were very small. The other variables involved are male and female ages at marriage, and the age distribution. Male adult mortality is estimated by female reports of widowhood, and female adult mortality is estimated by male reports of widowerhood. To avoid ambiguity, and the effects of remarriage, it is necessary to specify widowhood from first husband, or widowerhood from first wife. Such a method would fulfil both criteria specified at the end of section 2.6. Male adult mortality would be estimated from reports of females, the age distribution of males marrying single females being much narrower than the age distribution of male child begetting. The majority of events would be reported once only, and it would be very unusual for an event to be reported more than two or three times. This would reduce the bias potentially present in orphanhood analysis of one event being reported many times. However, a relationship between the mortality risks of spouses will introduce a bias, and no account is taken of the mortality of the never married population. A method based on widowhood data will have no equivalent of the adoption effect and it will therefore be possible to analyse reports of those who have not been exposed to risk for very long. This will reduce the impact of changing mortality.

A woman is at risk of widowhood from her first spouse (we shall call it widowhood, even if the woman has been divorced and remarried in between) from the moment of marriage. It is fairly easy to calculate the mean probability of widowhood per unit of exposure to risk, given any male marriage distribution. If widowhood information were tabulated by exposure to risk, such probabilities could be used to give a very quick and simple estimate of adult mortality. However, it is unlikely that satisfactory information on duration of marriage could be obtained in developing countries. Age reporting is subject to large and well known errors, and even quite short reference periods are known to be considerably distorted, so a question on period since first marriage would stand no chance of success. The obvious variable for cross tabulation purposes is age, but the relationship between age and exposure to risk of widowhood will not be simple. This will clearly be determined by the female age distribution at first marriage, but the age distribution of the males will vary with the age of the females. Thus young women marry younger men than older women, and this will affect the probability of widowhood for a given exposure to risk. Thus strictly speaking it is not sufficient to have male and female marriage distributions. A female age at first marriage distribution is required, together with a set of age of wife at marriage specific male age at first marriage distributions. This is likely to complicate the task of developing a method of analysis and to make such a method rather cumbersome to apply.

A method based on widowhood information does avoid some of the biases of the orphanhood approach, and it is likely to give usable mortality estimates for males and females in their thirties and forties. It is not devoid of its own biases, however. The higher than average mortality of widows and unmarried persons is the most serious worry. It is possible that any method will be complicated to apply, requiring fitting by more than one parameter, and it is reasonable to have doubts about the quality of the data, given the ambiguity surrounding the concept of marriage in many societies. However, it seems likely that it will at least be worth investigating the possibility of developing such a method, and this will be done in Chapter 4.

2.9 Conclusions.

Indirect methods of estimating mortality have been widely used, some of them apparently very successfully. An indirect method of estimating adult mortality from reports of orphanhood has been used in several countries, but doubts have remained about the importance of the biases inherent in the method. Two possible improvements have been suggested, one limiting responses to eldest surviving children, and the other analysing information on widowhood. Both of these are subject to fewer biases, but introduce new problems of their own. The next four chapters will describe the development of suitable techniques of analysis, a practical example of their use, and tentative conclusions as to their value in the estimation of adult mortality.

CHAPTER THREE

Orphanhood of Eldest Surviving Children.

3.1 Introduction.

If reports of the survival of a parent are limited to one respondant, that being the eldest surviving child of the parent, two advantages can be expected for estimating the level of adult mortality from such reports. First, there is only one report per event, reducing the possibility of error introduced by a correlation between the survival of the parent and the number and survival of the children. Some bias may be introduced, of course, through the connection between child mortality and birth order, and through child mortality differentials by sex, if the sex ratio at birth is not constant with birth order. These possible errors are unlikely to be large, as has already been pointed out in a discussion of them in Chapter 2. Second, the age difference between the parent and the respondent has a lower mean and smaller variance than in the all children case, reducing the distorting effect of very high mortality at older ages. The second advantage would actually be increased if reports of firtborn children only were considered, but this would destroy the first advantage, as well as creating data collection problems. However, the approach used in this research has been to estimate the relationship between orphanhood amongst firstborn children and mortality levels, and then to correct such relationships approximately using drastic simplifications to allow for mortality amongst firstborn children, and the resultant presence in reports of eldest surviving children of reports by secondborn, thirdborn, to nthborn children.

3.2 The Proportion Orphaned Amongst Firstborn Children.

If the assumptions on which the original orphanhood method is based are accepted, there is no difference of principle between the proportion orphaned amongst all children and the proportion orphaned amongst firstborn children only. The difference will arise only through different age patterns of fertility for all births as opposed to first births. Thus if the number of women aged t a years ago was $A(t)$, and $f(t)$ was the probability of having a firsborn child at age t, the number of firstborn children born a years ago will be

$$n(a) = \int_q^p A(t)\ f(t)\ dt$$

p and q being respectively the earliest and latest ages at which firstborn children are born. If $l_{(t)}$ is the probability of surviving from birth to age t, and $l_{(t+a)}$ is the probability of surviving from birth to age $t+a$, the proportion surviving from age t to age $t+a$ will be the ratio of the two probabilities. Thus the proportion of women still surviving having had a firtborn child a years ago, and hence (assuming no relation between child and maternal mortality experience) the proportion among firstborn respondents a years old having a surviving mother, will be

$$(3.0)\quad P1(a) = \frac{\int_p^q A(t)\ f(t)\ \frac{l_{(t+a)}}{l_{(t)}}\ dt}{\int_p^q A(t)\ f(t)\ dt}$$

If it is assumed that the age distribution is that of a stable population, A(t) can be defined in terms of the rate of growth of the population and the age pattern of mortality. Thus

$$A(t) = k\, e^{-rt}\, l_{(t)}$$

and the expression for the proportion of firtborn children aged a having a surviving mother becomes

$$(3.1)\quad P_1(a) = \frac{\int_p^q e^{-rt}\, f(t)\, l_{(t+a)}\, dt}{\int_p^q e^{-rt}\, f(t)\, l_{(t)}\, dt}$$

The same arguments and relationships hold for fathers as well as for mothers. The only difference is that the exposure to risk of orphanhood is not a years, the age of the child, but a+b years, where b is the period between conception and birth. The value of b averages around nine months, and though it can vary between seven and ten, no substantial error is introduced by assuming that it is always three quarters of a year.

3.3 Conversion from Firtborn to Eldest Surviving Child.

Deaths among firstborn children will lead to their replacement in the class of eldest surviving children by secondborn, or by thirdborn if the secondborn has also died, and so on. It would be possible to work out the proportion of each birth order orphaned by equations of the type of equation 3.1, and to work out the birth order composition of the class of eldest surviving children. It would, however, be a very complicated task, requiring the construction of model birth order specific fertility distributions for each order. The quality of the data available would not justify the construction of such detailed models, so a much more simple minded approach was adopted. With zero infant and child mortality, firstborn and eldest surviving children will be identical. With extremely heavy infant and child mortality, eldest surviving children become identical with all children. Thus with any feasible level of infant and child mortality, the birth order composition of eldest surviving children lies somewhere between that of firstborn children and that of all children. It is then argued that the proportion of eldest surviving children of a given age with a surviving mother will lie somewhere between the value for firstborn children and the value for all children, the actual point being determined by the birth order composition of eldest surviving children. A simple procedure was developed to interpolate between the two values according to the level of childhood mortality. The exact workings of this method are described later, along with other details of the calculations. The argument will, however, be briefly summarized here.

The aim is to estimate the birth order composition of the class of eldest surviving children of a particular age, say a years old. If a years ago, $n(a)$ firstborn children were born, the number surviving the a years will be $n(a)\ l_{(a)}$. The number failing to survive will be $n(a)\ (1- l_{(a)})$. Second, and subsequent, order children enter the class of eldest surviving children through deaths to firstborn children. However, a secondborn child aged a will be the sibling of a firstborn child born $a+d_1$ years ago, d_1 being the time that elapsed between the birth of the firstborn and the birth of the secondborn. In a growing population, there will have been fewer firstborn children born $a+d_1$ years ago, than born a years ago, by a factor e^{-rd_1}, where r is the rate of population growth. (This is strictly correct only for a stable population, but very little error could be introduced by changing growth rates over reasonable values of d). Also the probability of dying, and thus allowing in a second or subsequent order child, is not that from birth to age a, but from birth to age $a+d_1$. A further complication is introduced by the fact that not all first births are followed by second births, so a factor has to be introduced to allow for failure to continue from one parity to the next. With all these factors taken into account, the number of secondborn children eligible to join the class of eldest surviving children can be estimated. These children will of course have had to survive a years, so only a proportion $l_{(a)}$ of them will still be alive. The thirdborn component can be described in much the same way. They will be siblings of firstborn children born $a+d_1+d_2$ years ago, less by a factor $e^{-r(d_1+d_2)}$ than firstborn children born a years ago, having had to die between birth and age $a+d_1+d_2$, and secondborn children born $a+d_1$ years ago, less by a factor e^{-rd_1} than firstborn children born a years ago, having had to die between birth and age $a+d_1$.

Basic data limitations made the application of drastic simplifications appropriate in the calculations. It was assumed that all birth intervals could be concentrated at their means, and in practice it was assumed that all birth intervals were the same, regardless of parity, since this seemed to be justified by the available data. It was further assumed that all first births take place at the mean age of first births in the stable population for all women. These assumptions taken together fix the age at which births of particular orders occur. If the birth interval is b, and the first birth mean is M_1, second births occur at exact age M_1+b, third births at exact age M_1+2b, and so on.

The assumptions made in arriving at these approximations are sweeping, but even so the expressions become very complicated. If the assumptions were not made, logical difficulties would arise, such as the fact that it is impossible to know until the end of the childbearing period whether a woman will follow an nth birth by an (n+1)th birth. The model assumption that all birth intervals are the same length implies that once a birth interval has been exceeded without a birth occurring, no further births will occur to that woman. The errors introduced by these approximations will arise mainly from ignoring the effects of variance and skewness, and should not be too serious at normal mortality levels, since the proportion of high order births in the class of eldest surviving children will be low. The most serious error is likely to arise from any relationship between the length of a woman's birth intervals and the total number of children she ultimately bears.

3.4 Weights for Proportions with Surviving Mothers.

The estimate of adult mortality to be obtained is a survivorship probability from a base age B to some later age B+N. In practice for female mortality, B is set arbitrarily at 25 years, except for low mortality situations, where a base of 20 years is found more suitable. There is no essential virtue in using one base age rather than another. The survivorship probability is estimated from proportions of eldest surviving children having a surviving mother by the use of weights, calculated from a model situation. The following estimating equation is used to give the survivorship probabilities.

$$\frac{l_{(B+N)}}{l_{(B)}} = w(N)\ {}_5P_{N-5} + (1-w(N))\ {}_5P_N \qquad (3.2)$$

where $l_{(B+N)} / l_{(B)}$ is the probability of surviving from age B to age B+N, w(N) is the relevant weight for central age N, and P is the proportion with a surviving mother, first in the five year age group up to N, and second in the five year age group above N. The steps involved in working out the weights are first of all the substitution of suitable model values in equation 3.1, to estimate the proportion of first-born with a surviving mother; the second step is to correct this proportion for the difference between firstborn and eldest surviving children, and thirdly this porportion is then related to the relevant life table survivorship probability. The first step is to calculate the incidence of orphanhood amongst firstborn, and this requires that the first birth fertility function should be defined.

3.5 Female Age Specific First Birth Rates.

Current fertility has been tabulated by previous parity for a large number of countries, both developed and otherwise. Representatives of all continents are found in the relevant table of the Demographic Yearbook, which has been used as the source of data in this instance (U.N.; 1968). These data are of variable quality, frequently being distorted by changes in the age pattern of fertility or by mis-reporting. However, cumulated first birth rates should sum to the final proportion that ever fertile women make up of all women, and this provides a powerful consistency check on the data.

Several first birth distributions were selected for study, from a wide range of geographical areas. The basic features of all these distributions were much the same. A very rapid increase to an early peak not much after age 20 is typically followed by a rapid decline to a low level soon after age 30; the distribution is then completed by a long, low and rather erratic tail to the end of the childbearing period. 95 per cent of the distribution is normally concentrated within a span of four age groups. A process of trial and error showed that the function

$$f(t) \quad = \quad t^{\frac{1}{2}}(1-t)^2$$

spread over a range of 17½ years gave an adequate approximation to the early and central parts of the distribution, though it was unable to cope with the long, low tail. A more complex function could be found to include an adequate fit for the tail, but such a function would undoubtedly be less convenient to manipulate, and the improved fit for five per cent of the distribution was not felt to be worthwhile. Table 3.1 shows first birth rates for selected countries, restricted to women aged 15 to 35, together with their means and variances, together with rates calculated from the model from a starting age of 15 rather than fitted by the locational variable to any particular case. The variance of the model seems to be a good approximation to the observed values, though it seems likely that the model's peak is rather too low, and the decline after the peak is rather too slow. The model was accepted provisionally since it is fairly easy to test for the effects of using alternative models at a later stage.

3.6 The Mortality Schedule and the Age Distribution

Equation 3.1 requires the use of a model mortality schedule to give the proportions surviving from birth to age t and age $t+a$. The Brass Gener Standard logit life table system, described by Brass (1971) and Carrier and Hobcraft (1971), was used for this for several reasons. It is extremely convenien to use with a computer, its two parameter nature makes it very flexible in use, and it fits in well with the final estimation procedure. The cornerstone of the system is a set of 'standard' survivorship probabilities, that is $l_{(x)}$'s, from the logits of which a life table with almost any desired property can be obtaine by varying two parameters, called alpha and beta, according to the relationship

Table 3.1; Age Specific First Birth Rates, Selected Countries

Age Group	Uganda 1969	Guyana 1956	Japan 1950	Canada 1957	Fiji 1968	Model values
			Country			
15-19	.086	.042	.006	.020	.016	.092
20-24	.049	.062	.092	.097	.093	.079
25-29	.014	.019	.053	.046	.039	.027
30-34	.005	.006	.013	.016	.016	.001
Mean	20.48	22.07	24.73	24.12	24.18	20.83
Variance	13.27	14.21	9.89	13.45	13.31	12.45
Proportion Covered*	.959	.977	.970	.957	.914	-

* Proportion of the total first birth distribution covered by the four age groups shown.

$$Y_{(x)} = \alpha + \beta YS_{(x)}$$

where $Y_{(x)}$ is the logit of the proportion surviving to age x in the required population, and $YS_{(x)}$ is the same in the standard life table. Alpha can be regarded as fixing the overall level of mortality, and beta can be regarded as determining the relative weights of child and adult mortality. The basic set of tables uses an $l_{(2)}$ – life table survivors to age 2 – of 800, and a beta of 1.0, implying the same age pattern of mortality as the standard. This combination produces a life table with an expectation of life at birth of about 40 years. This basis was adopted as being more or less an average for the sort of population for which the techniques developed will be of value. The effects of deviations from these mortality levels will be examined later.

Equation 3.1 also requires a figure for the rate of natural increase of the population. Given the mortality pattern and level described above, and a fairly normal age pattern of fertility, a total fertility rate of 6 gives a rate of population growth of close to two percent, so this was the rate taken in the basic calculatic When different mortality levels are tried out, or different fertility rates assumed, the rate of growth is altered accordingly.

3.7 Birth Intervals and Completed Family Size

Reliable data on birth intervals and completed family size distributions are rare for developing countries. These are required for the correction for deaths among firstborn children, as already outlined. The only sources of data are small and carefully controlled specialist surveys or analyses, since fertility histories are rarely collected by censuses, and parity reports for women past childbearing age are notoriously inaccurate. Registration data from Taiwan has been analysed by Tuan (1958) to give mean birth intervals by parity. The birth intervals are, with the exception of the interval between marriage and first birth, remarkably stable with rising parity, all being within the range of 2.5 to 2.8 years until after parity 13. The mean birth interval for all parities was 2.6 years, and this figure is adopted for the basic calculations. The results of the Khanna study in India (Wyon and Gordon; 1971) give further confirmation to this figure. The study estimated an inter-pregnancy interval of 22 months, which, allowing a nine month gestation period, works out at a birth interval of 2.6 years also.

Figures are available from both the Taiwan data and the Khanna study for the distribution of women by parity after the age of childbearing. Chandrasekaran and George (1962) have also published data for three small areas of India. The figures from all three surveys are summarized in Table 3.2. All three sets of data show surprisingly high total fertility rates and low proportions sterile. As a result of these shortcomings, recourse was had to models. Brass (1958) has shown that a negative binomial distributi modified to allow for fixed-length periods devoid of exposure to risk following each event (corresponding to periods of pregnancy) gives a close approximation to observed distributions of mothers by number of births, in countries where contraception is not widely practised. The model was fitted by a trial and error procedure to give a total fertility rate of 6.0 with 95 per cent of women becoming mothers, and about 2½ per cent of mothers having just one child. The process was repeated for a total fertility rate to 5.0. These distributions are shown, together with the values of the two variables defining the models, in Table 3.2. The model values may be criticized on the grounds that the proportion of mothers having a second birth after a first is considerably too high, for areas where secondary sterility may be expected to be substantial, from lack of medical facilities during pregnancy and delivery, and from the incidence of disease, particularly gonorrhoea. The effect of having too high a proportion of mothers continuing from one parity to the next is to inflate slightly the proportion of second and subsequent births in the class of eldest surviving children.

Table 3.2: **Female Completed Parity Distributions**

Study	Completed parity														Total Fertility Rate
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Taiwan	.96	.92	.88	.81	.74	.64	.51	.38	.25	.13	.04	.01	-	-	7.1
Khanna	.99	97	.94	.90	.85	.74	.64	.52	.33	.18	.08	.03	-	-	7.2
Chandrasekaran George	.97	.92	.86	.80	.71	.59	.52	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Model 1	.95	.93	.87	.79	.68	.56	.43	.31	.21	.13	.07	.04	.02	.01	6.0
Model 2	.95	.91	.83	.71	.58	.44	.31	.20	.12	.07	.04	.02	.01	-	5.0

For model 1, $b = 0.64$, $K = 4.845$

For model 2, $b = 0.61$, $K = 4.500$

(*) Figures not published beyond parity 7.

3.8 Calculation of Proportion Orphaned Amongst Firstborn.

There is no explicit solution to equation 3.1, so estimates of proportions orphaned have to be made by numerical methods. All the calculations were carried out on a computer, this being fast and accurate, allowing more detailed approximations and a great number of tabulations to test the effects of deviations from the basic assumptions. The programme, written in Fortran IV, is reproduced with explanatory notes, in Appendix 3.1. All the calculations were gone through at least once by hand, prior to computerization, to help get the feel of the method. The steps may be summarized briefly.

The first step is to integrate the first birth function, and to evaluate it, to give age specific rates, at points corresponding to single years throughout the 17.5 year range. Each rate is then weighted to take account of the rate of growth, by a factor e^{-rt}, r being the rate of growth and t being the year. Then, assuming first of all that the earliest age at which first births occur is 10, the weighted fertility rate for year 1 is multiplied by the model life table survivors to age 10.5, that for year 2 by survivors to age 11.5, that for year 3 by survivors to age 12.5, and so on up to year 18 multiplied by survivors to age 27.5. The sum of all the products is the approximate value of the bottom line of equation 3.1, namely

$$\int_{10.0}^{27.5} e^{-rt} f(t)\, l_{(t)}\, dt$$

The same calculations can then be repeated with a starting point of age 11, the sum giving the bottom line of equation 3.1 between the limits of 11 and 28.5. However, this sum will also be the value of the top line of equation 3.1 for limits of 10 and 27.5, and a value of a of 1, namely

$$\int_{10.0}^{27.5} e^{-rt} f(t)\, l_{(t+1)}\, dt$$

If all the sums are calculated until there are no further survivors - effectively by age 95 - the model proportions of firstborn at ages 1,2,3, and so on having a surviving mother can be obtained for a starting age of 10 by dividing the second sum by the first, the third sum by the first, and so on. For a starting age of 11, the proportions can be obtained by dividing the third sum by the second, the fourth by the second, and so on. In this way, the proportions with a surviving mother at all ages, and for a variety of age locations of first childbearing, can be calculated.

Census and survey data are normally tabulated by five year age groups. Thus it is desirable to calculate the proportion of firstborn respondents in a five year age group having a surviving mother. This can be done quite simply from the proportions at exact ages 1, 2, and so on calculated above. If the age group is a to $a+5$, point values have been calculated for a, $a+1$, to $a+5$. These may be weighted to allow for the effects of the age distribution, so

$$_5P_a = \frac{\frac{w_0 P_a}{2} + w_1 P_{a+1} + w_2 P_{a+2} + w_3 P_{a+3} + w_4 P_{a+4} + \frac{w_5 P_{a+5}}{2}}{\frac{w_0}{2} + w_1 + w_2 + w_3 + w_4 + \frac{w_5}{2}}$$

and with a stable population age distribution the weights can be written as

$$w_{n,a} = e^{-r(a+n)} \; l_{(a+n)}$$

The proportions with surviving mother are now available by age at first childbearing. This is an inconvenient measure for location purposes, since it is hard to measure and liable to vary even between similar distributions. The mean age at first childbearing in the stable population is more suitable. This can be calculated quite easily for the model for different age locations of fertility as the mean of the values used to evaluate the denominator of equation 3.1, that is the number of children born a years ago by each age of mother. Once these have been worked out for the round values of age at which childbearing starts, it is easy to interpolate between values from different starting points to give the proportions required for round values of the mean. This was done by simple linear interpolation, since curvature was found to be not pronounced, and the values to be interpolated between were typically close together.

3.9 Deriving a Set of Weights for Firstborn Children.

Once the model values of the proportions of firstborn of each age group having a surviving mother have been calculated, it is easy to work out the weights required for use in converting such proportions into life table survivorship probabilities. Equation 3.2 can be re-written as

$$(3.3) \quad w_N = \frac{\dfrac{l_{(B+N)}}{l_{(B)}} - {}_5P_N}{{}_5P_{N-5} - {}_5P_N}$$

and the weight for correcting proportions in adjacent age groups with a surviving mother into a life table survivorship probability from age B to the central age of the two age groups can be arrived at.

3.10 Correcting for Deaths Amongst Firstborn.

It has already been pointed out that, for data collection and coverage reasons, it is necessary to use reports of eldest surviving children rather than of firstborn children. A brief outline of the methodology adopted to make this correction has been given. The details of the calculations will now be described. Since they are the same in principle for each age group of respondents, one age group will be used as an example.

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It has already been pointed out that, for data collection and coverage reasons, it is necessary to use reports of eldest surviving children rather than of firstborn children. A brief outline of the methodology adopted to make this correction has been given. The details of the calculations will now be described. Since they are the same in principle for each age group of respondents, one age group will be used as an example.

The eldest surviving children aged five to nine will be assumed to be aged 7½ years. The error introduced by this simplification will not be large for reasonable rates of growth and for age groups experiencing mortality rates that increase more or less linearly with age. If the first births 7½ years ago numbered F, the number of firstborn aged 7½ will be $F\ l_{(7\frac{1}{2})}$. It is now assumed that all births occur at the mean age for births of that order, and that first births occur at an age of 20 years. Since the mean birth interval has been assumed to be 2.6 years, second births are all assumed to occur at age 22.6, third births at age 25.2, and so on. The effect of arbitrarily selecting 20 as the first birth mean, rather than some other figure, is negligibly small. The effect of assuming that all births are concentrated at the mean for that birth order is very difficult to assess, even in general terms, and no attempt has been made to do so. It seems unlikely to give rise to any large or systematic bias however.

Secondborn children will appear in the class of eldest surviving children when a firstborn child has died, if that child had at least one sibling, and if the eldest of these siblings is still alive. Since all the eldest surviving children are assumed to be aged 7½, and since the birth interval is 2.6 years, the secondborn children will be the survivors of firstborn children born 10.1 years ago. In the assumed stable population, there will be rather fewer firstborn children born 10.1 years ago than 7½ years ago (if it is a growing population). The actual number can be expressed as

$$F' = F\ e^{-2.6r}$$

where r is, as usual, the rate of population growth. These firstborn will also have been exposed to the risk of dying for 10.1 years, so the number who will have died is

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Secondborn children will appear in the class of eldest surviving children when a firstborn child has died, if that child had at least one sibling, and if the eldest of these siblings is still alive. Since all the eldest surviving children are assumed to be aged 7½, and since the birth interval is 2.6 years, the secondborn children will be the survivors of firstborn children born 10.1 years ago. In the assumed stable population, there will be rather fewer firstborn children born 10.1 years ago than 7½ years ago (if it is a growing population). The actual number can be expressed as

$$F' = F\, e^{-2.6r}$$

where r is, as usual, the rate of population growth. These firstborn will also have been exposed to the risk of dying for 10.1 years, so the number who will have died is

$$F'_{(DEAD)} = F e^{-2.6 r} (1 - l_{(10.1)})$$

Some of the mothers having had these first children will not continue to have second children. Some of them will die between the age of 20 and the age of 22.6, when they would have had the second child. This can be allowed for by multiplying F'(Dead) by the survivorship probability from 20 to 22.6. Some of the mothers will become sterile, or will cease to be exposed to risk of pregnancy for some other reason. A set of parity progression ratios can be calculated from the parity model described in section 3.7. The number of mothers who, having had a first birth at age 20, and having survived to age 22.6, have a second child, is obtained by multiplying by the parity progression ratio from parity one to parity two. If this ratio is denoted by p_1, the number of secondborn children who fulfil the conditions necessary to become eldest surviving children is given by

$$S_{(BORN)} = F e^{-2.6 r} (1 - l_{(10.1)} \frac{l_{(22.6)}}{l_{(20.0)}} p_1)$$

The actual number of secondborn amongst eldest surviving children is then determined (given the assumptions) by the number who survive to age 7½. So

$$S_{(7\frac{1}{2})} = S_{(BORN)} \; l_{(7\frac{1}{2})}$$

The calculations become tediously long, especially in view of the frequent interpolations on the logit scale needed to estimate survivorship to non-integer ages when using the Brass model life table system.

The number of thirdborn and higher order children can be arrived at similarly, though the expressions get increasingly lengthy. The total number of eldest surviving children can be arrived at by addition, and the proportions of each order making up the class estimated. For young respondents and light mortality, the vast majority of eldest surviving children are also firstborn, with the contribution of orders higher than three negligible. For older respondents and heavier mortality, as few as 30 per cent may be firstborn, and one per cent tenth born (for an $l_{(2)}$ of 650, and age group 55 to 60).

The mean age at births in the stable population is calculated for all births from the values of p_n, again assuming that all births of particular order occur at the mean age for that order, suitably adjusted for population growth and mortality. The mean age at which eldest surviving births occur is calculated from the proportion of each order, all assumed to occur at the mean age for that order. The mean age for firstbirths is subtracted from the mean age for eldest surviving births, and this difference expressed as a proportion of the difference in the means for all births and firstbirths. This proportion is taken to be a measure of the extent to which mortality has changed the firstbirth situation into an all birth one, and is used to interpolate between weights for firstborn children and weights for all children, to give weights for use with eldest surviving children. The interpolation is made between the firstborn weight for the mean age of eldest surviving children and the all birth weight for the mean age of all births plus the difference between the mean age for firstborn and the mean age for eldest surviving children. All the interpolations are linear.

There is no formal justification for this procedure for correcting for the effects of mortality amongst firstborn children, but it accords with common sense. A few examples of the size of the corrections made are of interest. For the basic weight table, for which $l_{(2)}$ is 800, and beta is 1.0, the difference between the firstbirth and all birth means is 7.19 years, whilst the mean for eldest surviving children ranges from 0.82 years greater, for age 10, to 3.08 years greater, for age 55, than the firsbirth mean. When $l_{(2)}$ is only 650, the comparable figures are 7.33, 1.68 and 4.82. When $l_{(2)}$ is 900, they are 6.91, 0.36 and 1.47. Changes in the value of beta have little impact on the first and all birth means, a small effect on the difference between the eldest surviving and firstborn means for young respondents, but a larger impact for older respondents. Differences in the length of the birth interval have a rather similar effect, though less pronounced, and in addition have some impact on the differences between means for all births and first births.

3.11 Weights for Reports of Eldest Surviving Children.

A basic set of weights for converting proportions of eldest surviving children with surviving mothers were calculated as described. The set is shown in Table 3.3, for different values of M_1, the mean age of first childbearing in the stable population. Since the parity composition of eldest surviving children is much affected by the level of child mortality, it is necessary to correct for its effects. Weights for different levels of $l_{(2)}$, with beta constant at 1.0, were calculated in the manner described. Various methods by which the basic weights for $l_{(2)}$ of 800 could be corrected easily to allow for other levels of child mortality were tried. The most effective method found was a correction through the mean. For any given value of $l_{(2)}$, a certain amount could be added to the empirically determined mean such that the adjusted mean would give the correct weight from the basic table for an $l_{(2)}$ of 800. This amount was found to be remarkably stable for a wide range of values of the mean, so that although it does change with age of respondent, it provides a suitable method of correction. The corrections calculated for a value of the mean of 21 years, are shown in Table 3.4. 21 years was chosen as being about the middle of

TABLE 3.3. : WEIGHTS FOR CONVERTING PROPORTIONS OF ELDEST SURVIVING CHILDREN WITH MOTHER ALIVE INTO LIFE TABLE FUNCTIONS

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 27.18

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2951	.3492	.3953	.4343	.4673	.4963	.5233	.5503	.5788	.6097
15	.9050	.2114	.2801	.3424	.3992	.4516	.5016	.5507	.6007	.6525	.7067
20	1.0358	.0958	.1879	.2746	.3568	.4355	.5122	.5882	.6644	.7418	.8205
25	1.1774	-.0309	.0903	.2062	.3174	.4247	.5293	.6322	.7341	.8358	.9377
30	1.3307	-.1482	.0019	.1460	.2845	.4183	.5484	.6757	.8010	.9249	1.0479
35	1.5094	-.2048	-.0326	.1329	.2925	.4471	.5978	.7455	.8912	1.0356	1.1795
40	1.7329	-.2450	-.0573	.1240	.2998	.4713	.6397	.8064	.9730	1.1409	1.3115
45	2.0334	-.1971	-.0056	.1814	.3657	.5489	.7328	.9196	1.1113	1.3106	1.3922
50	2.4605	-.1473	.0405	.2284	.4187	.6139	.8171	1.0323	1.2644	1.5193	1.2762
55	3.0779	-.0330	.1427	.3260	.5209	.7328	.9681	1.2344	1.5414	1.5911	1.0841

the range of values likely to be found in countries where the method described may be used. These corrections are not perfect, and if great accuracy is felt necessary, the full table of weights for the observed $l_{(2)}$ should be used.

The size and direction of error arising from the use of these corrections is discussed in the next section, but it should be noted that the corrections are accurate for a mean of 21 years, and that any error involved will increase, the further the true mean is from the central value.

Table 3.4: Corrections For Child Mortality

N Central Age	Amount in years to be added to firstbirth mean for various levels of $l_{(2)}$					
	650	700	750	800	850	900
10	2.10	1.45	0.76	-	-0.75	-1.46
15	2.18	1.49	0.77	-	-0.79	-1.57
20	2.22	1.51	0.77	-	-0.79	-1.58
25	2.31	1.56	0.79	-	-0.79	-1.58
30	2.44	1.64	0.82	-	-0.81	-1.61
35	2.61	1.75	0.88	-	-0.86	-1.69
40	2.80	1.90	0.96	-	-0.94	-1.83
45	2.98	2.06	1.05	-	-1.07	-2.06
50	3.05	2.16	1.14	-	-1.22	-2.40
55	2.89	2.13	1.16	-	-1.40	-2.86

3.12 Effects on the Weights of Variations in the Assumptions.

To test the validity of the assumptions made, calculations were carried out to see what effect the use of different assumptions had on the weights. Some of the more outrageous assumptions, such as that all births of a particular order occur at one age, the mean, could not be tested because the methodology depends on them. All the numerical inputs, such as the first birth distribution, or the parity distribution, or the mortality conditions, or the rate of population growth, can be tested quite simply by repeating the calculations using different figures. The computations involved in producing even a single set of weights are laborious, so two computer programmes were developed to perform the repetitions. The first programme calculates weights for firstborn respondents, and, with minor alterations, for all respondents as well. The second programme performs the interpolation within these to give weights for eldest surviving respondents. The programmes are reproduced in Appendices 3.1 and 3.2. The birth interval and the parity distribution have no effect on the first birth or all birth weights, affecting only the interpolation process. All other variables affect the original weights, or the original weights and the interpolation process. The subsections that follow will describe the impact of different numerical inputs on the weights. The weights calculated are shown in Appendix 3.3.

The most serious theoretical error in the method is the assumption that the birth interval is constant for all births. The evidence already presented does indicate that the mean birth interval is much the same regardless of birth order, but it does not follow from this that the assumption of a fixed birth interval is acceptable. It is likely that a woman who has 10 children has shorter intervals than a woman who has only four, or for a particular interval, the woman who goes on to have several more children will have a shorter interval than a woman who only has the one more child. It is still possible for mean intervals to be the same because similar proportions of women may be continuing to have a given number of extra births after each interval. Thus a higher order child is likely to have been born after shorter intervals, and therefore to a younger mother. The incidence of orphanhood is therefore likely to be lower than the model would suggest amongst high order children. This means that the orphanhood of eldest surviving children is likely to be closer to that of firstborn children than the model would suggest.

(i) The level of childhood mortality.

The number of life table survivors from 1,000 births to age 2, i.e. $l_{(2)}$, is used as the index of child mortality. Its impact is mainly on the correction from firstborn to eldest surviving respondents, but it also has some effect on the basic weights, partly through age distribution effects, and partly through deaths to mothers. The pattern of the weights of firstborn children with variations in age of child and the firstbirth mean is almost constant for different values of $l_{(2)}$, although the mean has a slightly greater impact for high values of $l_{(2)}$ than for low. The greatest actual difference between a firstborn weight for an $l_{(2)}$ of 650 and one of 900 is only the difference between -1.033, for a value of 650, a mean of 16 and age of 55, and -1.384, the equivalent weight for a value of 900. All children weights behave in very much the same way.

The level of childhood mortality largely determines the point of interpolation between firstborn and all children weights, and is therefore a very important variable in weights for eldest surviving children. An approximate method of allowing for this has already been explained. Although for central ages of 10 or 15 the differences are not large, for a central age of 55, the basic weight for an $l_{(2)}$ of 650 is 1.507, and for an $l_{(2)}$ of 900 it is 0.168, for a mean of 21 years. By and large, the effect of lower child mortality is to increase the proportion of firstborn amongst eldest surviving children, to increase the actual survival probabilities of the mothers, and to increase the rate of population growth, and thus the proportion of younger mothers. All these factors will increase the proportion with a surviving mother, though of course the effect on the weights will depend on whether the change in $l_{(2)}$ has more effect on the proportion with a surviving mother than on the survivorship ratio $l_{(25+N)}/l_{(25)}$. The relationships involved are rather complex, so a common sense analysis of the differences is not possible.

The corrections developed for different levels of $l_{(2)}$ are not absolutely satisfactory. Although the approximations are reasonable for a narrow range of values around a mean of 21, and for the first five central ages, considerable errors appear for more extreme values. Table 3.5 shows the actual and the estimated weights for values of $l_{(2)}$ of 700 and 900, for values of the first birth mean of 18 and 24, at the central ages. In assessing the weights, it must be remembered that they are for interpolating between two proportions that may not be all that different from one another. Thus a large difference in a weight may have only a small effect on the estimated value of the survivorship ratio. This in turn may have a substantial impact on an index of adult mortality, however. On the other hand, as will be shown in section 3.13, the difference between a weight of 0.4 and one of 0.6 need not have a large effect on such an index.

Table 3.5: Actual Weights Compared With Estimated Weights.

N Central Age	$l_{(2)} = 650$				$l_{(2)} = 900$			
	$M_l = 19$		$M_l = 24$		$M_l = 19$		$M_l = 24$	
	Actual	Est	Actual	Est	Actual	Est	Actual	Est
10	.478	.470	.588	.613*	.324	.324	.522	.511
15	.479	.461	.683	.716*	.231	.241	.546	.523
20	.477	.452	.803	.838*	.115	.134	.576	.544
25	.483	.457	.938	.996*	-.007	.020	.608	.573
30	.499	.476	1.079	1.102*	-.123	-.090	.632	.598
35	.558	.539	1.257	1.267*	-.188	-.151	.675	.644
40	.618	.606	1.453	1.448*	-.253	-.187	.694	.668
45	.736	.729	1.751	1.472*	-.248	-.209*	.740	.722
50	.834	.828	1.474	1.021*	-.260	-.222*	.745	.736
55	.953	.942	.993	.633*	-.207	-.184*	.773	.766

Figures marked * thus were obtained by extrapolating linearly beyond the range of means in Table 3.3.

(ii) The level of adult mortality.

Since the method seeks to estimate the level of adult mortality, it would be convenient if the weights varied but little with the relative level of adult mortality. The index of adult mortality used is beta, which is a good index of relative adult mortality if child mortality, in this case $l_{(2)}$, is fixed.

For the basic set of tables, beta is assumed to take its neutral value of 1.0, but values between 0.8, low adult mortality relative to child mortality, and 1.3, high adult mortality, are not uncommon. These two values, by no means extremes, were used to test the effect on the weights of different levels of adult mortality.

The value of beta does not have a large effect on weights for firstborn children for any value of $I_{(2)}$. The effect is rather larger for low values of the firstbirth mean than for high ones, but the greatest absolute difference is only that between -1.32 and -0.94 when $I_{(2)}$ is 800, for a mean of 16, a central age of 55, and beta of 0.8 and 1.3 respectively. For all births also, beta has little effect on the weights, though the effect increases with mean and age of respondent. Weights comparable with those given for the firstbirth case, but with a mean of 23, are 0.14 and -0.29 respectively.

The value of beta has a rather variable effect on the interpolation to eldest surviving children. For young central ages and high values of the firstbirth mean it has little effect, whereas for older central ages and low values of the firstbirth mean, its effect can be substantial. Thus for an $I_{(2)}$ of 800, a first birth mean of 18 and a central age of 10, the weight for beta of 0.8 is 0.38, whereas for a beta of 1.3 the weight is 0.32. For a central age of 50, the comparable figures are -0.12 and 0.30. For a higher mean age of 24, a central age of 10 gives weights of 0.56 and 0.55 respectively, whereas a central age of 50 gives weights of 1.06 and 1.78. Heavier child mortality makes little difference to the size of such changes, but lighter child mortality markedly reduces the difference at higher central ages of respondent.

The errors introduced by the value of beta are considerable, especially for high child mortality and older respondents. In practice, the errors introduced into a final estimate of adult mortality are not too serious if analysis is restricted to central ages of respondent of 40 or below. Data errors, believed to result from the under-reporting of orphaned children. as a result of foster mothers being confused with real mothers, make the use of central ages 10 and 15 inadvisable in any case (these, and other data errors, will be discussed in greater detail in Chapter 5). It is best, therefore, to restrict analysis to central ages ranging from 20 to 40, using proportions with a surviving mother reported by age groups 15 to 19, to 40 to 44.

If particular accuracy is required, and if the data is thought to be good enough, the true weight for the observed values of $l_{(2)}$, mean, and beta should be used. This can be found from the full tabulations reproduced in Appendix 3.2. However, a very reasonable approximation to the true weight can be obtained much more simply. If the estimated value of $l_{(2)}$, found for instance from the proportion dead among children ever born to women aged 20 to 24, is 800 or below, and the final estimate of beta, using the standard weights suitably corrected for the value of $l_{(2)}$, is substantially different from 1.0, say below 0.85 or above 1.2, it is possible that this estimate is somewhat in error. In this situation, new weights should be calculated, using the corrections shown in Table 3.6. If the first estimate of beta is below 0.85, the 'low mortality' corrections should be used, whereas if it is above 1.2, the ' high mortality' corrections should be used. These corrections should be used in exactly the same way as, and in place of, those given in Table 3.4, that is the amount shown in the table should be added to, or subtracted from, the observed value of the firstbirth mean, and the weight for the corrected value of this mean extracted from the basic weight table. This procedure gives a much better approximation of the true weight for extreme values of beta, and the error introduced into the final estimate of beta is rarely more than 0.01. It also somewhat surprisingly, gives a better approximation than applying the standard corrections to a table of basic weights correct for the given value of beta. The final error is of about the same magnitude as that introduced by an error of 10 points in the estimate of $l_{(2)}$. Although this correction procedure is only important with medium or high childhood mortality levels, its use in low childhood mortality situations does no harm, and corrections for low child mortality levels are included in Table 3.6.

(iii) The first birth distribution.

The influence of the first birth distribution, given the assumptions made, is felt only on the weights for firstborn children, and only through them on the weights for eldest surviving children. Two sorts of variation in the first birth distribution were tried, the first being to alter the span, shortening it to 15 years and lengthening it to 20 years, while maintaining its form, and the second being to retain the original span, but with a more extreme distribution of the form

$$f(t) = t^{\frac{1}{3}} (17.5 - t)^2$$

and with a less extreme function of the form

$$f(t) = t (17.5 - t)^2$$

Both were used with the standard assumption of an $l_{(2)}$ of 800 and a beta of 1.0. The effects of altering the span were not substantial. The weights for the longer span tended to be lower than the standard ones, and the reverse was the case for the shorter span. The weights calculated for the more extreme and less extreme first birth distributions are virtually indistinguishable from the standard weights. The method seems to be robust to small deviations from the assumed first birth distribution, which

Table 3.6: Revised Corrections for Child Mortality, Allowing for Adult Mortality.

(a) Low Mortality Corrections.

N Central Age	Amount in years to be added to firstbirth mean for various levels of $l_{(2)}$					
	650	700	750	800	850	900
10	2.13	1.55	1.00	0.62	-0.32	-0.97
15	2.04	1.42	0.83	0.35	-0.50	-1.16
20	1.93	1.28	0.66	0.13	-0.67	-1.33
25	1.87	1.18	0.54	- 0.14	-0.82	-1.47
30	1.85	1.12	0.45	- 0.18	-0.96	-1.62
35	1.87	1.10	0.38	- 0.29	-1.10	-1.78
40	1.92	1.09	0.32	- 0.41	-1.26	-1.98
45	1.97	1.09	0.27	- 0.55	-1.47	-2.25
50	1.97	1.07	0.20	- 0.72	-1.76	-2.65
55	1.84	0.97	0.09	- 0.97	-2.17	-3.28

(b) High Mortality Corrections

N Central Age	Amount in years to be added to firstbirth mean for various levels of $l_{(2)}$					
	650	700	750	800	850	900
10	2.12	1.35	0.53	-0.33	-1.22	-2.07
15	2.47	1.67	0.81	-0.10	-1.08	-2.04
20	2.77	1.94	1.07	0.15	-0.82	-1.80
25	3.08	2.22	1.31	0.37	-0.61	-1.60
30	3.43	2.51	1.55	0.56	-0.47	-1.48
35	3.83	2.86	1.82	0.75	-0.37	-1.44
40	4.21	3.21	2.12	0.95	-0.28	-1.48
45	5.34	3.56	2.46	1.20	-0.19	-1.59
50	(*)	3.67	2.68	1.45	-0.05	-1.70
55	(*)	(*)	2.66	1.62	-0.14	-1.72

(*) Indicates that the weight is beyond the range of the standard set.

in itself is probably remarkably constant for a wide variety of countries.

(iv) The level of fertility, the birth interval, and the rate of population growth.

All these variables are closely connected with one another, and it was thought to be sensible to examine all three together. Accordingly, weights for applying to data on orphanhood of eldest surviving children were calculated for two plausible, but very different populations. One was a fast growing population having a rate of increase of 2.7 per cent, a short birth interval of 2.2 years, and the Taiwan parity distribution shown in Table 3.2 implying a total fertility rate of 7.1. The other was a slow growing population, having a rate of increase of 1.4 per cent, a birth interval of 3.0 years, and the parity distribution of model two in Table 3.2 implying a total fertility rate of 5.0. The mortality level was the same in both populations as that used in calculating the basic weights given in Table 3.3, that is an $l_{(2)}$ of 800 and beta of 1.0.

Testing the effect of all these variables at once makes it impossible to draw any firm conclusions about the effect of each variable individually. However, all the variables are interdependent, so testing them individually is unrealistic. The populations developed are consistent and plausible, and will give some idea how satisfactory the orphanhood method is for application to very different populations.

The details of the tabulations are reproduced in Appendix 3.3. To summarize, however, it is clear that population dynamics have a substantial effect. The mean age of mother at birth of all children is a full year lower for the high fertility, high growth population than for the standard one, which in turn has a lower mean than the low fertility low growth population. The mean age of mother at birth of an eldest surviving child behaves in much the same way, the differences between it and the first birth mean, and the all birth mean and the first birth mean, maintaining virtually constant proportions. These proportions are of importance in the interpolation process between first and all birth weights. The weights themselves do differ to some extent on either side of the standard case, the high growth weights being lower, the low growth weights being higher. This is in agreement with the common sense expectation that orphanhood should be lower in the high growth population. The differences increase somewhat with first birth mean, and more substantially with central age of respondent. For ages of 40 or under, and likely values of the firstbirth mean, the differences are never substantial, rarely exceeding 0.1. The three populations considered are really very different in age structure, birth intervals and parity progression ratios, straddling most developing country situations. The fact that no substantial difference arises in the weights suggests that the method is fairly robust to variations in such features.

(v) The value of B.

The value of B, the base age from which survivorship ratios are taken, is selected arbitrarily. The exact value chosen is not of crucial importance, and convenience of calculation while applying the method can be taken into consideration; from this point of view, there is nothing to choose between a base of 20 and a base of 25. B should be chosen so that the weights, in normal use, fall as close to 0.5, the central value, as possible. Weights much over one or much below zero should be avoided if possible, by selecting weights for a different value of B. The weights developed for eldest surviving children are rather sensitive to the value of B, because they are a composite of firstborn weights and all birth weights. The value of B most suitable for one will not be very suitable for the other, though of course the base must be the same in both cases, if interpolation is to be carried out between the two. To see if 25 was the most suitable base, a full set of weights, for all mortality patterns, was calculated for a value of B of 20. The results indicated that 25 was the most suitable base for use in high child mortality, high first birth mean situations, and that 20 was more suitable for use with low child mortality, low firstbirth mean situations. Suitability in this context is indicated by two features of the weights, closeness to the central value of 0.5 and consistency with rising age group of respondent. Examples of the differences found are shown in Table 3.7.

The table shows that if one base, and one base only, is to be chosen, it should be 25. For cases when $l_{(2)}$ is 650 and M_1 is 23 or 24, a higher base would be desirable; on the other hand, when $l_{(2)}$ is 800 or 900, and M_1 is 18, 20 would be the best base. For the values in between these extremes, 25 is the most suitable base.

One consequence of the very rapid fall in mortality rates in the last two decades has been the appearance of countries with low mortality and inadequate vital registration. It may be, therefore, that indirect methods of estimating population parameters will still be necessary even when child mortality reaches low levels. It has been suggested that a method such as the present one could be of value in, for instance, the reverse survival of mothers when back-projecting children for purposes of fertility analysis. To make such an analysis possible, a set of weights has been generated especially for use in low mortality situations. The basic table is for an $l_{(2)}$ of 900, and correction factors for applying to the mean have been calculated for values from 850 to 950 by steps of 25. In accordance with the conclusion of the preceding paragraph, 20 was chosen as the base. The life table survivorship ratio estimated is from age 20, being $l_{(20+N)}/l_{(20)}$. The basic weights are shown in Table 3.8, and the corrections in Table 3.9.

Table 3.7: A Comparison of Weights Obtained Using Different Bases.

		$l_{(2)} = 650$						$l_{(2)} = 800$						$l_{(2)} = 900$					
Beta		0.8		1.0		1.3		0.8		1.0		1.3		0.8		1.0		1.3	
Base, B		20	25	20	25	20	25	20	25	20	25	20	25	20	25	20	25	20	25
Central Age	First Birth Mean																		
20	18	0.61	0.40	0.64	0.41	0.69	0.44	0.51	0.22	0.52	0.19	0.55	0.18	0.42	0.06	0.42	0.01	0.43	-.05
	24	0.94	0.77	1.00	0.80	1.07	0.86	0.89	0.66	0.93	0.66	0.99	0.70	0.85	0.57	0.90	0.58	0.96	0.59
40	18	1.06	0.32	1.22	0.46	1.48	0.66	0.72	-.14	0.80	-.06	0.99	0.12	0.49	-.51	0.53	-.47	0.61	-.38
	24	1.90	1.26	2.20	1.45	2.29	1.51	1.55	0.89	1.70	0.97	2.06	1.17	1.34	0.66	1.42	0.69	1.59	0.76

TABLE 3.8 : WEIGHTS FOR MATERNAL ORPHANHOOD OF ELDEST SURVIVING CHILDREN IN LOW MORTALITY SITUATIONS

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 800 900 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 27.18

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.3743	.4277	.4729	.5108	.5427	.5703	.5959	.6213	.6481	.6771
15	.9050	.4031	.4683	.5266	.5791	.6269	.6719	.7159	.7605	.8070	.8557
20	1.0358	.4347	.5171	.5935	.6652	.7332	.7989	.8638	.9290	.9956	1.0636
25	1.1774	.4737	.5762	.6732	.7657	.8545	.9410	1.0262	1.1112	1.1964	1.2822
30	1.3307	.5185	.6411	.7583	.8709	.9796	1.0858	1.1904	1.2942	1.3980	1.5020
35	1.5094	.5658	.7068	.8427	.9741	1.1022	1.2280	1.3526	1.4768	1.6017	1.7281
40	1.7329	.6468	.8037	.9566	1.1064	1.2546	1.4025	1.5518	1.7041	1.8608	2.0234
45	2.0334	.7308	.9044	1.0773	1.2510	1.4275	1.6088	1.7972	1.9955	2.2068	2.2308
50	2.4605	.8858	1.0820	1.2844	1.4960	1.7208	1.9635	2.2300	2.5277	2.8653	2.2519
55	3.0779	1.0684	1.3061	1.5664	1.8569	2.1864	2.5661	3.0096	3.5341	3.4268	2.0307

It should be pointed out that it was thought suitable for these calculations to assume rather lower fertility rates, and hence lower rates of growth, than previously, to fit in with the sort of populations where the weights are likely to be useful. Thus a total fertility rate of 5.0 was used, with the parity distribution shown in Table 3.2. Rates of population growth consistent with this fertility rate and the relevant mortality level were also used.

Table 3.9: Amounts to be Added to M_I to Correct Weights for B = 20 years for Child Mortality.

N Central Age	$l(2)$				
	850	875	900	925	950
10	0.14	0.07	-	-0.06	-0.12
15	0.23	0.12	-	-0.10	-0.20
20	0.33	0.16	-	-0.15	-0.29
25	0.42	0.21	-	-0.19	-0.37
30	0.52	0.26	-	-0.23	-0.44
35	0.63	0.31	-	-0.27	-0.52
40	0.77	0.38	-	-0.33	-0.63
45	0.94	0.45	-	-0.40	-0.74
50	1.17	0.56	-	-0.51	-0.93
55	1.39	0.69	-	-0.66	-1.21

One point to cause concern was shown up when calculating weights for different bases. This is that in certain circumstances the weights for different bases were not consistent. A given set of proportions with surviving mother should give the same estimate of beta with weights calculated for different B's. In fact, when the weights for base 25 get rather high, with high mortality and high mean, the weights for base

20 rise to over two, and when applied to the same data give different estimates of beta. The difference between the two estimates increased with age of respondent. The source of this error was identified as the interpolation process between first and all birth weights, since first birth and all birth weights were both found to be consistent. When the gap between the first and all birth weights is substantial, the error involved in using linear interpolation between them is considerable, as it might also be in the case of a small gap between them, but the presence of a maximum or minimum somewhere in between. Since the error is only substantial for extreme values of $I_{(2)}$ and M_1, (introducing an error in the estimate of beta as large as 0.02 for an $I_{(2)}$ of 650), and is minimised if a suitable value of B is used, this error does not seem to be of great practical importance.

(vi) Comparison with the results of a simulation model.

It has been mentioned that it is not possible to test some assumptions of the method, such as the correction for deaths among firstborn children. It is possible, however, to estimate the same values by a completely different method. Close agreement between the two results would be encouraging, but disagreement would not necessarily condemn either, because it would still not be clear which of the two, if either, was correct.

A simulation process was developed to calculate directly the proportion orphaned amongst eldest surviving children, and the birth order composition of eldest surviving children. Great help was provided by Dr. J C Barrett, who modified his Monte Carlo simulation model of fertility histories (Barrett and Brass; 1974) to allow for mortality amongst mothers. For the case chosen, all women who ever marry get married at exactly 20, and the programme generates for each woman her age at the birth of each child, and the onset of sterility, or death , in lunar months. The mortality rates used came from a Brass model life table with $l_{(2)}$ of 800 and related average adult mortality. The model generated 1,000 complete fertility histories, and these were then used as a data input for another simulation process designed to pick out eldest surviving children. In brief, this programme worked as follows. Each fertility history was considered in turn; for each birth, a random number was generated and compared with model life table survivorship probabilities to determine the age at death. The firstborn child was eldest surviving child until its death, assumed to occur halfway between the last age at which it was alive and the first age at which it was dead; the second child would then be an eldest surviving child from this age less the interval between the two births to its death; if it had died before the firstborn's death, consideration passed directly to the thirdborn child, adjusting the age by two birth intervals, whereas if the secondborn had not been born at the death of the firstborn it was eldest surviving child from birth. Each case of an eldest surviving child was added into the relevant cell of a three way matrix of eldest surviving children by their age, birth order, and mother's age at their birth. In this way the distribution by these three variables of eldest surviving children was obtained for a stationary population. Proportions not orphaned were then obtained manually by applying suitable survivorship probabilities to the number of eldest surviving children of mothers of each age, and a suitable age distribution factor to convert the stationary population situation into a stable population with a growth rate of two per cent per annum. The birth order composition of surviving children was obtained by applying the growth rate factors to each cell of the matrix, and summing for each birth order. The proportions not orphaned for selected age groups are compared in Table 3.10 with the proportions estimated by the original method for a first birth mean of 21.5 years. Table 3.11 shows the birth order composition of eldest surviving children aged 20 and 40 as estimated by both methods.

Table 3.10: Proportions of Eldest Surviving Children not Orphaned by Different Methods of Estimation.

Age Group	Proportion of Eldest Surviving children not orphaned	
	Birth Order Method	Simulation Method
5 to 9	0.933	0.936
10 to 14	0.887	0.891
25 to 29	0.709	0.724
30 to 34	0.624	0.644
45 to 49	0.252	0.296
50 to 54	0.124	0.172

Proportions not orphaned are markedly higher for the simulation model than for the original method, the difference increasing with age. This is not encouraging, but the direction of the difference is as would be expected. First, the simulation uses for the test case a constant age at marriage, 20 years, and this will reduce the spread of the first and subsequent birth distributions, thus reducing the impact of rapidly rising mortality in old age. Second, the point made in the introduction to this section about the relation between birth intervals and fertility would help to explain the discrepancy. Third, the first birth mean from the simulation is a stationary population mean, and will thus be slightly higher than the stable population mean used to select the comparable original model. On the other hand, Table 3.11 shows that the simulation model estimates a lower proportion of firstborn among eldest surviving children, and this would be expected to result in a higher proportion orphaned. In fact, the estimates of the birth order composition of eldest surviving children are rather similar, which is encouraging. The simulation model has a rather higher proportion of higher orders, with much higher orders significantly represented. Again, this is what would be expected; the fertility of the simulation, with a total fertility rate of 7.5, is considerably higher than that of the original model, with a total fertility rate of 6.0 ; and the fact that the simulation allows variation in the timing of births, whereas the original model fixes the mother's age at birth for any given birth order, increases all the variances, and hence lengthens the tail of the distribution.

Table 3.11: Birth Order Composition of Eldest Surviving Children by Different Methods of Estimation.

Birth Order	Age Group of Children: 20		40	
	Birth Order Method	Simulation Method	Birth Order Method	Simulation Method
1	0.716	0.683	0.601	0.540
2	0.203	0.211	0.240	0.236
3	0.058	0.063	0.095	0.109
4	0.017	0.024	0.039	0.055
5	0.005	0.012	0.016	0.022
6	0.001	0.003	0.006	0.012
7	-	0.001	0.002	0.005
8	-	0.002	0.001	0.007
9	-	0.001	-	0.005
10	-	-	-	0.003
11	-	0.001	-	0.002
12	-	-	-	0.002
13	-	-	-	0.001
14	-	-	-	0.001

The fertility simulation model differs in several important ways from the situation in a typical developing country. The highest age at the onset of sterility is higher in the model than seems to be the case in developing countries. Thus in the model fertility histories there are one or two cases of women giving birth at the age of 53, whereas in developing countries very few women give birth after 45 or so. This partly explains the large difference between first and all birth means given by the simulation model of 9½ years, compared with about seven years by the original method; there are other factors affecting this as well, such as the fixed age at first marriage, which has more impact on the age at first birth than on the age at subsequent births. The fertility simulation also assumes that husbands remain alive as long as their wives can bear children, or that widows under 50 remarry immediately upon widowhood. This would imply a higher total fertility rate, and a higher proportion of higher order births born to older women, than would normally be the case. These differences would be expected to have some impact on orphanhood of eldest surviving children, though the size and direction of the effects is not clear to common sense alone. The results of the simulation method are also subject to sampling error, though the consistency of its results suggests that this is not an important factor.

The simulation fails to confirm the results of the original model. The final proportions orphaned are very different, but it seems likely that the original method is more realistic for the actual orphanhood. The simulation seems to give a more realistic account of the birth order composition of eldest surviving children, but the differences are not very great. The simulation thus neither confirms nor condemns the original method, and it is impossible to assess the success of interpolating linearly between first birth weights and all birth weights using the estimated birth order composition of eldest surviving children. It is not clear that the simulation would give better results than the original method, and the work involved, in calculating proportions for different first birth means, levels of child mortality, and patterns of mortality, would be very substantial. The model as used here does show one or two puzzling features, for instance that the difference between the first and all birth means is $9\frac{1}{2}$ years, much higher than any empirical values; this is probably partly an effect of the fixed age at marriage, partly that these are stationary population means, and partly the simulation's high age at sterility.

3.13 Errors in the Estimate of Beta.

So far, errors or approximations in the method have been discussed in terms of their effect on the weights. What is important, of course, is their effect on a final estimate of adult mortality. Since the index of adult mortality used in calculating the weights is beta, this is a convenient index of adult mortality to measure with the method. The procedure has been described (Brass and Hill, 1973), and it is also outlined in Chapter 5. The point by point examination in the previous section of the effects of deviations from the assumptions shows that only two deviations, in $l_{(2)}$ and in beta, are of a serious nature, if the method of analysis recommended is adopted. However, if no correction is made for beta, and if the approximate correction for $l_{(2)}$ is adopted, some systematic error is introduced. To find out the effect of this error on a final estimate of beta, the following procedure was adopted. The weights for a given value of beta (0.8 or 1.3), $l_{(2)}$ (650 or 900), and M_1 (19 or 24 years) were obtained for a range of central ages from 20 to 40 from the full tabulations. The proportions of eldest surviving children with mother alive in each age group that combined with the weight to give the relevant value of beta were calculated. Then the approximate weights, obtained with no allowance being made for child mortality, were applied to the 'correct' proportions with mother alive, and an estimate of beta arrived at. Some of the estimates of beta arrived at in this way are shown in Table 3.12. The estimate shown is the arithmetic mean of the values of beta obtained for central ages of 20 to 40. As can be seen, the estimates for high child mortality are very erratic. The figures in brackets are the estimates produced by using the high or low adult mortality weights from section 3.12. It can be seen that they give quite adequate results. As long as the recommended procedure is followed, the error in the final estimate of beta is unlikely to be more than one per cent. An error of between one and two per cent in the estimate of $l_{(2)}$ would be an equally serious source of error.

Table 3.12 Estimates of Beta using Approximate Weights

Firstbirth Mean	Beta = 0.8			Beta = 1.3		
	$l_{(2)} = 650$		$l_{(2)} = 900$	$l_{(2)} = 650$		$l_{(2)} = 900$
19	0.794	(0.797)	0.798	1.343	(1.312)	1.296
24	0.778	(0.792)	0.801	1.318	(1.312)	1.314

Figures in brackets arrived at by using the high mortality corrections.

3.14 Weights for Proportions with Surviving Fathers.

The principles and calculations are almost exactly the same for fathers as for mothers, and will not be described again. However, a first birth function for fathers will be needed, as will a "parity" distribution and a figure for the birth interval. An adjustment will also be needed to allow for the fact that children are at risk of paternal orphanhood from conception rather than from birth, so that the exposed period is not the age of the child, but approximately three-quarters of a year more than this. The result of this is, that if proportions not orphaned are calculated for survival times of the parent of one year, two years, and so forth, the ages of child corresponding to them will be a quarter, one and a quarter, and so on.

This may be simply allowed for when weighting the proportions orphaned at point ages into the proportion for a five year age group. Each age group will have five points in it, and the proportion orphaned in the age group can be approximated as

$$_5P_a = \frac{w_0 P_a + 3w_1 P_{a+1} + 3w_{2\frac{1}{2}} \frac{(P_{a+2} + P_{a+3})}{2} + 3w_4 P_{a+4}}{w_0 + 3w_1 + 3w_{2\frac{1}{2}} + 3w_4}$$

where the weights, w_n, are age distribution factors, calculated as before from the mortality schedule and the rate of population growth.

3.15 A First Birth Function for Males.

There are very few data on which a model first birth distribution for males can be based. Censuses have never collected information about male fertility, and tabulations of female fertility by age of husband, living in the same household, are unsatisfactory, since not all fathers are included, and a previously married husband may have had children already. Registration data are also of little value, since most registration systems include a provision that the name, and other details of the father, need not be included on the registration form or birth certificate. This is not a criticism of censuses or registration systems. Such information is not of much value in the normal course of events, though it is disappointing not to be able to find any data when the need arises. Proportions of men, by age group, who have been fathers would provide a cumulated first birth distribution, but even this is not available anywhere. Only one source of data on first births by age of father has been found. This is a special tabulation of registration data for the United States, produced to investigate the effects of birth order and parental ages on the sex ratio at birth (Novitski and Kimball, 1958). First births by age of father and mother were tabulated for the U.S. for 1955. An estimated mid year population was obtained for the continental U.S. (U.S. Department of Commerce, 1956), and combined with the figures for first births to give an age specific first birth function for males. The births by age group, the male population, and the resultant distribution are shown in Table 3.13.

Table 3.13 A Male Age Specific First Birth Distribution.

Age Group	First Births to males, U.S.A 1955	Mid-Year Population Continental U.S.A 1955 '000	Age Specific First Birth Rate	Model Rates
-20	75,796	5,523*	.0137	.0233
20-24	417,702	4,941	.0845	.0728
25-29	315,240	5,659	.0557	.0598
30-34	123,660	5,990	.0206	.0332
35-39	48,546	5,628	.0086	.0104
40-44	18,514	5,476	.0034	.0005
45-49	6,383	4,980	.0013	-

* Population aged 15 to 19

Mean = 25.94 years

Variance = 28.19

Various other approaches were tried in an attempt to get more evidence, such as manipulating the data available for England and Wales (Registrar General of England and Wales, 1968) on number of families with or without dependent children. The data could not be persuaded to give anything useful, because children were ceasing to be dependent before all first births would have occurred, and because of the basic problems involved in a family approach to the issue.

It is clearly unsatisfactory to base a model distribution on one set of figures, especially when the figures are from the U.S. and the method is to be applied to demographically quite different countries. There seems however to be no alternative. Some slight crumb of comfort is provided by a comparison of the male and the female first birth distributions for the U.S. in 1955. The mean of the male distribution is over three years higher, 26.17 as opposed to 22.72, and the variance works out considerably higher, at 28.19 instead of 22.60. The female first birth distribution fits quite well with the female model, and the differences in mean and variance seem plausible.

Obviously what is required to fit the data is a distribution broadly similar to that for mothers, but with a slightly larger range. It is clearly not worthwhile spending much time finding a function to fit exactly the one distribution available. It was found that a reasonable approximation was achieved by using the same function as for mothers but with a range of 25 years. This gives a distribution with a mean 8.3 years after the start of fatherhood, and a variance of 25.3 years. Rates for five year age groups are shown in Table 3.11, fitted to the U.S. data through the mean. The function used is

$$f_m(t) = t^{\frac{1}{2}} (25 - t)^2 ,$$

and as can be seen from the table, the fit is adequate with the one empirical distribution available.

3.16 Birth Intervals and Total Children Born.

Whereas there are hardly any data on male first birth distributions, there is nothing at all on male birth intervals and parity distributions. Certain assumptions can be made, however. In a perfectly monogamous society, with no extramarital births and no remarriage, birth intervals will be exactly the same for males as for females. If the "parity" distribution is also the same, then the male and female total fertility rates will be the same. However, since each birth to a woman is also a birth to a man, the total numbers of births to each must always be the same. Since males marry later, they will be subject to heavier mortality, and to maintain the same number of births will need a higher total fertility rate. If the assumption of strict monogamy is relaxed, this effect will be reinforced by a greater propensity to remarry and have more children by a subsequent wife, and by an ability to do this until later in life. The proportion childless is also likely to be lower, since it is often the practice that marriages are not considered to be binding until the wife has shown herself to be fertile; if she fails to do so, whether through her own failure or the husband's, the husband may put her aside and take another wife. If the assumption of strict monogamy is relaxed to allow remarriage, but not extramarital births, male and female birth intervals will be the same, as long as they do not change with age and parity. Polygamy will make the male birth interval shorter than the female, and is likely to make the female interval rather longer than usual. It is also likely to raise the age of male marriage, and as such will need an even higher male total fertility rate to produce the same number of children.

The upshot of these considerations is that it seems reasonable to use the same birth interval for fathers, namely 2.6 years, since most societies are basically monogamous. The total fertility rate should be somewhat higher, so a value of 6.5 was used, with 97 per cent becoming fathers.

The "parity" distribution was derived from the negative binomial already mentioned (Brass, 1958), and is shown in Table 3.14 together with the model parameters. The model was developed to describe female parity distributions, and it was not designed for fathers. The arguments above suggest, however, that in a broadly monogamous society there will not be much difference, though the model may underestimate somewhat the numbers with parities over ten or so. To take account of this hunch, based on no data at all, would have meant developing a new model; this was not felt to be feasible or sensible. The model shows one per cent of fathers as having 14 children, and less than half of one per cent have more than this, so 14 is used as the cut off point. With a birth interval of 2.6 years, this means (given the assumptions of the method) that no father will have a child more than 34 years after the age at which first births occur. If this is 25 years, then no father will have a child after the age of 59, which is not all that unreasonable, as a crude approximation.

Table 3.14: Male Completed Parity Distribution.

Proportions with Completed Parity of at least

1	2	3	4	5	6	7	8	9	10	11	12	13	14
.97	.95	.91	.84	.75	.62	.49	.37	.26	.16	.10	.05	.03	.01

Total Fertility Rate = 6.5

b = 0.66, k = 4.82

3.17 Weights for Reports of Eldest Surviving Children.

Weights for analysing reports of eldest surviving children about the survival of their fathers were calculated in just the same way as similar weights for mothers, except that numerical values given above were substituted, and a rather different system of weighting into age groups, also described in the previous section, was used.

The weights calculated are obviously of a type similar to those for mothers, and they behave in much the same way. Thus they are much affected by the level of childhood mortality, with the effect increasing with age of respondent. As for females, a correction process is needed to get round this. Some experimentation was also carried out to find the most efficient estimating equation for the method, and the best base B. For the all children case, it had been found that the most suitable survivorship probability to estimate was $l_{(B+N+2\frac{1}{2})}/l_{(B)}$, with values of B of 27.5 or 32.5 (Brass and Hill, 1973). Three different probabilities were tried in the eldest surviving children case, $l_{(30+N)}/l_{(30)}$, $l_{(32\frac{1}{2}+N)}/l_{(30)}$, and $l_{(30+N)}/l_{(27\frac{1}{2})}$. None of these probabilities gave satisfactory results over the full range of values of child mortality and firstbirth mean. The first ratio was found to be best for low mortality, and the second ratio for high mortality. It is suggested that the proportion in the 20 to 24 age group with a surviving father is used as the index for deciding which probability to use, since this is a combined index of not only the level of child mortality, but also the firstbirth mean and beta, both of which have a bearing on which is the best function to use. So the estimating equation

$$\frac{l_{(30+N)}}{l_{(30)}} = w_N \; {}_5P_{N-5} + (1 - w_N) \; {}_5P_N$$

should be used if the proportion with surviving father in the 20 to 24 age group is 0.55 or higher, and the estimating equation

$$\frac{l_{(32\frac{1}{2}+N)}}{l_{(30)}} = w_N \; {}_5P_{N-5} + (1 - w_N) \; {}_5P_N$$

should be used if the proportion is below 0.55. The method for fathers is much more sensitive to the form of the estimating equation, and the value of B, than is the method for mothers. Thus it is necessary in certain circumstances to use the rather less convenient form of the second of these equations.

Corrections for the level of child mortality were calculated, as for mothers, and again an encouraging degree of consistency with the first birth mean was evident. The corrections are not perfect, though they seem to be slightly better than those for mothers, and represent a very worthwhile simplification. Corrections were calculated for both sets of weights, and for the heavy mortality weights, corrections from an $l_{(2)}$ of 700 were calculated, as well as from the normal $l_{(2)}$ of 800. It was found however that the corrections from an $l_{(2)}$ of 800 were more consistent, and gave better approximations for different values of the first birth mean. It was then observed that the corrections for the two tables were very similar, and that the corrections for the low mortality table gave results as good as, or better than, the high mortality corrections, when applied to the high mortality basic table. Thus only one set of corrections is necessary for the two tables. The low mortality weights, for an estimating equation of $l_{(30+N)}/l_{(30)}$, are shown in Table 3.15, the high mortality weights, for an estimating equation of $l_{(32\frac{1}{2}+N)}/l_{(30)}$, are shown in Table 3.16, and the child mortality corrections, to be applied to either table, are shown in Table 3.17.

TABLE 3.15 : WEIGHTS FOR PATERNAL ORPHANHOOD OF ELDEST [redacted]LITY SITUATIONS

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 32.51

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	22	23	24	25	26	27	28	29	30	31
10	.8272	.5454	.5814	.6166	.6525	.6897	.7289	.7701	.8129	.8572	.9027
15	.9171	.4521	.5150	.5777	.6412	.7060	.7723	.8398	.9084	.9775	1.0471
20	1.0513	.3501	.4449	.5387	.6323	.7259	.8196	.9134	1.0069	1.1000	1.1926
25	1.1970	.2496	.3756	.4993	.6211	.7415	.8607	.9788	1.0959	1.2121	1.3275
30	1.3555	.1883	.3393	.4870	.6319	.7748	.9161	1.0561	1.1954	1.3344	1.4739
35	1.5405	.1128	.2831	.4499	.6142	.7769	.9390	1.1014	1.2654	1.4323	1.5817
40	1.7734	.0813	.2611	.4390	.6166	.7955	.9774	1.1640	1.3572	1.5595	1.6145
45	2.0887	.0065	.1868	.3690	.5551	.7473	.9484	1.1617	1.3916	1.6435	1.5017
50	2.5399	-.0367	.1332	.3097	.4963	.6973	.9181	1.1652	1.4465	1.7283	1.2775
55	3.1964	-.0323	.1189	.2847	.4704	.6826	.9300	1.2243	1.5820	1.3107	1.2796

TABLE 3.16 : WEIGHTS FOR PATERNAL ORPHANHOOD OF ELDEST SURVIVING CHILDREN IN MODERATE AND HIGH MORTALITY SITUATIONS

FUNCTION ESTIMATED : $l_{(32\frac{1}{2}+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 32.51

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	22	23	24	25	26	27	28	29	30	31
10	.8272	-.0154	.0339	.0833	.1341	.1869	.2422	.2998	.3593	.4203	.4825
15	.9171	-.1412	-.0586	.0240	.1076	.1924	.2786	.3660	.4541	.5423	.6305
20	1.0513	-.2717	-.1525	-.0346	.0826	.1992	.3153	.4305	.5446	.6575	.7689
25	1.1970	-.3676	-.2159	-.0676	.0778	.2205	.3609	.4990	.6348	.7685	.9002
30	1.3555	-.4501	-.2745	-.1038	.0628	.2257	.3855	.5427	.6974	.8504	1.0023
35	1.5405	-.5055	-.3165	-.1327	.0469	.2228	.3961	.5677	.7388	.9104	1.0689
40	1.7734	-.5252	-.3368	-.1526	.0288	.2088	.3891	.5712	.7569	.9481	1.0456
45	2.0887	-.5721	-.3982	-.2257	-.0528	.1220	.3009	.4863	.6813	.8898	.8951
50	2.5399	-.5050	-.3581	-.2098	-.0580	.1005	.2691	.4525	.6559	.8678	.7785
55	3.1964	-.4124	-.3016	-.1852	-.0601	.0777	.2326	.4109	.6211	.6901	.7542

Table 3.17: Corrections for Child Mortality.

Amount in years to be added to male firstbirth mean for various values of

N Central Age	$l_{(2)}$ 650	700	750	800	850	900
10	1.97	1.33	0.67	-	-0.72	-1.46
15	2.08	1.38	0.69	-	-0.69	-1.36
20	2.20	1.45	0.72	-	-0.69	-1.34
25	2.34	1.54	0.75	-	-0.71	-1.34
30	2.50	1.64	0.80	-	-0.74	-1.37
35	2.64	1.74	0.86	-	-0.78	-1.42
40	2.77	1.86	0.92	-	-0.86	-1.55
45	2.86	1.96	1.00	-	-0.96	-1.77
50	2.84	2.02	1.06	-	-1.11	-2.12
55	2.67	1.96	1.07	-	-1.25	-2.55

3.18 Deviations from the Assumptions.

In an exact parallel with the case of weights for mothers, several of the assumptions are essential to the methodology, and thus could only be tested by devising another method. Most of the assumptions can be tested, though, by using alternative numerical inputs. This has not in fact been done for weights for fathers, because the behaviour of these weights is in general so very similar to the behaviour of weights for mothers in similar circumstances. There is no reason to suppose that any of the conclusions drawn for mothers in section 3.12 would not apply equally for fathers. For those variables which did have a significant effect on the weights for mothers, tabulations were run to find out the size and direction of the effect on weights for fathers. Weights were calculated for a range of levels of child and adult mortality as a result. For those variables which did not have a significant effect on the weights for mothers, it was assumed that they would not affect weights for fathers either. The weights calculated are shown in Appendix 3.4.

(i) The level of childhood mortality.

All birth weights vary a little with child mortality. The differences are not very great for low central ages and low mean, so that for a mean of 28 and central age of 10, the weights for $l_{(2)}$'s of 650 and 900 are 0.78 and 0.82 respectively. The comparable weights for a central age of 55 are -0.49 and -0.52. For a mean of 40, however, the pairs are 1.27 and 1.40, and 2.04 and 2.26 respectively. Firstborn weights vary rather more, and the other way round, so that there is least variation for high central ages and high means. For a first birth mean of 22, and central age of 10, the weight for an $l_{(2)}$ of 650 is 0.49, and for an $l_{(2)}$ of 900, 0.37. For a central age of 55, the comparable figures are -0.90 and -0.73. For a mean of 30, the weights are much less affected by child mortality, the comparable pairs being 0.71 and 0.73, and 0.25 and 0.27. It will be noticed that the difference between the all birth weights and the first birth weights is considerable.

The effect of $l_{(2)}$ on the weights for eldest surviving children is a composite of the effects of $l_{(2)}$ on the original first and all birth weights, and on the correction procedure. A method of correcting for $l_{(2)}$ has already been described, and it has been noted that it gives rather satisfactory results. This seems to be partly because the effect of $l_{(2)}$ on the basic weights is in opposite directions, so that a figure interpolated in between the first and all birth weights is less affected than the size of the differences would suggest. The point made in section 3.13 about linear interpolation between two points very wide apart should be born in mind. The same problem of getting different estimates of beta from the same proportions with surviving father using different estimating equations arises for fathers as it did for mothers. Once again, all that can be said is, that reasonable results will be obtained so long as the most suitable estimating equation is used.

(ii) The level of adult mortality.

Beta has some effect on the all birth weights, but this is not substantial except for a combination of high mean and high central age. Thus for beta of 0.8, the weight for a mean of 40 and central age of 55 is 2.40, but only 1,80 for a beta of 1.3. For central ages of 40 or below, the differences are never substantial. The first birth weights are more seriously affected, surprisingly. This is especially so for high central ages and low means. For a mean of 22 and a central age of 10, the weight for a beta of 0.8 is 0.46,, that for a beta of 1.3 is 0.38; for a central age of 55, the comparable weights are -0.90 and -0.64. For all these figures $l_{(2)}$ is 800; the effect of $l_{(2)}$ on that of beta is neither consistently in one direction nor substantial. Beta does unfortunately have some effect on the weights for eldest surviving children. As is usual, the largest diffences are for high mean, high central age weights. Thus for a central age of 40 and first birth mean of 30, the weight for a beta of 0.8 is 1.45, whereas for a beta of 1.3 it is 1.80. This degree of dependence on beta is of very much the same scale as for mothers, though perhaps rather more serious in high mortality, high mean situations. It was thought likely that a correction system similar to that developed for mothers would eliminate much of the error. It was then found, however, that the simple expedient of using the high child mortality weights was an even better correction. There is no need, therefore, to worry about the effect of beta on a final estimate so long as the recommended procedure for high child mortality has been followed. This suggests that a lot of the error introduced by changes in the value of beta arises from the use of an inappropriate estimating equation.

3.19 Errors in the Estimate of Beta.

Calculations were carried out, in just the same way as for mothers, to find out how large an error in the final estimate of beta was introduced by the approximate nature of the corrections for child and adult mortality. Proportions in each of the age groups 15 to 19 to 40 to 44 were calculated from the true weights, and the approximate weights were then applied to these to estimate beta. The results are summarized in Table 3.18.

Table 3.18: Estimates of Beta using Approximate Weights.

	Beta = 0.8			Beta = 1.3		
Firstbirth Mean	$l_{(2)} = 650$		$l_{(2)} = 900$	$l_{(2)} = 650$		$l_{(2)} = 900$
	a	b		a	b	
24	0.796	0.789	0.799	1.309	1.298	1.305
29	0.795	0,792	0.800	1.332	1.300	1.291

It will be seen that for each value of beta, there are two columns, a and b, for an $l_{(2)}$ of 650. Column a shows the estimate obtained using the low mortality weights and estimating equation, column b the estimate obtained using the high mortality weights and estimating equation. It can be seen that both give reasonable results for a beta of 0.8. For a beta of 1.3, however, the results in column b are much better than those in column a ; also, the final estimate of 1.309 for a first birth mean of 24 using the low mortality weights is misleading, since it is the average of some very erratic estimates, differing from the true value of 1.3 by as much as 0.05.

The method seems to be fairly robust for a considerable range of mortality levels and patterns. It would of course be nice to have a method with no built in error of this sort, but if the improvement in the accuracy of the data is greater than the error introduced by the method, a net gain results. The data so far collected are critically examined in Chapter 5 to see whether they justify the theoretical errors of the method.

The situations examined above have all been for values of beta away from its central value, and the estimates have all included error introduced by two factors, beta and the correction for child mortality. For a beta of 1.0, only the error due to the child mortality correction will be present. This error is not serious in practice, and the estimate of beta will usually be closer to its true vlaue than the estimates in cases where the true value of beta is further away from the central value, given the same mean and $I_{(2)}$.

3.20 Estimating the Firstbirth Mean for Males.

The mean age at first births to fathers in the stable population is used for fitting the model to an actual population for selecting weights. It has already been pointed out, however, that information on male fertility is never collected. There is a problem about how to calculate the first birth mean, if it cannot be obtained directly. The same problem applies to the all birth case, too, and has generally been met by using marriage data, but this has never really been very satisfactory. There is some reason to suppose that data on proportions married by age will be a more satisfactory measure for first births than for all births. The proportion ever married distribution is a cumulation of the first marriage function; it is unaffected by remarriages and by polygamy, and the first birth function is likely to be independent of these too. If all marriages are reported in the same way by both partners, the mean length of time between marriage and first birth will be the same for both males and females, except where either partner dies or the marriage dissolves beforehand. The difference between the mean age at first marriage for males and for females should be very similar to the difference between the mean age at first birth for males and for females. Thus if the mean age at first marriage can be computed for both sexes, an estimate of the mean age at first birth for males can be obtained by adding the difference between the two to the firstbirth mean for females. The mean age at first marriage can be roughly estimated very easily. The proportion ever married in an age group is considered as being the proportion ever married at the central point of the age group. Each proportion married is subtracted from the previous one to estimate a first marriage rate from one central point to the next. The first age group will thus be 15 to 17½, the second 17½ to 22½, and so on. The population in each of these age groups can then be estimated from the reported age distribution using age splitting coefficients such as those of Carrier and Hobcraft (1971). The number of marriages at each age can be calculated from the estimated marriage rates and the population mean age at first marriage can be obtained from these numbers. This is a crude procedure, but it does give an age distribution weighted first marriage mean, more closely related to the required first birth mean than the singulate mean age at marriage (Hajnal, 1953).

This method should give a reasonable estimate, as long as extra-marital first births are not very frequent (they are of course liable to be more common than extra-marital second or subsequent births). If extra-marital births are very frequent, it is hard to see how marriage data could help in estimating the male first birth mean. It is hard to see also what other data are available which could in any way help. For all births, the mean age of childbearing in the stable population is very similar to the mean length of generation (Coale, 1972) and this might be some help, but it is of no help whatever for first births.

CHAPTER FOUR

Estimating Adult Mortality from Information of Widowhood.

4.1 Introduction.

The analysis of information on widowhood, or widowerhood, to estimate adult mortality has some apparent advantages over the analysis of information on orphanhood. The marriage function is much more compact with a lower variance, than any all children fertility function, thus reducing the importance of possible deviations from model assumptions. This is similar to one of the advantages of analysing orphanhood reports of eldest surviving children already mentioned in Chapter 3, with the additional advantage of not involving a doubtful correction for the level of mortality. The well known problem of being able to place no reliance on reports of orphanhood for respondents under the age of 20, because of a bias thought to be due to the adoption of orphaned children by related families, is not present in the analysis of widowhood. Although remarriages may introduce some mis-reporting, it should be possible to obtain estimates from reports of young adults, who will not have been married long, whose exposure to risk of widowhood is short, and whose widowhood experience thus reflects very recent mortality levels.

Other advantages relate specifically to the estimation of male mortality. When using orphanhood data, the estimating model has to be fitted by the mean age of childbearing to fathers in the population. This can never be directly estimated because information on births in the preceeding 12 months by age of father is never available. (Recent attempts to obtain an estimate of this by tabulating births in the preceeding 12 months to all women by age of husband, when the woman and her husband were recorded as living together, have not given satisfactory results). The male mean has usually been estimated by adjusting the directly estimated female mean by some amount derived from an analysis of the male and female first marriage functions. The merits and demerits of this procedure, and a suggested way of making the calculations, are discussed at the end of Chapter 3, and it is sufficient to say here that it cannot be regarded as altogether satisfactory. The analysis of widowhood data, however, suffers from no such disadvantage, since the marriage distribution is what is required for fitting purposes, and this is normally available from census or survey sources. Another minor point is the consideration that a widow is at least likely to know who her husband was, whereas in the confused social context associated with, say, rapid urbanisation it might be quite common for a child to have no idea of its father's identity.

Some serious problems are involved in the analysis of widowhood information. First, the information may be seriously distorted by re-marriages, and to avoid the theoretical problems involved in this the data collected must relate to the survival of the first spouse, though such a limitation may introduce data accuracy problems. Second, marriage data tend to be regarded with suspicion by many demographers, especially for areas where the majority of 'marital' unions are possibly temporary consensual unions, on the grounds that the western concept of marriage, implicit in the questions asked, is not understood by the people being surveyed, and that the definitions are impossibly imprecise. The regular excess of currently married females over currently married males reported by censuses underlines the errors in the data. However, these considerations need not be very important as long as any particular individual is consistent in his replies, for instance not reporting himself as single and with first wife dead, and as long as a high proportion of all unions are included, so as to avoid a possible social bias in the selection of spouses from all men or all women. Third, in a society where unions tend to be rather unstable, there is a substantial risk, that increases with the time elapsed since first marriage, that a respondent will not know whether his or her first marriage partner is still alive. The fourth problem is posed by exposure to risk. In the case of orphanhood, the exposure to risk of maternal orphanhood is equal to the age of the respondent, and of paternal orphanhood is equal, as an adequate approximation, to that age plus three quarters of a year for the female gestation period. No such simple relationship exists with widowhood, unless the proportion widowed can be tabulated by time elapsed since first marriage. Failing this, an analysis of widowhood data tabulated by age group of respondent will have to take into account the male marriage distribution, which will determine the widowhood probabilities for given exposures to risk of widowhood, and the female marriage distribution, which will determine the exposure to risk structure within each age group. Such a method becomes rather complicated, and in application it requires fitting by two parameters, one for each marriage distribution.

Some of these advantages and disadvantages are theoretical, and some are concerned with data. The former will be discussed, and their importance assessed, in this chapter, but the latter will be investigated in the next chapter, when the method developed is applied to real data.

4.2. Proportions Widowed by Duration of Marriage.

Estimating proportions widowed of first spouse by duration of marriage (or rather time elapsed since first marriage) is an exact parallel of estimating proportions orphaned by age. Starting with widowhood, let the number of males aged t a years ago be $A(t)$. If the distribution of male marriages to single women by age is described by function $f(t)$, the number of males marrying a years ago will be

$$\int_p^q A(t)\ f(t)\ dt$$

where p and q are the earliest and latest ages at which males marry. The probability of surviving from exact age t to exact age t + a is $l_{(t+a)}/l_{(t)}$, so the proportion of the women involved in the marriages not widowed after a years of marriage is

$$p(a) \quad = \quad \frac{\int_p^q A(t)\ f(t)\ \frac{l_{(t+a)}}{l_{(t)}}\ dt}{\int_p^q A(t)\ f(t)\ dt}$$

In a stable population, the number of males aged t a years ago can be described in terms of the mortality schedule and the rate of population growth, so that

$$A(t) \quad = \quad k\ e^{-rt}\ l_{(t)}$$

so the proportion of women whose first husbands will still be alive after exactly a years is

$$(4.1) \qquad P(a) \quad = \quad \frac{\int_p^q e^{-rt}\ f(t)\ l_{(t+a)}\ dt}{\int_p^q e^{-rt}\ f(t)\ l_{(t)}\ dt}$$

which is exactly equivalent to equation 3.1, with the substitution of a marriage function for a first birth function, and time elapsed since first marriage for age of firstborn child. Such proportions with first husbands still surviving could be simply weighted to give proportions for five year age groups, as described in section 3.8, and a set of weights derived for converting such empirically observed proportions into life table survivorship probabilities as described in section 3.9.

A method based on these relationships would be simple to produce, and theoretically satisfactory because of the small varance of the male marriage distribution, However, any attempt to collect data on time elapsed since first marriage would almost certainly be vain in the areas where such a method would find its application. In most statistically underdeveloped countries age reporting is grossly inaccurate, so it would be unreasonable to expect accurate reporting of one particular period of that age. Attempts to date events tried for instance in the collection of migration data, have rarely proved a success, and the 20 per cent or more error commonly found in the reference period for a question on births in the last 12 months gives powerful confirmation of the problems involved (Brass et al.; 1968).

4.3 Proportions Widowed by Age of Respondent

The hope of deveoping a useful method of analysing widowhood data by duration of marriage has to be abondoned, and if any analysis of information on widowhood is to be feasible it will have to use some other proxy for exposure to risk. The obvious first choice for such a proxy is age, since it is a variable by which almost all survey material is tabulated, and since it is clearly related in some way to the time elapsed since first marriage through the distribution of first marriages by age. For the sake of clarity, the discussion that follows will be limited to widowhood reports of females, though widowerhood reports of males could be substituted throughout.

In a group of N women currently aged exactly a, and subject to an age at marriage function $f(t)$, the number of women currently married, in the absence of mortality and divorce, is

$$N \int_{p}^{a} f(t)\ dt$$

where p is the earliest age at which marriages occur. The number of women with the longest exposure to risk of widowhood will be those who married first, and they will number

$$n(a-p-1) = N \int_{p}^{p+1} f(t)\ dt$$

the duration of marriage being $a-p-1$ completed years, assuming p to be an integer. The proportion of ever married women aged a having a duration of marriage $a-p-1$ completed years is thus

$$Q(a-p-1) = \frac{\int_{p}^{p+1} f(t)\ dt}{\int_{p}^{a} f(t)\ dt}$$

and similar proportions for shorter durations can be worked out in just the same way.

Thus it is possible to work out the composition by exposure to risk of widowhood of ever married women of any given age. A probability of widowhood by exposure to risk could then be calculated as outlined in section 4.2, or described in detail for orphanhood in section 3.8, and applied to the proportions with each exposure to risk to estimate the incidence of widowhood for those women. There is, however, one rather serious problem involved, namely that it can not be assumed, and indeed is far from the case, that men marrying women of 15 are distributed by age in the same way as men marrying women of 45. To investigate this, cohort marriage data are needed to eliminate age distribution effects, and suitable sets of data are few and far between. One source of information is the Irish census of 1911 (Registrar-General of Ireland; 1913), which includes apparently satisfactory data on duration of marriage tabulated by age of husband and age of wife at marriage. It is thus possible to follow through the survivors of a cohort of marrying men, to obtain the age specific marriage rates for males marrying females of a given age group. The distributions obtained are shown, for both sexes, in Table 4.6.

These distributions powerfully support the earlier assertion that it could not be assumed that one male age distribution at marriage could be applied to all female age groups at marriage. The age distribution of males marrying women 15 to 19 is practically the reverse of that of males marrying women aged 45 to 49. It is perfectly possible, if somewhat laborious, to calculate separate widowhood probabilities by exposure to risk for each different age distribution at marriage. These probabilities could then be used with the relevant proportions of wives by exposure to risk, to estimate the overall probability of widowhood for women of a given age group. More will be said about the details of such a system in section 4.11. It is sufficient to say here that such a model would be a highly theoretical construct somewhat removed from reality. It would be based on age at marriage distributions obtained from the 1911 census of Ireland, a country at that stage being an extreme example of what has been called the European marriage pattern (Hajnal; 1964), with marriages occurring very late, and a very high proportion of the population not marrying at all. This consideration alone makes the inclusion of Irish marriage patterns in a method intended for use in developing countries highly questionable. Little can be done to get round this problem, since the sort of data needed are just not available for any developing country.

To make any further progress, a gross simplification is needed. The greatest possible simplification would be to assume that all male and female marriages are concentrated at their means, thus eliminating the use of distributions at all. Both male and female marriage distributions have low variances in most developing areas (though the male marriage pattern in parts of Africa is unusual in this respect) so such an approximation would perhaps not be too far wrong. However, the approximation is more draconian than is required, because the combination of a distribution of male ages at marriage with a fixed female age at marriage removes the necessity for a whole family of male marriage distributions.

4.4 Proportions Widowed Given a Fixed Female Age at Marriage.

If all the women who ever get married marry first at exact age b, a woman now aged exactly a will have been exposed to the risk of widowhood from first husband for exactly $a-b$ years. If the age distribution of the males marrying hitherto single females is described by $f(t)$, the proportion widowed amongst the females aged b, $P(b)$, will be

$$P(b) = \frac{\int_p^q e^{-rt} f(t)\ l_{(t+a-b)}\ dt}{\int_p^q e^{-rt} f(t)\ l_{(t)}\ dt}$$

where p and q are the age limits of t. Given a marriage function evaluated for single years, proportions widowed for intervals of single years can be calculated, and these may be straightforwardly weighted to estimate the proportion widowed in an age group of women. Care has to be taken, however, if a does not happen to be the starting point of a conventional five year age grouping. Thus there is no problem if a is 10,15 or 20, but if a is 17, for instance, those aged 15 or 16 in the 15 to 19 age group are neither married nor widowed, and are thus left out altogether; those aged exactly 17 are all married, but none are widowed since their exposure to risk is zero; those aged exactly 18, 19 and 20 are all married, and some will be widowed, their overall numbers decreasing with the age distribution.

The only other problem is the nature of the male marriage distribution. Since the question relates to the survival of first husband, the male marriage distribution needed is not that of male first marriages, but of male marriages to previously single females. Data on age at marriage of first husband by previous marital status of bride are available for some countries producing comprehensive tabulations from reasonably complete registration of marriages, for instance for England and Wales (Annual reports of the Registrar-General), but this sort of information is not available for developing countries. All that is normally available from censuses and surveys is the numbers single, legally married, consensually married, divorced, separated, and widowed by age group. These sorts of data are only suitable for calculating the age distribution of males at first marriage. Since there is no information of the required sort available for developing countries, a male first marriage distribution has been used in the model. The possible error introduced by this will be discussed in the critical evaluation of the method presented in section 4.11.

4.5. Model Male and Female First Marriage Distributions.

An excellent double exponential model of female first marriage distributions has been developed by Coale (Coale, 1971; Coale and McNeil, 1972). This model gives an excellent fit to a wide range of empirical distributions, though the marriage patterns revealed by the 1971 census of India could not be brought within the range of model values tabulated by Coale. Two variables are required for fitting the model, one fixing its age location, and one determining the rate at which marriages occur thereafter. This makes the model rather tedious to fit, and two variables is more than one would willingly introduce into an already highly simplified model such as that being developed. It would be possible to fix one variable at an average value for the sort of countries the method is intended for, retaining only the age location variable. However, it was decided to adopt a simple polynomial model, in the same way as was done with first and all birth distributions. Another reason for adopting this procedure is that a distribution is required for male first marriages as well as female. Coale's model in fact gives a very reasonable fit to most of the male marriage distributions studied, though it in no way claims to be able to do this, but one or two of the empirical distributions fell outside the tabulated range of Coale's model.

Thus a search was made to find two fairly simple polynomials, one for male, and one for female, marriages, to represent the main features of a wide range of first marriage distributions from developing countries, whilst retaining convenience of manipulation. The search for suitable functions was not very exhaustive; as soon as one with roughly the right shape and dispersion was found, it was accepted. With so many other assumptions implicit in the approach, the search for a totally satisfactory function would have been a waste of time. The function adopted for female marriages was

$$f(t) = t^{\frac{1}{3}} (30-t)^4 ,$$

a function having a very early peak, with half the women married only $5\frac{1}{2}$ years after earliest marriages, and 90 per cent married after $12\frac{3}{4}$ years.

Various empirical female first marriage functions are shown in Table 4.1 (a), each with a set of comparable model values, fitted by the mean. The examples were selected to give a wide geographical, and hence hopefully social, spread, with one population from mainland Asia, one from East Africa, one from Latin America, and one from the Pacific. It is clear that marriage patterns do vary substantially; there is practically a four year difference between the earliest mean and the latest mean, and the highest variance is twice the lowest variance. There are obvious points of similarity though; virtually all those who ever marry are married by the 40 to 44 age group, with the bulk of marriages, always more than 85 per cent, occurring by the late 20's. Thus all the first marriage distributions are narrow, not more than 25 or 30 years, all are relatively skewed, most of the distribution coming in the first third of the range, and all have fairly low variances. The Korean example takes all these features to an extreme, and is very much the odd one out of the four. These common features are very much the principal features of the model distribution as well. Table 4.1 (a) shows that the model fits the Columbian data very well, even having the same variance. Its fit to the other three distributions is not so satisfactory

- it would be impossible to find a one parameter model to fit both the Korean and the Columbian data - but in terms of variance and age group by age group comparisons it does seem to represent successfully a middle or average case. The only serious reservation concerns the repeated over-estimation of the proportion married in the 15 to 19 age group. This could result from poor fitting if the mean were an inefficient parameter for fixing purposes, but could also result, and this seems more likely, from the fact that the model distribution is convex up to and beyond the mode, whereas the observed functions may well start concave and not become convex until shortly before the mode.

The function adopted for the male first marriage distribution was rather similar, being

$$f(t) \quad = \quad t^{\frac{1}{2}} \ (30-t)^3 \quad .$$

This distribution has the same range, 30 years, as that for females, but is slightly less sharply peaked and heavily skewed, the mean being 8.3 years after the start of marrying, compared with 6.3 years for females. Half the men who ever marry are married after rather less than 7½ years, and 90 per cent are married after about 15½ years. The model has been fitted, as before, to the marriage data for the same four countries, and the results are shown in Table 4.1 (b). The model does not fit any of the cases very well, but it obviously occupies the middle ground between the extremely sharp distribution for Korea, with an extremely low variance, and the much more gentle distribution, with greater variance, reported in the British Solomon Islands. The model has no obvious failings, however, and the differences between it and the actual values seem to result largely from fitting deficiencies, except in the case of the Korean distribution, which is not well estimated. The fit is best, probably, for Kenya, where all the age groups fit reasonably well, except the 20 to 24 age group.

Table 4.1 Marriage Distributions From Various Countries and Fitted Model Distributions.

Age Group	Proportion of those married 45 to 49 married by age group							
	Korea 1966		Colombia 1964		Kenya 1969		British Solomon Islands 1971	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model
(a) Females								
15 to 19	.039	.099	.194	.226	.374	.484	.160	.209
20 to 24	.484	.545	.656	.652	.839	.805	.609	.638
25 to 29	.924	.838	.887	.886	.963	.948	.852	.880
30 to 34	.991	.960	.964	.976	.990	.992	.965	.973
35 to 39	.998	.995	1.000	.997	.996	1.000	.974	.997
40 to 44	.999	1.000	1.002	1.000	1.000	1.000	1.006	1.000
45 to 49	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mean	22.83		21.24		19.10		22.16	
Variance (approx)	12.59	22.19	21.53	21.53	14.20	16.42	26.35	21.87
(b) Males								
15 to 19	.006	.010	.019	.006	.047	.044	.023	.002
20 to 24	.100	.249	.277	.231	.302	.364	.221	.200
25 to 29	.617	.607	.651	.591	.727	.691	.585	.561
30 to 34	.948	.844	.851	.835	.926	.890	.827	.818
35 to 39	.991	.959	.936	.955	.974	.976	.920	.949
40 to 44	.998	.995	.979	.994	1.000	.998	.968	.993
45 to 49	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mean	26.71		26.50		25.22		27.47	
Variance (approx)	14.84	31.40	37.35	31.77	25.57	30.64	40.36	31.63

The models proposed do not give nearly such satisfactory fits to the actual distributions studied as does Coale's two parameter model for females. If, however, the shape variable were fixed in Coale's model, leaving only a locational variable, there would be no great advantage to be obtained from using it. In developing a method of analysing widowhood, there could be no possible justification for using a two parameter marriage model. This would merely increase the labour involved in applying the method, while the improvement in accuracy would be trivial in comparison with the errors introduced by other, unavoidable simplifications. The simple polynomials described represent the main features of the observed distributions, and their variances seem to fall somewhere near the centre of the observed range, so they can be accepted as adequate for the purpose in hand. It will be shown in section 4.11 that the method is not sensitive to the exact marriage function chosen.

4.6 Mortality Pattern and Age Distribution.

Some of the properties of the Brass model life table system, and some of its advantages for use in this sort of application, have already been mentioned in section 3.6. The system's flexibility and convenience are again powerful arguments in its favour, and there is no reason to adopt an alternative mortality model in its place. The basic widowhood method has been worked out with $l_{(2)}$ set at 800 and beta set at 1.0; these values are somewhere near the centre of the range likely to be found in populations where these techniques may find an application. They imply an expectation of life at birth of about 40 years.

Some sort of age distribution is required for the calculations of proportions widowed by exposure to risk, and for the calculations of mean exposure to risk for each age group. A stable population age distribution has been used in equation 4.1, and consistency requires the use of the same age distribution for the latter purpose also. Once the mortality schedule is fixed, only the intrinsic rate of natural increase is required to determine the age distribution. With the mortality pattern specified above, a total fertility rate of 6.0, and a fairly normal age distribution of fertility, a population would grow at close to two per cent per annum, and this value has been used in the basic tabulations.

The effects of making different assumptions are discussed in section 4.9. It is easy to try out various levels of mortality by varying $l_{(2)}$, and various age patterns of mortality, by varying beta. A variety of combinations were tried out, the age distribution varying with mortality in such a way as to remain consistent with a total fertility rate of 6.0.

4.7. Calculation of Proportions Widowed by Age of Spouse.

The calculation of proportions widowed by age of spouse falls into two distinct parts, one the calculation of the probability of widowhood by length of exposure to risk, that is, time elapsed since first marriage, and the other the weighting of the calculated probabilities into proportions widowed in conventional five year age groups, given a fixed age of marriage. The discussion will be conducted in terms of female respondents, that is, male mortality, though the only difference for the two sexes is the marriage distribution. The calculation of the probability of widowhood by exposure to risk is very similar to the calculation of orphanhood amongst firstborn children, described in section 3.8, but a brief account will again be given here.

The age at first marriage function is integrated, and evaluated at single year points, in the range p to q, p being the age at which first marrying starts, and q, equal to $p+30$, being the age by which it is completed. The model value corresponding to an age specific first marriage rate is obtained by subtracting one value of the integral from the next, so that

$$F(t) = \int_{p}^{t} f(t)\ dt - \int_{p}^{t-1} f(t)\ dt$$

Each age specific first marriage rate is then multiplied by e^{-rt} to allow for the effect of population growth on the age distribution. The first age specific marriage rate is for age p, that is for exact ages p to $p+1$, so the second age distribution effect can be reproduced by multiplying by the life table survivors to age $p+\frac{1}{2}$, that is, $l_{(p+\frac{1}{2})}$, as a proxy for $L_{(p)}$, person years lived aged p. This estimates the number of first marriages being entered into by men aged p. If similar calculations are carried out for males aged $p+1$, $p+2$, and so on, until q is reached and first marriages cease, the sum of the products estimates the bottom line of equation 4.1, that is

$$\int_{p}^{q} e^{-rt}\ f(t)\ l_{(t)}\ dt$$

If such calculations are repeated, starting not with age p but with age $p+1$, the resulting sum is an estimate of the value of

$$\int_{p+1}^{q+1} e^{-rt}\ f(t)\ l_{(t)}\ dt$$

but, at the same time, it is also an estimate of the top line of equation 4.1 for a starting age of p and an exposure to risk, a, of one year,

$$\int_p^q e^{-rt} f(t)\ l_{(t+a)}\ dt$$

since $e^{-rt} f(t)$ moves with the origin without changing its value. Thus the probability of not being widowed after being married exactly one year when marrying starts at age p, is estimated by dividing the second sum by the first. The probability of not being widowed after any duration of marriage, for any starting age at marriage, can be simply estimated as the quotient of the two relevant summations of this type. Since the computations are rather lengthy, especially if they have to be repeated time and again for different assumptions, a computer routine developed for firstborn children was used again.

Orphanhood data are tabulated by exposure to risk, since the age of the respondent is the exposure to risk, or the exposure to risk less the gestation period for paternal orphanhood. It has already been mentioned that this is not the case for widowhood, since the data have to be tabulated by the age of the woman. To simplify the problem introduced by this consideration, it is assumed that all women whoever marry get married at one exact age. Since it has already been observed that the female first marriage function has a very narrow dispersion, this assumption is unlikely to result in serious error, such error as there is being concentrated in the early age groups. It is not difficult, with this assumption, to estimate the proportion not widowed in any age group. Taking the age group 15 to 19, and assuming that all women marry at exact age 15, all the women aged exactly 15 will be married, but none will be widowed since the exposure to risk of widowhood is zero. The number of women aged 15 can be written as

$$N_{(15)} = k\, e^{-15r}\, l_{(15)}$$

Women aged exactly 16 have been exposed to risk of widowhood for one year. If male marriages start at age p, and the probability of not being widowed after an exposure to risk of one year is $P_{(1)}$, the number of women not widowed at age 16 will be

$$N_{(16)}\; P_{(1)}$$

where

$$N_{(16)} = k\, e^{-16r}\, l_{(16)}$$

The argument can be continued, exact age by exact age, up to exact age 20. The proportion not widowed in the 15 to 19 age group can then be estimated, assuming only a linear age structure between one exact age and the next, as

$$\frac{\sum_{b=15}^{19} N_{(b)}\; P_{(c)} + N_{(b+1)}\; P_{(c+1)}}{\sum_{b=15}^{19} N_{(b)} + N_{(b+1)}}$$

where c is equal to $b-a$, a being the age at which all marriages occur. Similar expressions can be written for all subsequent age groups of respondents. If all women marry, not at 15, but at 16, there is no basic difference, except that the value of b runs from 16 to 19. There is no need to worry about the single women aged 15, since the analysis is restricted to ever-married respondents. Nor, for the same reason, is there any reason to worry about women who never get married at all - they are simply excluded from the analysis. A computer routine described in Appendix 4.1 has been developed to carry out the necessary computations for all relevant age groups, and for a variety of marriage ages, from 15 to 24. The point age at marriage can be regarded as the mean age at first marriage, and may be estimated empirically by Hajnal's singulate mean age at marriage (Hajnal; 1953), which is very easy to compute.

4.8 Deriving Weights for Proportions Widowed.

In order to be useful in the estimation of mortality, proportions widowed by age group have to be related to some conventional life table function. Since the incidence of widowhood is determined by mortality after marriage, the most suitable function to use is survivorship from some fixed exact age to some other, later, age, which is related to the age group of the respondent. In developing the analysis of orphanhood, the function used was the probability of surviving from a fixed age B to age B+N, N being the central point of two adjacent age groups of respondents. A weight, w(N), was calculated to relate the proportions not orphaned in the two age groups to the life table function according to equation 3.2. The situation is not quite the same for widowhood, since the age of the respondent (that is, the surviving spouse) is equivalent neither to the exposure to risk of widowhood nor to the point on the mortality schedule from which the exposure should run. If all women get married at exactly 15, the 15 to 19 age group will be made up of women with an exposure to risk of widowhood ranging from zero to almost five years, whereas if all women get married at 18 it will be made up of women with an exposure varying from zero to almost two years, and if they all get married at 20 none of the women will have been married at all. Thus there is no necessary connection between the exposure to risk of the respondents and their age. There is no reason other than convenience why there should be such a necessary connection, so long as the relationship between the exposure to risk and the life table survivorship period is constant. For paternal orphanhood the correction has been stretched somewhat, with proportion orphaned being related to survivorship from age B to age B+N+2½ (Brass and Hill; 1973). This latter condition is not really fulfilled in the widowhood case since the relation between exposure to risk and age of respondent varies with age at marriage. Thus it is necessary to select arbitrarily some survivorship ratio, the grounds for such a selection being convenience of use, and a resultant set of weights in the zero to one range for most age groups of respondents, rather than some connection with common sense. This is not the only problem involved in choosing a survivorship ratio, for it must be remembered that it is the survivorship of the husband from his age at marriage for the period of his duration of marriage which is of interest. His age at marriage will on average be related through the mean ages at male and female marriages to the age of the female respondent, but this is very indirect. Thus uncertainty surrounds the exposure to risk period because of variations in the female age at marriage, as well as the starting point because of variations in the male age at marriage.

If males marry on average five years later than females, the exposure to risk will run from around 22½ if females all marry at 17½. Thus for wives aged 20, husbands will have survivied, as a rough average, from 22½ to 25. Similarly, wives aged 25 will have husbands who have survived from 22½ to 30. Thus, where N is the central age of respondents, and females marry before 20, the estimating equation

$$\frac{l_{(N+5)}}{l_{(22\frac{1}{2})}} = w(N)\ {}_5P_{N-5} + (1-w(N))\ {}_5P_N \qquad (4.2)$$

represents an adequate average of the husbands' experience. When females marry later, with the mean age over 20, the husbands are likely to marry later, and the exposure to risk will be shorter for a given age. Females marrying between 20 and 25 will on average have been married for 2½ years by 25, and their husbands, by the same argument as that used above, will by then have survived from 27½ to 30. Thus a suitable estimating equation will be

$$(4.3) \qquad \frac{l_{(N+5)}}{l_{(27\frac{1}{2})}} = w(N)\ {}_5P_{N-5} + (1-w(N))\ {}_5P_N$$

Both these estimating equations have the advantage of convenience in application, since the numerator of the survivorship ratio involves survival to a round age, 25, 30 and so on. The denominator is survivorship to an awkward half year point, but it is the same for all age groups of respondent. The use of a fixed estimating equation for a range of exposures to risk from 2½ years less to 2½ years more than that used in the equation gives rise to considerable variation in the weights as the mean age at female marriage varies. This will be discussed in the next section. The assumption of a single age at marriage also has a substantial effect for respondents below the age at which first marriage is completed, because of its effect on exposure to risk. This is discussed in section 4.11.

For male respondents, reporting about female mortality, the situation is the same. There is still no necessary connection between age of respondent, which is known, and starting point and duration of exposure to risk, which are not. Somewhat arbitrary estimating equations based on a very rough average of different situations, are again needed. When the mean age of male marriage is between 20 and 24, the average exposure to risk of widowhood, over all possible situations, will be around 2½ years by age 25. The wives will have survived from 17½ to 20, if on average they marry five years earlier than men. The most suitable estimating equation to cover the possibilities is

$$(4.4) \qquad \frac{I_{(N-5)}}{I_{(17\frac{1}{2})}} = w(N)\ {}_5P_{N-5} + (1-w(N))\ {}_5P_N$$

For the situation in which the average age at male marriage is between 25 and 30, the same arguments suggest the following as the most suitable estimating equation.

$$(4.5) \qquad \frac{I_{(N-5)}}{I_{(22\frac{1}{2})}} = w(N)\ {}_5P_{N-5} + (1-w(N))\ {}_5P_N$$

The ultimate justification of an estimating equation in this context is that it should produce a set of weights close to 0.5 for a wide range of age groups and means. Given the inevitable problems of variable exposure to risk, these estimating equations do give rise to a consistent and stable set of weights.

4.9. Fitting the Model to Empirical Values.

In order that the method may be used, it is necessary that the widowhood model be fitted by some empirically measurable parameter or parameters to an actual situation. For orphanhood this fitting is achieved by using the mean age at birth in the stable population, which is affected both by the age distribution and the fertility distribution. For widowhood, the situation is rather more complicated because two parameters are needed. In the case of female respondents, a measure of the female age at marriage is needed to select an appropriate exposure to risk, and a measure of male age at marriage is needed to select an appropriate point from which the exposure is to run. It turns out that both these parameters are necessary, the first particularly so for young respondents, the second particularly so for older respondents. The nature of the parameters needed in the two cases is not the same, however. The exposure to risk is not influenced by the female age distribution (except trivially within five year age groups), and thus a straightforward mean age at marriage is needed for fitting purposes. Hajnal's singulate mean age at marriage (Hajnal; 1953) is suitable, and is easily calculated from data on proportions single by age, the sort of marriage data usually available from censuses and surveys. For fitting the male marriage distribution to empirical data, however, something more like the stable population mean used in orphanhood is required. A given marriage function will give a younger distribution of husbands with a younger age distribution, and thus also a lower incidence of widowhood, than with an older age distribution. Thus using an age distribution weighted mean will give a more satisfactory estimate of widowhood, given an extreme age distribution, than a straightforward marriage distribution mean. That this will provide a better fit can be easily illustrated. A young, or steep, age distribution will have younger husbands, and thus overall lower widowhood, than the marriage pattern alone would suggest. The age distribution weighted mean will be lowered by the steep age distribution, and thus the weight selected will be from an earlier marriage model, and thus a lower widowhood situation. This weight will be more suitable unless there is a drastic overcorrection, but there is no reason to suppose that such overcorrection should occur, since within the range of the marriage function mortality is relatively low, and increasing more or less linearly with age.

From theoretical considerations, then, an age distribution weighted mean age at male marriage is required for fitting purposes. If the only data available are proportions ever married by age group, no first marriage rates or numbers marrying are directly available, making direct calculation of a suitable mean rather difficult. It is necessary to indulge in some fudging around of the data to estimate an age distribution weighted mean, and it may be that what is lost in this fudging process outweighs what is gained by using a more suitable fitting parameter, particularly where the age distribution is not extreme. A method of estimating the population mean is as follows. The proportion ever married in an age group is considered as being the proportion ever married at the central point of the age group. Each proportion married is subtracted from the previous one to estimate a first marriage rate from one central point to the next; the first age group will thus be 15 to 17½, the second 17½ to 22½, and so on. The population in each of these age groups can then be estimated from the reported age distribution using age splitting coefficients, for instance those of Carrier and Hobcraft (Carrier and Hobcraft; 1971). The number of marriages at each age can be calculated as the product of the synthetic population and the synthetic marriage rates thus calculated, and the population mean calculated from the number of marriages at each age. The difference between the mean thus calculated, and the singulate mean age at marriage is rather small in those cases where both have been calculated, and this complicated procedure seems scarcely worth the effort. However, just in case of age distribution problems, the means calculated from the model for fitting purposes are a singulate mean age at marriage for respondents and a mean age at marriage in the stable population for the spouses.

4.10. Weights for Applying to Proportions Widowed.

A computer programme, reproduced in Appendix 4.1, was developed to simplify the largely repetitious calculations needed to work out weights for a range of male and female marriage locations, and a range of mortality levels and patterns. It was found that the variation in the weights with mean marriage age of respondent was virtually constant for all central ages and all population mean ages at marriage of spouse. It is therefore only necessary to have one table of weights, for a given mean marriage age of respondent, and a simple table of corrections for other means. The weights for female respondents, for a mean age at marriage of 18 and estimating equation 4.2, are given in Table 4.2 (a), and for a mean age at marriage of 22, and estimating equation 4.3, in Table 4.2 (b). The weights for male respondents, for a mean age at marriage of 23, and estimating equation 4.4, are given in Table 4.3 (a), and for a mean age at marriage of 27, and estimating equation 4.5, in Table 4.3 (b). The full weights, for all reasonable means, are reproduced in Appendix 4.2.

The corrections developed for different mean ages of respondent have simply to be added on to the weights obtained from Tables 4.2 and 4.3. The fact that these corrections vary only a little with the other mean involved, the population mean age at marriage of the spouse, avoids the need for a three way table of weights, and the fact that they vary scarcely at all with age of respondent means that even a two way table of corrections is unnecessary. This materially simplifies the use of what is, in effect, a two parameter model. Some variation was found in the corrections by mean age at marriage of respondent, and this was greatest where the two means were either very close to one another, or very far apart. For likely differences between the two means, it is adequate to use the simple corrections shown in Table 4.4. These corrections are what common sense suggests. The weights effectively interpolate between proportions not widowed in two adjacent five year age groups. A change in exposure to risk, which is what the mean age at marriage of respondents is measuring, simply moves the point of interpolation required to give a fixed reference point. Thus if the observed mean is one year earlier than the mean on which the standard table is based, a correction of 0.2, representing one year more in a five year age group, has to be added to the weight to maintain the original reference point. The error introduced into the weight by the use of this simple correction is rarely in excess of 0.05, and that only for large differences in means, or a female mean in excess of the male mean. The possible error is related to the size of the correction, so the

TABLE 4.2 : WEIGHTS FOR CONVERTING PROPORTIONS WIDOWED INTO LIFE TABLE FUNCTIONS

FEMALE RESPONDENTS

Alpha = 0.0221 Beta = 1.0 $l_{(2)}$ = 800 Growth Rate = 2.00%

(a) FUNCTION ESTIMATED : $l_{(N+5)}/l_{(22\frac{1}{2})}$

Mean Age at Female Marriage : 18 years

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	.4564	.2573	.2488	.2209	.1741	.1102	.0279	-.0404	-.1478	-.2305
20	.4928	.3052	.3100	.3003	.2771	.2386	.1802	.1299	.0363	-.0430
21	.5232	.3459	.3648	.3744	.3749	.3614	.3259	.2934	.2137	.1393
22	.5481	.3805	.4142	.4440	.4683	.4790	.4657	.4508	.3953	.3178
23	.5678	.4097	.4590	.5099	.5580	.5921	.6002	.6028	.5521	.4940
24	.5830	.4344	.5006	.5731	.6447	.7015	.7303	.7504	.7154	.6696
25	.5945	.4563	.5404	.6349	.7294	.8079	.8568	.8944	.8767	.8462
26	.6038	.4770	.5799	.6965	.8131	.9123	.9807	1.0359	1.0375	1.0257
27	.6120	.4979	.6205	.7589	.8966	1.0154	1.1027	1.1761	1.1994	1.2103
28	.6204	.5204	.6630	.8226	.9802	1.1178	1.2236	1.3160	1.3639	1.4026
29	.6300	.5449	.7078	.3878	1.0643	1.2197	1.3438	1.4569	1.5326	1.6057
30	.6408	.5715	.7547	.9543	1.1485	1.3212	1.4636	1.5998	1.7071	1.8235

(b) FUNCTION ESTIMATED : $l_{(N+5)}/l_{(27\frac{1}{2})}$

Mean Age at Female Marriage : 22 years

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	3.1951	.6196	.3856	.2623	.0757	-.1584	-.4145	-.6257	-.8404	-.9722
20	3.0786	.6513	.4344	.3253	.1631	-.0394	-.2606	-.4428	-.6368	-.7617
21	2.9801	.6780	.4763	.3841	.2454	.0747	-.1129	-.2677	-.4419	-.5600
22	2.8983	.7002	.5121	.4367	.3235	.1844	.0291	-.0997	-.2547	-.3663
23	2.8329	.7180	.5424	.4851	.3982	.2902	.1658	.0617	-.0746	-.1797
24	2.7839	.7318	.5682	.5303	.4703	.3928	.2980	.2174	.0992	.0011
25	2.7490	.7424	.5910	.5738	.5409	.4930	.4263	.3681	.2677	.1776
26	2.7243	.7509	.6127	.6171	.6113	.5918	.5516	.5149	.4319	.3514
27	2.7054	.7584	.6347	.6615	.6823	.6897	.6745	.6585	.5930	.5240
28	2.6871	.7660	.6582	.7078	.7544	.7873	.7957	.7996	.7521	.6970
29	2.6659	.7747	.6837	.7563	.8277	.8847	.9155	.9389	.9104	.8719
30	2.6407	.7846	.7112	.8068	.9019	.9317	1.0340	1.0768	1.0690	1.0504

TABLE 4.3 : WEIGHTS FOR CONVERTING PROPORTIONS WIDOWED INTO LIFE TABLE FUNCTIONS

MALE RESPONDENTS

Alpha = 0.0221 Beta = 1.0 $l_{(2)}$ = 800 Growth Rate = 2.00%

(a) FUNCTION ESTIMATED : $l_{(N-5)}/l_{(17\frac{1}{2})}$

Mean Age at Male Marriage : 23 years

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	.3853	.1129	.0999	.1110	.1113	.1043	.0861	.0483	.0172	-.0593
16	.4423	.1930	.1869	.2087	.2252	.2371	.2380	.2174	.1988	.1325
17	.4944	.2635	.2669	.3004	.3332	.3638	.3831	.3790	.3733	.3175
18	.5399	.3242	.3386	.3847	.4343	.4835	.5209	.5332	.5408	.4964
19	.5783	.3758	.4017	.4614	.5284	.5964	.6516	.6804	.7017	.6704
20	.6100	.4191	.4566	.5310	.6161	.7028	.7757	.8211	.8568	.8408
21	.6357	.4546	.5041	.5943	.6980	.8034	.8939	.9563	1.0070	1.0090
22	.6553	.4826	.5451	.6522	.7751	.8990	1.0070	1.0865	1.1535	1.1765
23	.6693	.5049	.5811	.7061	.8483	.9906	1.1160	1.2127	1.2977	1.3447
24	.6790	.5228	.6143	.7579	.9193	1.0795	1.2221	1.3360	1.4413	1.5154

(b) FUNCTION ESTIMATED : $l_{(N-5)}/l_{(22\frac{1}{2})}$

Mean Age at Male Marriage : 27 years

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	3.7890	.4844	.2145	.1576	.0613	-.0829	-.2588	-.4511	-.6037	-.7760
16	3.5958	.5381	.2932	.2462	.1628	.0397	-.1097	-.2744	-.4057	-.5625
17	3.4193	.5870	.3636	.3277	.2584	.1567	.0333	-.1049	-.2163	-.3577
18	3.2457	.6297	.4253	.4010	.3468	.2671	.1695	.0567	-.0355	-.1613
19	3.1049	.6659	.4784	.4657	.4279	.3708	.2987	.2106	.1373	.0269
20	2.9865	.6961	.5233	.5223	.5021	.4682	.4214	.3572	.3027	.2076
21	2.8889	.7208	.5602	.5717	.5703	.5600	.5381	.4972	.4615	.3818
22	2.8142	.7398	.5897	.6148	.6333	.6470	.6494	.6313	.6143	.5505
23	2.7622	.7536	.6129	.6529	.6924	.7301	.7563	.7604	.7619	.7153
24	2.7289	.7631	.6320	.6883	.7496	.8109	.8601	.8857	.9056	.8777

absolute error in a correction of 0.6 will be larger than that in a correction of 0.2.

The procedure for obtaining a set of weights is not complicated. The first step is to estimate the two means required, one a distribution mean for respondents, and one a population mean for the spouses at risk. The respondents' mean is used first, to select the relevant estimating equation, and then to estimate, by linear interpolation within the round values given in Table 4.4 the correction value needed. The population mean is then used to interpolate within the relevant part of Table 4.2 or Table 4.3, and weights obtained for each central age of respondents required. The final weights are then arrived at by simply adding to each such weight the correction value already estimated.

Table 4.4 Correction Factors for Mean Age of Respondents' Marriage.

	Female Respondents				Male Respondents			
Estimating	$^{l}(N+5)/^{l}(22\frac{1}{2})$		$^{l}(N+5)/^{l}(27\frac{1}{2})$		$^{l}(N-5)/^{l}(17\frac{1}{2})$		$^{l}(N-5)/^{l}(22\frac{1}{2})$	
	Marriage Mean	Correction	Marriage Mean	Correction	Marriage Mean	Correction	Marriage Mean	Correction
	15	0.6	20	0.4	20	0.6	25	0.4
	16	0.4	21	0.2	21	0.4	26	0.2
	17	0.2	22	-	22	0.2	27	-
	18	-	23	-0.2	23	-	28	-0.2
	19	-0.2	24	-0.4	24	-0.2	29	-0.4
	20	-0.4			25	-0.4		

4.11 Effects on the Weights of Variations in the Assumptions.

The assumptions on which the widowhood method just described rests are fewer and less sweeping than those on which the eldest surviving children technique relies. Some assumptions, such as the model parameters, can be tested by the simple expedient of using alternative numerical inputs, whereas others, such as the effect of assuming a fixed age at marriage for respondents, are much more difficult to test. There must also be doubts about the quality of the data to which the method may be applied, but consideration of this will be left to Chapter 5.

(i) Theoretical Assumptions.

The most obvious theoretical objection is to the assumption that there is no relation between mortality experience and marital status. It is well established that mortality is higher, perhaps as much as 50 per cent higher, for the single population than for the married population. There is also some evidence that mortality is higher amongst the widowed and divorced than amongst the married. If this is so, the analysis of widowhood would underestimate mortality since the widows would form too small a proportion of the population as a result of dying off faster. For England and Wales in 1961, apparent mortality rates for widowers and divorced men were about twice the rates for married men, and the rates for widows and divorced women were also substantially higher than for married women (Registrar-General; 1968). The interpretation of this information requires care, however, since there is some doubt as to the comparability of the marriage data from census and from registration sources.

Much more detailed analysis has been conducted in the United States. Kraus and Lilienfield (1959) examined mortality differentials between the married and widowed populations using data from the 1950 census and deaths registered in the years 1949 to 1951, by sex, age and cause of death. The excess mortality of widows and widowers was particularly marked in the age group 20 to 34, the cause of death specific death rates being always at least twice the rates for the married. There were also very substantial variations by cause of death, the rates from tuberculosis, influenza, pneumonia, diseases of the heart, suicide, and motor accidents being ten times the comparable married rates in the 20 to 34 age group, whereas the rates from cancer were only twice as high. It is hard to explain these differences in terms of different reporting of marital status in a census and at registering a death. The differences are too large to be explained by the somewhat higher average age of widows than married persons in an age group, or by the fact that the widowed population is selected for ill health by failure to remarry, or by the possible effect of marriage prospects on reporting of marital status. Three classes of possible explanation are proposed, and called 'mutual choice of poor risk mates', 'joint unfavourable environment', and 'effects of widowhood'; the built in effect of social class mortality differentials is dismissed on the grounds that it cannot explain a large enough portion of the gap. The mutual choice of poor risk mates is the only explanation that covers the observed decline of the gap with age; it is easier to recognize a poor risk five years hence than a poor risk 15 years hence.

These conclusions are largely borne out by the United States matched records study of 1960 (National Center for Health Statistics; 1969), which matched census and death registration reports. Substantial errors in reporting marital status were discovered, but nothing like large enough to explain away all the higher mortality amongst widows. The study found that an apparent excess of 75 per cent for white widowers over marrieds was reduced to 63 per cent; for white females, the reduction was from 40 per cent to 27 per cent; for non-white males from 119 per cent to 77 per cent; and for non-white females from 81 per cent to 57 per cent.

It seems clear that mortality amongst widowers in the United States is higher than amongst the married population, and that this excess is most marked amongst young widows; the differences over the age of 40 could well be explained by the various factors mentioned above. This obviously has implications for the widowhood analysis, and will tend to lower estimates of mortality by reducing the proportion widowed. Fortunately the differences are greatest for young widows, at ages where mortality is very low, so that although the proportion widowed is low, so is the mortality of widows, even though it is proportionately much higher than for married persons The rising probability of widowhood with age also means that the numbers widowed more than five years ago are only a small part of all widows, so the excess mortality does not accumulate for a long period. This error is in the same direction as that resulting from taking no account of higher mortality in the single population, which could be important for countries with substantial proportions never marrying. There is a compensating upward bias, however, introduced by the effects of falling mortality, so the net effect could be small.

The evidence for this excess mortality amongst the widowed comes from developed, low mortality countries, particularly from the United States. There is therefore no direct evidence for the same relationship being found in underdeveloped, high mortality countries, to the same proportional extent, or indeed at all. The non-white population of the United States shows higher differentials than the white population, but this would be partly an age distribution effect; this population can hardly be regarded as typical of developing countries anyway.

(ii) Assumptions about Mortality and the Age Distribution.

The mortality schedule used in the basic model was from the Brass model life table system, described in Chapter 3 (Brass et al, 1968; Brass, 1971b). The same overall level and pattern was used as for the basic orphanhood calculations, that is, with an average relationship between adult and child mortality, and with $l_{(2)}$, life table survivors to age two, being set at 800. This particular life table was chosen as being roughly an average for a wide range of developing countries. The age distribution assumed in the model was that of a stable population, determined by the mortality schedule and the rate of population growth. A fertility pattern similar to that developed by Brass (Brass et al, 1968), and a total fertility rate of six were found to imply an intrinsic rate of growth of close to two per cent per annum.

In reality, mortality schedules and rates of population growth vary widely even, or especially, in the developing world. The robustness of the model to different situations was tested by using different mortality schedules and growth rates in the model, and noting how much difference this made to the final weights. The tests were carried out for weights for female respondents with the female age at marriage fixed at 20, but using both estimating equations; for male respondents, the male age at marriage was fixed at 25. Weights were calculated on the basis of four life tables for each sex of respondent. The parameters of these life tables were (i) beta = 1.3, $l_{(2)}$ = 800; (ii) beta = 0.8, $l_{(2)}$ = 800; (iii) beta = 1.0, $l_{(2)}$ = 650; (iv) beta = 1.0, $l_{(2)}$ = 900. Growth rates consistent with these mortality schedules and with a total fertility rate of 6.0 were used to determine the model age distribution. Table 4.5 shows the weights calculated using these different life tables and age distributions, for three central ages of respondent and for a typical male - female marriage mean gap; the comparable weight obtained from Tables 4.2, 4.3, and 4.4 in the manner described earlier, is also shown.

Table 4.5 shows that the weights do not vary much with the level of child mortality, as measured by $l_{(2)}$, or the age pattern of

TABLE 4.5: The Effect on Widowhood Weights of Different Mortality Patterns

	$l_{(2)}$	Beta	Growth Rate % per annum	Female Respondents: Female Mean = 20, Male Mean = 24						Male Respondents: Female Mean = 20, Male Mean = 25					
Estimating Equation				$l_{(N+5)}/l_{(22\frac{1}{2})}$			$l_{(N+5)}/l_{(27\frac{1}{2})}$			$l_{(N-5)}/l_{(17\frac{1}{2})}$			$l_{(N-5)}/l_{(22\frac{1}{2})}$		
Central age				25	40	60	30	40	60	30	45	60	35	45	60
Estimated Value	800	1.00	2.00	.034	.245	.315	.968	.870	.499	.019	.216	.421	.923	.902	.757
True Values	800	1.30	1.75	.035	.231	.218	.946	.830	.407	.031	.222	.392	.909	.869	.705
True Values	800	0.80	2.17	.026	.236	.377	.979	.887	.578	.007	.192	.437	.933	.914	.787
True Values	650	1.00	1.15	.017	.199	.256	.986	.895	.506	-.004	.155	.357	.935	.919	.764
True Values	900	1.00	3.15	.042	.278	.409	.948	.841	.553	.035	.256	.500	.915	.880	.766

mortality, as measured by beta. The largest difference between a value estimated from the basic table and the true weight is 0.097, which is unlikely to have a serious impact on a final estimate of adult mortality, as results given in Chapter 3 indicate. The differences shown in Table 4.5 also reflect the error introduced by using the correction factors from Table 4.4, and thus confirm that this error is not important. The true values shown in Table 4.5 are of course only a selection of all the weights calculated; the full tabulations, for a full range of means and all central ages, are reproduced in Appendix 4.3. Weights have only been calculated for respondent means of 20, for females, and 25, for males, but it seems most unlikely that the respondent mean would be an important source of variation with different mortality patterns, so this can not be regarded as a serious drawback. It seems safe to conclude that, although the weights vary somewhat with beta, $l_{(2)}$, and the age distribution, this variation is so small that the method can be regarded as fairly robust to fluctuations in mortality patterns and age distributions. It is, in fact, rather more robust to changes in beta than the original orphanhood method, and is clearly superior to the somewhat fragile eldest surviving child development of that method.

(iii) Assumptions about Marriage Patterns.

Two major assumptions have been made about marriage patterns, one, that all the respondents' sex marry at one exact age, and two, that all the spouses' sex get married according to the simple polynomials described in section 4.5. The difficulty in avoiding the first assumption was explained partly in terms of a lack of suitable data on joint ages at marriage of both partners, and partly in terms of unjustifiable complexity. Some data are available from the 1911 Census of Ireland (Registrar-General of Ireland; 1913) on marriages by duration and age of bride and groom at marriage. The marriages are not, unfortunately, limited to first marriages, but divorce at least would be unknown, and separations very unusual; the only important cause of marriage dissolution, and thus possible remarriage, would be widowhood. The data are tabulated by five year age groups for age at marriage, and five year duration periods. It is thus possible to follow an approximate cohort through the years when most marriages occur. Those married 0 to 4 years and married at age 45 to 49 were aged 45 to 54 at the time of the census, as were those married 30 to 34 years and married at age 15 to 19. Since the data are also tabulated by age group of spouse at marriage, it is possible to derive marriage rates by age of spouse for each age group at marriage of the sex under consideration, and since it is more or less a cohort which is followed through the various tabulations for different durations of marriage, there is no need to worry about the effects of age distribution or mortality. The marriage rates obtained, based on the 45 to 54 cohort, are shown in Table 4.6. The rates behave in just the way one would expect, though they become somewhat erratic at higher ages, where there are few marriages taking place. The overall distribution of marriages by age can be obtained from the number of marriages being entered into in each age group, and is also shown in Table 4.6 as a proportion of all marriages entered into by those under 50.

Irish marriage patterns for the late nineteenth and early twentieth centuries cannot be regarded as typical of developing countries. Marriage was extremely late (the singulate mean age at marriage for females works out at 27.8) and very far from universal. However, to calculate proportions widowed based on these marriage patterns, and then to apply model weights to them, would test two assumptions of the model, these being that taking a fixed age at marriage for respondents does not seriously distort the results, and that the method is robust to variations in marriage patterns.

The calculations required to work out the proportion widowed by age group using male and female marriage distributions are much more elaborate

Table 4.6: Marriage Rates by Age Group of Each Spouse, Census of Ireland, 1911.

(a) Age Distribution of Husbands Marrying Wives of Given Age Group

Age Group of Wife	Age Group of Husband							
	Under 20	20-24	25-29	30-34	35-39	40-44	45-49	Proportion of all marriages within range
Under 20	.116	.347	.300	.142	.070	.020	.005	.092
20 to 24	.017	.270	.299	.228	.114	.055	.017	.305
25 to 29	.004	.070	.297	.250	.217	.114	.047	.283
30 to 34	.004	.031	.107	.301	.241	.219	.097	.179
35 to 39	.005	.019	.062	.150	.322	.252	.190	.092
40 to 44	.002	.023	.045	.104	.166	.406	.254	.036
45 to 49	.001	.028	.070	.077	.139	.220	.465	.012

(b) Age Distribution of Wives Marrying Husbands of Given Age Group

Age Group of Wife	Age Group of Wife							
	Under 20	20-24	25-29	30-34	35-39	40-44	45-49	Proportion of all marriages within range
Under 20	.567	.318	.085	.024	.005	.001	–	.020
20 to 24	.180	.582	.164	.059	.012	.003	–	.150
25 to 29	.087	.347	.406	.116	.036	.007	.001	.236
30 to 34	.057	.253	.316	.272	.072	.025	.004	.226
35 to 39	.049	.176	.275	.245	.196	.045	.014	.179
40 to 44	.031	.154	.209	.248	.195	.139	.024	.125
45 to 49	.010	.093	.225	.213	.231	.118	.110	.064

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30 to 34	.004	.031	.107	.301	.241	.219	.097	.179
35 to 39	.005	.019	.062	.150	.322	.252	.190	.092
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(b) Age Distribution of Wives Marrying Husbands of Given Age Group

Age Group of Wife	Age Group of Wife							
	Under 20	20-24	25-29	30-34	35-39	40-44	45-49	Proportion of all marriages within range
Under 20	.567	.318	.085	.024	.005	.001	-	.020
20 to 24	.180	.582	.164	.059	.012	.003	-	.150
25 to 29	.087	.347	.406	.116	.036	.007	.001	.236
30 to 34	.057	.253	.316	.272	.072	.025	.004	.226
35 to 39	.049	.176	.275	.245	.196	.045	.014	.179
40 to 44	.031	.154	.209	.248	.195	.139	.024	.125
45 to 49	.010	.093	.225	.213	.231	.118	.110	.064

than those required if one distribution is concentrated at its mean. A computer programme was developed out of the original programme WIDOW, to perform the necessary calculations, but the output was the proportion widowed by age group rather than a weight for a central point of two age groups. The computations involved will be described in terms of female respondents, though they are exactly the same for male respondents. The starting point is the female marriage distribution, interpolated into rates for 2½ year age groups, and seven male marriage distributions, one for each five year age group of wife at marriage, and the standard Brass mortality model with beta equal to 1.0 and $l_{(2)}$ equal to 800. The marriage distributions were all transposed to five years younger than recorded, to bring the calculated proportions widowed within the range of the weights calculated by the original WIDOW programme. The probability of not being widowed by exposure to risk in 2½ year intervals was then calculated for each of the male marriage distributions.

The female marriage distribution was then used to calculate the distribution by exposure to risk of ever married women of a given age. If the marriage rate for females aged 10 to 12½ is f_1, the proportion married by age 12½ is $2.5f_1$; their mean exposure to risk of widowhood is approximately 1.25 years, the exact figure depending upon the shape of the marriage distribution. By age 15, these women will have been exposed to risk for another 2½ years, and those married between 12½ and 15, numbering $2.5f_2$, will have been exposed to risk for about 1.25 years. The risk of widowhood for these two groups will be that calculated from the first male marriage distribution, that marrying the youngest age group of females. By age 17½, the first group will have been exposed for about 6.25 years, the second group for about 3.75 years, and a third group, numbering $2.5f_3$, will have been exposed for about 1.25 years. This third group, however, will have married males distributed by age according to the second male marriage distribution, giving a different probability of widowhood for each exposure to risk (and generally a higher probability, since the age at marriage for this group of males is somewhat higher). In this way, it is possible to build up a number of females married, and a number widowed, at each exact age. As long as mortality is not related to marital status, there is no need to consider mortality amongst the women at this stage, since at each point the women are all the same age, although some have been married longer than others. The programme developed, called WIDOW1, carried out all the necessary accumulations at each stage, and calculated the proportion widowed at each point age.

In practice, a rather more sophisticated procedure was adopted for the exposure to risk of the just married age group than assuming that it was always 1.25 years. For this, the original female marriage function was used, even though it bears little resemblance to the Irish marriage pattern. The female marriage function is

$$f(t) = t^{\frac{1}{3}} (30 - t)^{4}$$

and if this is integrated, evaluated at 2½ year intervals, and each subtracted from the result for one interval later, it simulates marriage rates over 2½ year intervals. If the function is integrated again, and the same operations are carried out, it simulates person years lived ever married in 2½ year intervals. In any 2½ year age group, the person years lived ever married in that age group by persons married before the start of the interval can be obtained as the number married by the lower boundary of the interval multiplied by 2½; if this is subtracted from person years lived ever married by everyone during the age group, the result is the person years lived by those marrying during the age group, and if this is divided by the number marrying during the age group, the result is the average number of years lived married in the age group by those people, or in other words, the mean exposure to risk of widowhood. The necessary calculations were carried out for female and male marriage distributions, and the results, expressed as proportions of full intervals of 2½ years, are shown in Table 4.7. Where the marriage rate is increasing, the mean exposure to risk will be shorter than half an interval, and where the rate is decreasing it will be longer than half an interval. This is borne out by the results in Table 4.7. Using these exposure factors is theoretically more satisfactory than using a straightforward mid point, but the impact on the results is negligible.

Once the proportions not widowed at point ages of respondent had been calculated, they were weighted by suitable age distribution factors to estimate the proportions not widowed by age groups of respondents, the rate of population growth used being two per cent. The resulting proportions are of course in no way estimates of the actual Irish situation, since the mortality schedule and growth rate were chosen to be compatible with the original WIDOW model rather than to represent the Irish population up to 1911. The resulting proportions, together with the fitting means required, are shown in Table 4.8. Also shown in Table 4.8 are the life table functions estimated from these proportions, using the standard weights presented earlier, and the life table functions implied by the mortality model. It can be seen that mortality estimated from female respondents is overestimated for the two youngest central ages, but is thereafter very close to the theoretical value. The situation is not quite so satisfactory for male respondents. The mortality estimate is substantially too high up to a central age of 35, and for older ages it is consistently higher than the expected value, though being quite close to it. It has already been mentioned that the estimates for the first two central ages are likely to be seriously affected by the assumption of a fixed age at marriage for respondents, and that these results should be treated with caution. The poor results for these ages is not too serious therefore. It is interesting to note that in both cases the first central age estimates an inverse survivorship ratio, and still gives a not unreasonable mortality estimate. These results confirm that widowhood is likely to be rather more satisfactory for estimating male mortality than for estimating female mortality. This is largely because the assumption of a fixed age at marriage for respondents is more satisfactory for females than males.

This in fact, is a very severe test. Not only is the assumption of a fixed age at marriage for respondents abandoned, but the distributions used to replace it have a very wide spread; thus for females, the mean age at marriage comes nearly 13 years after the age at which marriage starts, compared with less than seven years for the simple marriage model described in section 4.5. The Irish marriage patterns are certainly much less sharp than any of the marriage distributions from developing countries shown in Table 4.1. This suggests that the widowhood method is surprisingly robust to variations in marriage patterns, and that the simplifying assumptions do not seriously distort results. If no snags arise with data collection, the analysis of widowhood data should be more satisfactory than the alternative indirect approaches.

Table 4.7: Mean Exposure to Risk, As Proportion of Full Interval, Of Those Marrying Between Two Ages.

Those Marrying Between t and t + 2½	Value of t											
	0	2½	5	7½	10	12½	15	17½	20	22½	25	27½
Female Marriages	.454	.514	.524	.531	.538	.545	.554	.564	.572	(.58)	(.59)	(.6[illegible]
Male Marriages	.418	.495	.510	.517	.524	.531	.539	.549	.564	.584	(.59)	(.6[illegible]

Figures in brackets indicate those which could not be calculated satisfactorily at the accuracy level used.

Table 4.8: Proportions Widowed Based on Irish Marriage Patterns.

Age Group of Respondents	Female Respondents: Proportion not Widowed	Female: Estimated $I_{(N+5)}$	Female: Model $I_{(N+5)}$	Male Respondents: Proportion not Widowed	Male: Estimated $I_{(N-5)}$	Male: Model $I_{(N-5)}$
15 to 19	0.979			0.985		
		0.667	0.673			
20 to 24	0.961			0.970		
		0.631	0.642		0.691	0.704
25 to 29	0.934			0.951		
		0.608	0.612		0.648	0.673
30 to 34	0.897			0.927		
		0.583	0.579		0.627	0.642
35 to 39	0.850			0.898		
		0.549	0.543		0.603	0.612
40 to 44	0.790			0.859		
		0.507	0.500		0.574	0.579
45 to 49	0.720			0.814		
		0.455	0.448		0.537	0.543
50 to 54	0.636			0.754		
		0.394	0.386		0.491	0.500
55 to 59	0.537			0.684		
		0.320	0.311		0.436	0.448
60 to 64	0.428			0.602		
					0.372	0.386
65 to 69				0.507		
Distribution (Respondent's) Mean			22.8			27.64
Population (Spouse's) Mean			25.7			21.20

In one minor respect, the above is not a very searching test. For female respondents, the female marriage mean works out at 22.8 years, and this figure is used to interpolate into Table 4.4 to obtain a correction to add to the weight obtained from Table 4.2 (b). This correction is not large, because the corrections are based on a mean of 22 years, and the scope for error in this correction is not large either. Table 4.9 shows estimated and true weights for a variety of means, to indicate the size of the error introduced by using the simple method of correction suggested. No error exceeds .045 , and though the errors do, on average, increase with age of respondent, the absolute size of the errors is still small enough to give rise to no objection to using weights up to a central age of 60. Considering the great simplification in applying the method that results from using these corrections, the size of the error introduced is not serious.

The simplifying assumption that all respondents get married at one exact age has two principal effects. The exposure to risk is affected, particularly for young respondents, and no account is taken of the relationship between male and female ages at marriage. If all female marriages are assumed to take place at the singulate mean age at marriage, 22.8 years in the adjusted Irish marriage pattern already described, all those aged 23, 24 and 25 have been exposed to the risk of widowhood since they reached 22.8. In fact, however, the female marriage distribution continues on beyond 25, so that the mean age of those marrying before 25 is less than 22.8. Thus the mean exposure to risk of widowhood in the 20 to 24 age group is longer than the model would suggest, and the proportions widowed correspondingly higher. This accounts for the high mortality estimates obtained for the 15 to 19 and 20 to 24 age groups in Table 4.8.

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Table 4.9: Error Introduced into Weights by use of Correction Factors

Estimating Equation	Respondents' Mean	Spouses' Mean	Age of Respondent					
			25		40		60	
			Est.	True	Est.	True	Est.	True
(a) Female Respondents								
$l_{(N+5)}/l_{(22\frac{1}{2})}$	15	19	0.857	0.854	0.774	0.779	0.452	0.478
		24	1.034	1.030	1.245	1.204	1.315	1.304
	20	23	-0.010	-0.007	-0.158	-0.147	-0.152	-0.145
		27	0.098	0.093	0.497	0.509	0.799	0.806
			30		45		60	
$l_{(N+5)}/l_{(27\frac{1}{2})}$	20	23	0.942	0.940	0.690	0.693	0.325	0.345
		27	1.035	1.026	1.090	1.065	0.993	0.985
	24	27	-0.235	-0.232	0.290	0.297	0.193	0.188
		30	-0.311	-0.310	0.582	0.601	0.669	0.676
(b) Male Respondents								
$l_{(N-5)}/l_{(17\frac{1}{2})}$	20	15	0.713	0.713	0.711	0.719	0.648	0.666
		20	1.019	1.018	1.216	1.184	1.421	1.369
	25	18	-0.076	-0.085	0.034	0.020	0.133	0.118
		23	0.105	0.103	0.448	0.455	0.813	0.843
			35		45		60	
$l_{(N-5)}/l_{(22\frac{1}{2})}$	25	18	0.825	0.823	0.747	0.747	0.457	0.477
		23	1.013	1.010	1.092	1.074	1.160	1.134
	29	20	-0.123	-0.123	-0.102	-0.093	-0.043	-0.071
		24	0.232	0.230	0.350	0.350	0.486	0.496

Above the age at which first marriages occur, the bias introduced by the simplifying assumption is much more difficult to assess. If it is still assumed that there is no relation between age of husband and age of wife, there is only one widowhood function involved. If this function increases approximately linearly with exposure to risk, as is likely for younger age groups, the bias introduced by taking all exposures from the mean age at first marriage will be small. The actual direction of the bias will depend critically upon the shape of the widowhood function, and on the skewness of the exposure to risk function, the inverse of the first marriage function. It seems likely that if mortality rates are rising very rapidly with age, widowhood will be overestimated by the simplifying assumption. If women aged 80 who all got married at age 20 to men in the age range 15 to 35 are considered, the husbands surviving would be aged 75 to 95. If the same women had married at a range of ages from 15 to 30, the range of the husbands' ages would be 70 to 105. If mortality were much lower at 70 than at 75, this would suggest more surviving husbands in the latter case. The positive skewness implied by the suggested female marriage range reduces the effect however, and the number of women surviving to age 80 would have to be very small indeed. A similar conclusion can be reached by introducing a further simplification, of assuming a single male age at marriage, and comparing the proportions widowed using a fixed age at female marriage, or a distribution of ages. If women marry men of 25 at 20, the proportion of women aged A who are not widowed will be $l_{(A+5)}/l_{(25)}$. If the women marry at a range of ages from 15 to 30, but mean 20, the proportion not widowed at age A will be $\int_{15}^{30} f(t)\ l_{(A+25-t)}/l_{(25)}\ dt$. The relative sizes of these proportions will depend on the mortality pattern and on the skewness of $f(t)$, the female marriage distribution.

The second effect comes about from the relation between ages of husbands and wives; young tend to marry young, old to marry old. For wives of a given age, the ones with long exposures to risk will have relatively young husbands, the ones with short exposures to risk relatively old husbands. The long exposures, associated with lower risks per unit of exposure, are concentrated in a narrow range before the mean, whereas the short, higher risk exposures are spread out over a wide range after the mean. Because of this, the simplifying assumption will tend to overestimate widowhood in the model.

Thus the simplifying assumption gives rise to a substantial downward bias in model widowhood through an exposure to risk effect for age groups in which female first marriages are taking place. In later age groups the exposure to risk effect is of uncertain direction and generally small. The joint ages at marriage effect leads to an exaggeration of model widowhood, though not on the same scale as the truncation effect reduces it early on. The Irish marriage patterns should exaggerate any existing bias, so the satisfactory results shown in Table 4.8 suggest that only the truncation effect is quantitatively important.

(iv) First Marriages as Opposed to All Marriages.

When a survey question is designed, ambiguity inherent in the question has to be reduced to a minimum, since more than enough ambiguity will be introduced by the interviewer and respondent. Thus in a question about widowhood, one particular marriage needs to be specified, and the first is the obvious choice, having the largest coverage. Survey questions on marital status only yield first marriage distributions, from analysis of proportions single, and this is another advantage of using first marriages. However, a difficulty in this is that though a respondent may report on the survival of first spouse, the respondent may not be that spouse's first spouse. Thus the age at marriage distribution required is not that of first marriages, but of all marriages to single partners, information which is rarely available. In view of the robustness of the widowhood procedure to variations in marriage patterns, it seems unlikely that this should be too important. The age at marriage distribution of those marrying single partners will be less peaked than the first marriage distribution, but will be less dispersed than the all marriage distribution, since a higher proportion of those marrying single partners are themselves single than of those marrying regardless of marital status of partner.

Some data on this are available for England and Wales, with the current year's marriages tabulated by the marital status of both bride and groom (Report of the Registrar-General; 1971). Table 4.10 shows the age distribution for marriages of single to single, single to all, and all to all, for both sexes. This confirms that the age at marriage distribution for marriages of single people to people of any marital status does lie between the age distributions for single to single and all to all marriages, and shows that it is much closer to the single to single distribution. The rates shown are of course for marriages occurring in a year, and are thus age distribution dependent, but this will not affect the overall conclusions. Given that the widowhood method has been shown to be robust to variations in age patterns of marriage, and that the age pattern at marriage for those marrying single partners is not too dissimilar to the age pattern at first marriage, the use of a first marriage function instead of a marriage to single spouse function will not give rise to substantial error. The largest error is likely to arise from an error in fitting; the difference in the distribution means of the two functions is about 0.5 of a year, for both brides and bridegrooms, and this could make a difference of about 0.1 in a weight estimated for a central age of respondent of 60 years, though much less for younger respondents.

Table 4.10. Marriage Rates by Age and Previous Condition: England and Wales 1971.

Age Group	Bachelors who married Spinsters	Bachelors who married Any	All Bridegrooms	Spinsters who married Bachelors	Spinsters who married Any	All Brides
-20	.108	.102	.090	.331	.313	.276
20-24	.619	.594	.531	.545	.532	.481
25-29	.205	.211	.209	.094	.104	.119
30-34	.043	.051	.069	.018	.024	.044
35-39	.014	.020	.037	.006	.011	.025
40-44	.006	.011	.026	.003	.007	.020
45-49	.003	.007	.021	.002	.005	.019
50-54	.002	.004	.017	.001	.004	.016
Mean Age at Marriage	23.9	24.4	25.9	21.9	22.4	24.0

CHAPTER FIVE

The Methods Applied to Empirical Data

5.1 Introduction

One of the main problems with developing a new analysis requiring the collection of data not needed for established procedures is a chicken and egg situation; it is necessary to show that the analysis represents an improvement over existing techniques by applying it to a substantial amount of data, and it is necessary to have shown that the analysis represents a worthwhile improvement before anyone will be persuaded to collect the data needed. Some methods of analysis strike the eye with their elegance and plausibility, and these may suffer no long delay before their widespread use, whereas others appear complicated, roundabout, and over dependent on dubious assumptions. The techniques described in Chapters 3 and 4 fall into the second of these categories. However, in the present instance it is fortunate that the possibility of developing these analyses had been suggested by Brass before the methodological details had been investigated. This led to the inclusion of some questions relating to orphanhood of eldest surviving children and to widowhood in a retrospective survey forming part of the Honduras National Demographic Survey. This multi-round survey started in 1971, and whilst its final results have only been partly published to date, preliminary tabulations from the retrospective survey have been made available. Unfortunately, the orphanhood question only covered maternal orphanhood, the question as to whether the respondent was the parent's eldest surviving child also only related to mothers, and the question on widowhood was only asked of female respondents about the survival of their first husband. It is thus not possible to compare the results of the orphanhood methods and the widowhood method, since the first measure female mortality, and the second male mortality. The only comparison that is possible is that between the conventional orphanhood method and the eldest surviving child orphanhood method.

The questions needed for applying the widowhood and eldest surviving child orphanhood methods have been included in a large sample survey conducted in Bangla Desh in April 1974. This survey has covered about 350,000 people, and will allow comparisons of all three indirect methods for each sex; several tabulations are being included in the tabulation programme to check the consistency of reporting. The results of the Bangla Desh survey will thus make a very considerable contribution to assessing the practical value of the techniques described here, and to other methodological considerations as well. However, the final tabulations from the survey cannot be expected till the end of 1974, too late for inclusion here. A small pilot survey was conducted in February, 1974, and tabulations have been produced from its results. Unfortunately, the population covered numbered only about 2,000, drawn from Dacca and its peri-urban area, and when this total is further broken up into age groups by sex, the numbers are far too small for a worthwhile analysis. Thus the Bangla Desh survey, though promising at some time in the future to be a goldmine of useful information for methodological investigations, has to be written off for present purposes.

5.2 The Honduras National Demographic Survey

The Honduras National Demographic Survey (EDENH) was organised in 1970 to provide the data needed for the measurement of population trends. The 'Direccion General de Estadistica y Censos' of Honduras was responsible for the survey's organisation, with the assistance of the Latin American Demographic Centre (CELADE), and support from the United Nations Fund for Population Activities. No final report on the organisation or results of the survey has yet been published. The account of the organisation of the survey given here is taken from the English summaries of monthly

EDENH Information Bulletins produced in 1971 and 1972 (CELADE; 1971 to 1972). The figures given in this chaper either come from these bulletins, or were very kindly provided prior to publication by Mr. J. Somoza of CELADE.

The EDENH study was planned as a multi-round sample survey. It was the first such survey to be used in Latin America on a non-experimental basis for estimating national population growth. On the first round, the population residing in the sample areas was recorded and then vital changes were recorded at each subsequent round, the planned interval between rounds being about four months. It was intended to have four such rounds, with the possibility of further rounds being added later. The objective of the survey was to obtain a set of current demographic rates for the country as a whole, and for the principal regions. A large, remote and little populated area in the eastern part of the country was excluded from the sampling frame, leaving an estimated population of about 2½ million, about 98 per cent of the total population, subjected to sampling. The sampling fraction was set at 1.2 per cent, and the total sample size came to about 35,000 people. The sample selection procedure is described in the first Information Bulletin (CELADE; 1971).

The area under investigation was divided into nine regions, identified for planning purposes, each of which was made up of districts. The population of each district and region was estimated by projection from census data. Some regions were subdivided to give a total of 16 strata, including the Central District around the capital, Tegucigalpa, and the municipality of San Pedro Sula, which were taken as self represented strata. Each stratum was divided into primary sampling units, most of which were districts. One primary sampling unit was selected, with a probability proportional to its size, from each stratum, and a proportion of the population in that primary sampling unit equivalent to 1.2 per cent of the urban and the rural population of the stratum was selected for interview. Within each district, the capital town was regarded as urban, and the rest as rural. The procedure for selecting final sample segments was somewhat different for urban and rural areas. In urban areas of selected primary sampling units, a complete registration was carried out, and a sketch map prepared showing the location of dwellings. Sampling segments were produced from groups of about 30 dwellings, and the required number of these groups selected at random. In rural areas, segments of approximately 60 dwellings were formed on the basis of available information, and the necessary segments selected for inclusion in the sample. Once the segments had been selected, sketch maps showing the boundary of each segment, and the location of dwellings within it, were prepared. Segments were sometimes slightly adjusted to ensure that the segment limits were easily recognisable.

The main questionnaire used included questions on years of schooling and occupation of the head of a household, relationship to head of household, sex, age, date of birth, and marital status, as well as all the usual identification questions. Space was left for changes between one round and the next, for recording in-migrants, out-migrants, changes in marital status, births, pregnancies and deaths. For the fourth and last survey round, in 1972, a special investigation referred to as RETRO-EDENH was included in addition to updating the original questionnaire. This investigation took the form of a single round retrospective survey, and included questions on sex, age, marital status, maternal orphanhood and whether eldest surviving child of mother, total number of live births per woman, total number surviving, date of birth of most recent child and whether it was still alive, and whether first husband was still alive. It is the data from this retrospective survey which are of interest in the justification of the indirect techniques developed in Chapters 3 and 4. The total population covered by RETRO-EDENH should have been equal to the population covered by the first EDENH registration plus net additions by the fourth round, but in fact the total population surveyed by RETRO-EDENH amounted to just under 30,000. This shortfall of about 15 per cent was apparently caused by a shortage of retrospective questionnaires in some segments, and gives rise to doubts about the validity of taking the retrospective information as representative of the sampled area of Honduras.

5.3 Estimating Basic Population Parameters from RETRO-EDENH Data

Certain population parameters are required for using the indirect mortality estimation methods. An estimate of childhood mortality is needed for the orphanhood of eldest surviving children, and necessary for finally constructing a life table. For the traditional orphanhood method, the mean age of mothers at births in the last year is needed for fitting purposes, and for the eldest surviving child development an estimate is needed of the mean age of mothers having first births in the last year. For the widowhood approach, the mean age at first marriage for females, and the population mean age at first marriage for males, are both needed for fitting purposes. For all the methods, it is useful to check the level of fertility, to make sure that the growth rate of the population is of the right order. The data required for the standard methods of analysis were available from RETRO-EDENH, except the proportion of males ever married by age, which was taken from the first registration round of the survey, and thus from a slightly different, and larger, population.

(i) Childhood Mortality

The standard Brass analysis of proportions dead amongst children ever borne by women of various age groups (Brass, 1964; Brass et al, 1968) was applied, and gave an estimate of $q_{(2)}$, proportion dead by age two, of 0.165. The modification of this technique proposed by Sullivan (Sullivan, 1972) gave an identical estimate. This common value was taken as being correct, and life table survivors to age two were assumed to be 835 out of a radix of 1,000 births. A simple correction for sex differences in childhood mortaility was applied by subtracting 10 points for males, giving an $l_{(2)}$ of 825, and adding 10 points for females, giving an $l_{(2)}$ of 845.

(ii) Mean Age at Childbearing

Births in the year before the survey by age group of mother were tabulated for all children, and for first births alone. The mean age of mother for all births, totalling 1,433, was 26.92, compared to the mean of the age specific fertility rates of 29.12. This is a rather larger difference than would normally be expected. The mean age of mothers of first births in the year before the survey was 19.93, based on only 254 births. Thus the difference between the first and all birth means was almost seven years, close to the value predicted by the model described in Chapter 3. The number of first births recorded is rather small, and the mean could be significantly affected by sampling error.

(iii) Mean Age at First Marriage

The proportions of women never married by age group were available from the retrospective survey, and Hajnal's singulate mean age at marriage (Hajnal, 1953) was calculated from these proportins as 20.10. This can be compared with the mean of the age specific first birth rates of 20.58. This would seem to be a rather small difference, but it must be remembered that consensual or common law unions are often not regarded as established until the birth of the first child. Thus in societies where consensual unions form a substantial portion of marriages the difference between mean age at marriage and mean age at first birth is much reduced; the main EDENH survey showed that more than half of married males were consensually married, and that in the 15 to 29 age group about 65 per cent of married males were in this sort of union. Comparable proportions for females are not available.

The population mean age at first marriage was calculated, according to the method proposed in section 4.9, as 22.71; the singulate mean age at marriage was calculated as 23.47 from the information on proportions married. The male proportions married were obtained from the original EDENH survey, covering a rather larger population than RETRO-EDENH. This procedure was necessary because the male marriage data collected by RETRO-EDENH have not been tabulated. It has been assumed that the EDENH male marriage distribution is the same as that of RETRO-EDENH, and it has therefore been used without adjustment. It is difficult to test the validity of this assumption, since the male distribution is not available from one survey, and the female distribution is not available from the other. The only information available from both is the male age distribution. The two age distributions are very similar, except for the age group 0 to 4, where EDENH has a substantially higher proportion of the population (0.217) than RETRO-EDENH (0.195). The proportions under 15 are 0.520 and 0.504, and over 45 0.116 and 0.120 for EDENH and RETRO-EDENH respectively. The difference between the two age distributions is largely accounted for by the different proportions under five. There is no alternative, however, to accepting the distribution available.

(iv) Fertility

Births in the last 12 months by age of mother, and total children borne by age group of women were both tabulated from RETRO-EDENH. This information makes possible the application of the standard Brass consistency check between cumulated current fertility rates and reported parity (Brass et al., 1968). Applying this check gave a series of P/F correction factors varying between 1.02 and 1.04 for age groups between 20 and 50 (the unreliable 15 to 19 age group gave a value of 0.83). The consistency of these factors with age suggests that fertility is more or less constant, and their closeness to 1.0 suggests that the reference period used for collecting current fertility information has been accurately report. The age specific fertility rates give an estimate of the total fertility rate of 7.2, and the application of the four per cent correction suggested by the Brass method gives a final estimate of 7.5. This indicates a very high level of fertility, and a considerably faster growth rate for any given mortality pattern than assumed in the orphanhood and widowhood models. Higher fertility will affect the birth order composition of the population, and the growth rate will affect the age distribution.

5.4 The Orphanhood Analysis

RETRO-EDENH collected information on maternal orphanhood for all children by sex of child, and for eldest surviving child by sex of child. It is therefore possible to compare estimates of female adult mortality derived from the all children orphanhood method and derived from the eldest surviving child development of that method. It is also possible to compare proportions orphaned by sex of child, as a check on the data. The methods will be applied to respondents of both sexes together, since this is likely to give the best estimate when numbers are rather small.

The results obtained by applying the all children method to the data are shown in Table 5.1; two measures of mortality are given, one a life table survivorship probability and the other beta, the second, shape determining parameter of the Brass model life table system.

Table 5.1: Estimate of Female Mortality in Honduras : all Children Orphanhood Method

Age Group of Respondent	Proportion not Orphaned	Weight	$l_{(25+N)} / l_{(25)}$	$l_{(25+N)}$	Beta	
5 to	.9815					
		.633	.9742	.7459	.665	
10 to 14	.9616					
		.734	.9528	.7296	.659	
15 to 19	.9287					
		.829	.9199	.7044	.681	
20 to 24	.8772					
		.905	.6707	.6667	.722	
25 to 29	.8085					
		.948	.8035	.6152	.777	0.77
30 to 34	.7133					
		.977	.7106	.5441	.821	
35 to 39	.5954					
		.943	.5902	.4519	.867	
40 to 44	.5036					
		.883	.4902	.3753	.850	
45 to 49	.3888					
		.706	.3573	.2736	.844	
50 to 54	.2815					
		.476	.2359	.1806	.817	
55 to 59	.1945					

$l_{(2)} = 845$ $\quad l_{(25)} = 766$ $\quad \overline{M} = 26.92$ $\quad \alpha = -.297$

The results obtained by applying the eldest surviving child method are shown in Table 5.2, in exactly the same form as for the all children results.

Table 5.2: Estimate of Female Mortality in Honduras : Eldest Surviving Child Orphanhood Method

Age Group of Respondent	Proportion not Orphaned	Weight 1/	$\frac{l_{(25+N)}}{l_{(25)}}$	$l_{(25+N)}$	Beta	
5 to 9	.9755					
		.431	.9691	.7291	.758	
10 to 14	.9642					
		.382	.9439	.7101	.750	
15 to 19	.9314					
		.316	.8962	.6742	.797	
20 to 24	.8799					
		.242	.8469	.6372	.816	
25 to 29	.8364					
		.174	.7583	.5705	.884	0.88
30 to 34	.7418					
		.144	.6236	.4692	.983	
35 to 39	.6037					
		.111	.5472	.4117	.942	
40 to 44	.5402					
		.133	.4421	.3326	.922	
45 to 49	.4271					
		.131	.3327	.2503	.882	
50 to 54	.3185					
		.166	.2365	.1779	.821	
55 to 59	.2202					

$l_{(2)} = .845$ $l_{(25)} = 752$ $\overline{M}_1 = 19.93$ $\alpha = -.219$

1/ The weights have been corrected for a low mortality situation (see Chapter 3)

It can be seen that the all children and eldest surviving child orphanhood techniques give somewhat different results. The value of beta estimated from responses of all children is 0.77, whereas that estimated from responses of eldest surviving children is 0.88. For every age group of respondents, the probability of surviving to age 25+N is higher when estimated from responses of all children than when estimated from reports of eldest surviving children. Although the difference between the two sets of estimates is consistent, it is not really very large. Both indicate a below standard level of adult mortality for the given childhood mortality, so the use of either should represent an advantage over the straightforward application of a rigid model life table. The spread of results is much the same for both methods, with a range of just over 0.2 in the estimates of beta. The age pattern of the mortality estimates is very similar for both groupings of respondents, starting low, rising to a peak at a central age of 35 or 40, and then falling somewhat. It has already been argued that some of the early part of this pattern is explained by the reporting of foster parents as real parents, and there is no strong reason to suppose that this would be more or less important for eldest surviving children than for all children. It is interesting to note that the actual proportions not orphaned are not all that different for the two groupings of respondents; orphanhood is more likely amongst eldest surviving children aged 5 to 9 and 10 to 14 than amongst all children (possibly suggesting a lower fostering effect) and again above 60. This latter is hard to explain convincingly.

It is worth considering what sort of errors would account for one set of proportions being correct, and the other incorrect. If the proportion not orphaned among all children is too low, but the proportion orphaned amongst eldest surviving children is closer to the true level, orphanhood must have been consistently under-reported by all children other than eldest surviving children or the effect of the downward biases must be substantial. Tables 5.1 and 5.2 show similar foster parent effects for both methods, so it is unlikely that orphanhood is consistently under-reported by all children except eldest surviving children. It is possible, however, that the over-reporting of high survivial families, and the higher mortality of orphans, would produce a substantial downward bias in the all children method not present in the eldest surviving children method. On the other hand, the proportion orphaned amongst eldest surviving children would be exaggerated if children who were not eldest surviving children were included in the grouping in substantial numbers. However, it will be suggested in section 5.7 that the proportion eldest surviving children made up of all children does not seem to be consistently inflated, and that there is no obvious sex bias in the reporting of eldest surviving children. In the absence of any other estimates of female adult mortality, it is not possible to determine which estimate is right and which is wrong, but the difference must give rise to reservations about the eldest surviving children method.

5.5 The Widowhood Analysis

RETRO-EDENH included a question for female respondents as to whether their first husband, either legal or consensual, was still alive. The possible answers were 'yes', 'no', 'don't know', or 'never had a husband'. The analysis of responses to this question gives an estimate of male adult mortality, and there is no other estimate from orphanhood available for the purposes of comparison. The analysis is shown in Table 5.3, and is performed as described in Cahpter 4. A correction factor was obtained from Table 4.4, using the female singulate mean age at marriage, and added to the weight selected from Table 4.2(b) using the male population mean age at marriage. Since the female mean was over 20, estimating equation 4.3 was used.

Table 5.3: **Estimate of Male Mortality in Honduras: Widowhood Method**

Age Group of Respondent	Proportion not Widowed	Weight	$l_{(N+5)}/l_{(27\frac{1}{2})}$	$l_{(N+5)}$	Beta	
15 to 19	0.992					
		3.232	1.021	0.728	0.852	
20 to 24	0.978					
		1.093	0.981	0.700	0.879	
25 to 29	0.950					
		0.914	0.948	0.676	0.875	
30 to 34	0.930					
		0.851	0.920	0.656	0.848	
35 to 39	0.860					
		0.757	0.858	0.612	0.901	0.87
40 to 44	0.850					
		0.640	0.824	0.588	0.861	
45 to 49	0.779					
		0.506	0.751	0.536	0.881	
50 to 54	0.724					
		0.395	0.703	0.502	0.834	
55 to 59	0.690					

$l_{(2)} = 825$ $l_{(27\frac{1}{2})} = 713$ $\alpha = -.153$

Singulate mean age at marriage = 20.10

Population mean age at male marriage = 22.71

The estimate for a central age of 20 should be excluded from further consideration on the grounds, explained in section 4.11, that it is seriously affected by the assumption of a fixed single age at female marriage. The average of the remaining seven results gives an estimate of beta of 0.87, the range of estimates being from 0.834 for a central age of 55 to 0.901 for a central age of 40. The estimates of beta are rather erratic, without the clear age pattern evident from the orphanhood estimates, but the range of the estimates is less than half the range of the orphanhood estimates. The final estimate is obviously not absurd, being of the same order of magnitude as the estimates already obtained for female mortality. A sex differential has already been introduced into the estimates of childhood mortality. It is impossible to make any firm assertion as to whether male adult mortiality should be relatively higher than that of females. In most western populations male adult mortality is relatively higher than female, especially over age 60, but this may not apply in central America. The male mortality level estimated is almost exactly the same as the female level estimated from orphanhood reports of eldest surviving children, but substantially higher than that estimated from orphanhood reports of all children. There are no grounds for deciding which of these is more likely.

5.6 Comparison with Other Mortality Estimates for Honduras

Population censuses have been held in Honduras at ten yearly intervals for a considerable period. The 1951 and 1961 censuses, at least, collected information on age and sex, but it is not possible to estimate surviviorship ratios from one census to the next because the coverage of the two censuses seems to have been different (Arriaga 1968). The censuses did not include questions aimed at estimating demographic rates, but Arriaga (1968) has developed life tables for each censal year up to 1961. These life tables are based on the United Nations family of model life tables (United Nations, 1955), and since the age pattern of mortality is fixed for a given level of mortality, a comparison between these and the results of the orphanhood and widowhood analyses, which are intended to estimate the age pattern of mortality, cannot be very illuminating. Such a comparison is made in Table 5.4, however, where certain columns of the Arriaga life table for 1961 are compared with the corresponding values estimated from RETRO-EDENH for 1972. It can be seen that the level of mortality in the 1972 life table is substantially higher than in the 1961 life table. The differences are most marked in childhood and early adulthood. Expectation of life from age 25 is rather higher in the Arriaga life table for males, and substantially higher for females. RETRO-EDENH sugests a rather low mortality differential in adulthood between the sexes. The expection of life at birth is between four and five years greater for the Arriaga life tables, despite the fact that they are for a period 11 years earlier, a period during which mortality could be expected to have declined. Thus the overall level of mortality, as well as its age pattern, is irreconcilably different for the two life tables.

Data on mortality by age are also available from the multi-round survey part of EDENH (CELADE, 1972). The retrospective survey was included with the fourth and last round of the registration. These rounds took place at approximately four monthly intervals, and a total of 51,000 person years had been covered by the fourth round. Sampling and other errors did not seem to have entirely levelled out, however, and all the mortality rates calculated after four rounds were substantially higher than those calculated after three rounds, by which time only 26,000 person years were included. (This also suggests that the time lapse between the third and fourth rounds was much longer than the average lapse between previous rounds. It is rather surprising that

Table 5.4: Two Life Tables for Honduras Compared

Age	Males				Females			
	1961 (Arriaga)		1972 (EDENH)		1961 (Arriaga)		1972 (EDENH)	
	$l_{(x)}$	$q_{(x)}$	$l_{(x)}$	$q_{(x)}$	$l_{(x)}$	$q_{(x)}$	$l_{(x)}$	$q_{(x)}$
0	10,000	.1255	10,000	.1401	10,000	.1078	10,000	.1230
1	8,745	.0484	8,599	.0760	8,922	.0458	8,770	.0683
5	8,322	.0209	7,946	.0190	8,513	.0204	8,171	.0171
10	8,148	.0100	7,795	.0143	8,339	.0105	8,031	.0130
15	8,067	.0148	7,683	.0240	8,252	.0146	7,927	.0218
20	7,948	.0216	7,499	.0324	8,131	.0206	7,754	.0296
25	7,776	.0244	7,256	.0333	7,964	.0235	7,525	.0305
30	7,586	.0259	7,014	.0347	7,776	.0251	7,296	.0319
35	7,390	.0299	6,771	.0389	7,581	.0273	7,063	.0360
40	7,169	.0379	6,507	.0461	7,375	.0317	6,809	.0427
45	6,897	.0513	6,207	.0578	7,141	.0404	6,518	.0539
50	6,543	.0712	5,849	.0764	6,852	.0545	6,166	.0718
55	6,078	.1003	5,402	.1019	6,479	.0770	5,724	.0966
60	5,468	.1437	4,852	.1458	5,980	.1143	5,171	.1396
65	4,682	.2074	4,144	.2027	5,296	.1738	4,449	.1963
70	3,711	.2960	3,304	.3011	4,376	.2616	3,576	.2955
75	2,613	.4106	2,309	.4203	3,231	.3767	2,519	.4174
80	1,540	.5486	1,339	.5505	2,014	.5107	1,468	.5510
85	695	1.0000	602	1.0000	985	1.0000	659	1.0000
	$e_{(25)} = 41.5$		$e_{(25)} = 40.1$		$e_{(25)} = 43.6$		$e_{(25)} = 40.8$	
			$\alpha = -.153$				$\alpha = -.219$	
			$\beta = 0.87$				$\beta = 0.88$	

more deaths per unit of exposure were reported for the longer interval, implying negative recall lapse). The birth rate estimated after three rounds was 48.9, and this rose to 49.3 after four rounds; the estimated death rate, on the other hand, rose from 12.8 to 14.2, and the infant mortality rate from 110 to 118. The annual death rates calculated after four rounds are compared in Table 5.5 with those of a United Nations model life table (United Nations, 1955) having an expectation of life at birth of 55 years, and those of a Brass model life table calculated on the basis of parameters calculated in sections 5.3, 5.4, and 5.5. Also included in Table 5.5 are the age specific death rates from a life table calculated on the basis of the EDENH survey data (Ortega, 1973). The article available is in Spanish, and it is not quite clear from this how the life table was devleoped. It is clear, however, that it follows the registered death rates very closely, though the full life table presents far more detail than would be available just from the registered death rates. Two points stand out from Table 5.5; first, the Brass model life table fitted by the analysis of retrospective and indirect questions fits recorded deaths up to age 15 much better than the United Nations model selected; and second, both models indicate higher than reported death rates after age 55. The infant mortality rate calculated from EDENH, of 117, is also rather lower than that of the Brass model, of 132. These comparisons suggest that deaths among infants and old people have been omitted by the EDENH survey. This conculsion is in line with normal experience of such registration systems. As a result, the mortality rates calculated from the death registration cannot be used as a check on the indirect methods of estimation developed.

Table 5.5: Death Rates Registered by EDENH Compared with Model Life Table Values

Age Group	Annual Death Rates (both sexes)			
	EDENH Registration	U.N. Model Life Table[1/]	Brass Model Life Table[2/]	EDENH Life Table[3/]
1 to 4	20.7	11.9	18.6	19.2
5 to 9	4.2	2.9	3.6	4.8
10 to 14	3.0	2.1	2.7	3.0
15 to 29	3.3	4.3	5.7	3.4
30 to 44	5.1	5.9	7.8	5.4
45 to 54	11.6	10.7	13.1	10.3
55 to 64	20.5	21.6	25.4	20.2
65 to 74	34.5	49.9	55.3	37.6
75 +	88.2	136.4	142.4	101.3

[1/] Expectation of life at birth = 55 years

[2/] The male and female life tables of Table 5.4 combined.

[3/] Expectation of life at birth = 54.6 years; at age 25, 45.1 years (Ortega, 1973).

Available sources of information about the level and pattern of mortality in Honduras are thus unable to justify the indirect methods based on orphanhood and widowhood. It is also the case, of course, that they are unable to show that these indirect methods are not satisfactory. The fact that no method exists, apart from the orginal orphanhood method, to measure age patterns of mortality in developing countries was used as the justification of developing new indirect techniques. Thus it should not be too disappointing that the results cannot be directly tested, since if they could be the methods themselves would be unnecessary, whether or not they proved to be satisfactory. It is encouraging however that all the estimates are broadly similar, and that the results of the two new methods are extremely close to one another, though being for different sexes they are not strictly comparable.

5.7 Data Shortcomings of Orphanhood amongst Eldest Surviving Children

The most obvious faults in data on orphanhood amongst eldest surviving children are age mis-reporting by the respondents, mis-reporting of orphanhood status, and errors in being classed as an eldest surviving child. The question of age mis-reporting, and its effect upon mortality estimates derived from orphanhood, is discussed in Chapter 7, and will not be discussed here.

It is well known that mortality estimates based on orphanhood data are far too low for respondents up to age 15 or even age 20. It is generally supposed that this underestimation results from the adoption by relatives or close friends of children orphaned young. They then either regard the child as their own, or fail to make it clear to a survey interviewer that the child is not their blood child, but is in fact orphaned. This mis-reporting seems to be present for eldest surviving children as much as for all children. The betas estimated in Table 5.2 from reports of eldest surviving children rise over much the same age span and overall range as those estimated in Table 5.1 from reports of all children. It might have been expected that reports of eldest children, being heirs, would be less affected by this bias, but the evidence suggests that a standard proportion of orphans, regardless of family order, are reported in this way; it is not clear whether they subsequently change to reporting themselves correctly, or whether they continue to report about their adoptive parents.

Errors in classifying respondents as eldest surviving children are unique to this method. If some eldest surviving children were not reported as such, but no non-eldest surviving children were included in their places, the estimate of mortality would not be affected, as long as the misclassification was not related to orphanhood status or birth order, although the proportion eldest surviving children formed of all children would be too low. If some eldest surviving children were not reported as such, and a similar number of other children were incorrectly reported as such, mortality would be overestimated, although the apparent overall proportion of eldest surviving children would be about right. If most eldest surviving children were reported as such, and some other children were also reported as eldest surviving children, mortality would be overestimated, and the overall proportion of eldest surviving children would be too large. It is possible to calculate the proportion of eldest surviving children in any age group for different mortality levels by the method described in section 3.10 for correcting for deaths amongst firstborn children; the estimated proportions obviously depend on the same assumptions. The calculated proportions are shown in Table 5.6, together with the proportions reported in Honduras, and the interpolated predicted value for the Honduras mortality level.

The theoretical values behave much as expected, except that as age and mortality increase, there is no clear tendency for the proportions to approach 1.0 assymptotically. It seems likely, for instance, that the proportion of eldest surviving children aged 55 to 59 would exceed 1.0 where beta is 1.3 and $l_{(2)}$ is 650. A proportion of 1.0 cannot be achieved in reality until just before the age at which all members of the life table have died. This is a criticism of the method of allowing for deaths amongst earlier children; it is clearly unsatisfactory in extreme mortality conditions. The reported proportions from EDENH are rather variable, and are initially substantially lower than

Table 5.6 Expected and Reported Proportions of Eldest Surviving Children

Mortality level β	$l_{(2)}$	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54
		Proportions Eldest Surviving for age groups									
	650	.320	.336	.354	.371	.386	.408	.435	.470	.521	.594
0.8	800	.261	.268	.277	.286	.296	.307	.321	.341	.370	.413
	900	.238	.242	.246	.250	.255	.260	.267	.277	.291	.313
	650	.334	.355	.379	.403	.429	.459	.499	.553	.628	.736
1.0	800	.268	.278	.291	.304	.318	.335	.358	.390	.437	.508
	900	.242	.247	.253	.259	.266	.274	.285	.301	.325	.364
	650	.356	.388	.425	.464	.504	.553	.616	.701	.818	.932
1.3	800	.281	.297	.316	.338	.362	.392	.432	.490	.577	.708
	900	.247	.256	.265	.276	.287	.302	.323	.353	.400	.478
Honduras, Reported		.208	.227	.239	.264	.262	.308	.300	.358	.391	.402
Honduras, Expected [β = 0.88, $l_{(2)}$ = 835]		.255	.262	.271	.279	.289	.300	.314	.335	.364	.392
Honduras, male respondents		.209	.233	.237	.253	.283	.310	.310	.352	.403	.422
Honduras, female respondents		.206	.221	.241	.272	.242	.306	.290	.364	.380	.385

the expected values, though exceeding them after age 40. Fertility in Honduras is somewhat higher than that assumed by the model (a total fertility rate of 7.5 as opposed to 6.0) and this would tend to reduce the proportion of eldest surviving children somewhat. Thus it seems likely that the reported proportions may be about right, except for minor irregularities, for respondents aged between 20 and 40. Outside this range, the reporting of eldest surviving children seems to be incorrrect, with too few young eldest surviving children, and too many old ones; good reasons can be thought up to explain such errors. As pointed out, this does not mean that a mortality estimate would necessarily be biassed at other ages, or not biassed within this age range, but it definitely shows the need for caution in analysing orphanhood reports. It seems quite likely that the higher mortality estimate derived from reports of eldest surviving children could result from the inclusion of other children amongst eldest surviving children, and the exclusion of an approximately equal number of eldest surviving children.

Another error that had been anticipated was a sex bias in reporting oneself as eldest surviving. There is no evidence of this from the Honduras survey. The sex ratio of eldest surviving children varies somewhat with age, but there is no consistent trend or tendency towards one sex being excessively represented. Similarly, there is no marked tendency for the proportion orphaned to vary with sex of child. Table 5.7 shows the proportions orphaned by age and sex, and although there is considerable variation, there is no obvious pattern by sex.

Table 5.7: Orphanhood of Eldest Surviving Children by Sex : Honduras 1972

Sex of Respondents	Age Group of Respondents									
	5 - 9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
Male	0.036	0.039	0.066	0.106	0.112	0.241	0.398	0.428	0.606	0.678
Female	0.014	0.032	0.071	0.132	0.178	0.273	0.394	0.488	0.540	0.681

It has been reported by those responsible for the Honduras field work that great difficulty was experienced with the eldest child question. This is not altogether surprising; it is a difficult concept, requiring an allowance to be made for deaths of older brothers and sisters, and respondents of middle age and over could be reasonably excused for not knowing the answer (hence perhaps the excess of reported over expected proportions eldest surviving after 40). In fact, only 116 out of 29,991 respondents were classified as 'don't know's', a very low figure suggesting a good deal of pressure from enumerators to get some sort of answer. It is possible that limiting responses to firstborn children only would be more satisfactory; the question would be less ambiguous, a respondent's status could not change over time, no recent knowledge of family affairs is needed, and although the number of responses would be much smaller, necessitating rather larger samples, the unsatisfactory correction for mortality would be unnecessary.

5.8 Data Shortcomings of Widowhood

There are not the opportunities for checking the consistency of the widowhood reports that there are for checking orphanhood reports of eldest surviving children. It would have been interesting to compare reports by type of marriage, since those widowed of a consensual union, having no legal force, might consider themselves as returning to a single state, though obviously this would not be easy to investigate in a retrospective survey. There is a tendency in some countries where consensual unions are commen for proportions single to increase after about age 40; this could be the result of increasing proportions marrying, or of some such error as that suggested here. It would also have been interesting to have conducted the analysis by present marital status; the question referred to widowhood from first husband, and if the information were tabulated by current marital status, and by whether married once or more than once, it would be possible to get some check as to whether it was first husbands that were being reported. It is obviously vital that this limitation to first husbands should be adhered to. If a widowed woman remarries and fails to report herself as widowed from first husband, mortality will be seriously underestimated. If a divorced woman remarries and is then widowed of her second hushand, and reports herself as widowed of first husband, mortality may be overestimated, and assumptions about exposure to risk and the age distribution of males at marriage will be invalidated. Unfortunately, it was not possible to produce these tabulations, and even if they had been produced, it is doubtful whether the sample size would have been sufficient to allow firm conclusions to be drawn. Firm conclusions as to the success of the question will have to wait for the results of further, larger surveys with tabulation programmes designed for this sort of evaluation.

As it is, comment has to be restricted to the consistency and plausibility of the proportions not widowed. These proportions, shown in Table 5.3, do not fall with perfect regularity with age, although the mortality estimates derived from them fall within a satisfactorily narrow range. It is possible that the variations from age group to age group can be accounted for by sampling error; the number of widowed women exceeds 100 for only three age groups, and up to age 35 the number is an age group does not exceed 52. The widowhood method analyses reports of older respondents than orphanhood, and is only concerned with the ever-married portion of respondents; the numbers are therefore smaller, especially in a rapidly growing population or a late marrying population, and the possible sampling errors of proportins not widowed are correspondingly greater, for a given sample size. No estimates of the sampling errors attached to the widowhood proportions reported by the Honduras survey are available, but it seems reasonable to suppose that they could explain much of the variation with age.

CHAPTER SIX

Conclusions

6.1 Introduction

The development, criticism and application of the two indirect methods of analysis in the previous chapters have been described in such detail that it is difficult to indentify the most important points. This chapter will therefore summarize the advantages and disadvantages of each method, from theoretical and practical standpoints. Drawing all the threads together in this way will make it easier to assess the suitability of these methods for use in developing countries.

6.2 Orphanhood of Eledest Surviving Children

The method based on an analysis of reports of eldest surviving children has two principal theoretical advantages over the original orphanhood method. The first is that each parent is reported only once, so any bias introduced by a relation between number of children and survival of parent is eliminated. The second is that, at least for respondents up to early middle age, most eldest surviving children are firstborn children; the age distribution of parents at the birth of their first child is both narrower and earlier than that for all children. This reduces the errors that arise from deviations from the assumptions, such as for example the shape of the model age specific fertility distribution. The method gives no advantage, however, in the case of parents with no surviving children, or non-parents, both of whom will be unrepresented in any mortality estimate. A further advantage of the earlier and narrower fertility distribution is that the age difference between parent and respondent is smaller, and the events reported will thus have ocurred both more recently and over a shorter time interval. The principal theoretical disadvantage of the method arises from the limitation to eldest surviving children. The birth order composition of eldest surviving children turns out to vary sharply with the level and age pattern of mortality, as well as to some extent with fertility, and the orphanhood experience of eldest surviving children is dependent on the birth order composition of the class. This in practice makes it necessary to use a different set of weights for different levels of childhood mortality, and for different age patterns of mortality, an unsatisfactory situation since it is this latter which the method aims to estimate. The inclusion of later births amongst eldest surviving children also reduces the advantage of the narrow and early first birth distribution.

From the practical point of view, the most important point is probably that the survey question 'Are you your mother's eldest surviving child?' caused great difficulty in Honduras in the field. The data underline this; the proportions of respondents reporting themselves to be eldest surviving children have an age pattern quite unlike that suggested by the model, starting lower and ending up higher as age increases. The fact that proportions orphaned were very similar for both eldest surviving and all children suggests that the classification as an eldest surviving child was more or less arbitrary. It is not of course impossible that a respondent should not know whether he is an eldest surviving child or not. This is so particularly in the case of remarriages, where a child of the first marriage may be looked after by relatives, thus giving the eldest surviving child of the second marriage no grounds for supposing that he is not an eldest surviving child. The same effect will arise when the children leave home, or when a family breaks up, as it might if one or other of the parents died. The method seems to show no lessening of the adoption effect amongst young respondents, with the result that proportions orphaned up to the age of 15 or 20 are of little value. This restricts the usable age range considerably, since over the age of 40 the correction for mortality becomes increasingly suspect.

A minor disadvantage of the eldest surviving child technique is that in application it is rather untidy. The selection of a set of weights is made with three criteria, the first birth mean, the level of childhood mortality, and the overall level of mortality; this makes the selection procedure somewhat tedious. It might be thought that restricting the number of reports, as the eldest surviving child technique does, would necessitate increased sample size for a given precision. This is not so, however, since almost all demographic sample are selected using the household as the basic unit of investigation; the number of events (or non-events) reported will be only a little smaller in the eldest surviving child case than in the all children case. On the other hand, one source of sample variance, arising from multiple reporting of the same event, will be eliminated. Sample size does not need to be increased much for this method and will usually still be smaller than the sample needed for collecting fertility information.

One of the principal reservations about the use of the all children orphanhood technique arises from the multiple reporting, by a number of children, of the same event, the survival or otherwise of the parent. The reduction of any bias arising from this is one of the advantages put forward in favour of the eldest surviving children development. An alternative approach has recently been suggest (U.N.;

forthcoming) whereby the orphanhood question is paired with a question about the number of the respondent's siblings. This information is then used to weight the orphanhood information to simulate the effect of one report per parent. As with the eldest surviving children development, an extra survey question is required, but it is a more difficult question since it requires a numerical response. Answering it also requires a complete knowledge of the current state of the family. This development does not share with the eldest surviving children development the added advantage of a narrower fertility distribution. For young respondents a bias is introduced because age and birth order together are related to age of mother; a child of one with ten siblings will have an older than average mother, a child of one with no siblings a younger than average mother. It is unlikely that this bias will be important for respondents aged 20 or more, so in practice its impact will be small. On the whole however the development seems to have more disadvantages, and fewer advantages, than the eldest surviving children development.

6.3 Widowhood from First Spouse

The theoretical advantages of this method are rather similar to those given in the previous section. The question relates only to first spouse, so there is by and large only one report per event; more than two such reports would be rare. The age distribution of first marriages is very narrow and early, narrower and earlier than the first birth distribution. The first marriage distribution is only of interest for respondents; for their spouses, the distribution required is that of those marrying single members of the respondent's sex; this distribution also seems, on the somewhat scanty evidence examined, to be fairly narrow and fairly early. Thus the effects of deviations from the assumptions are kept low, and the mortality experience being measured is fairly recent. Trials with different levels and patterns of mortality, and extreme marriage patterns, showed the widowhood method to be robust to deviations from the model assumptions. The method does have disadvantages, of course. The aim is to measure the mortality of the whole population, but the whole population is not in fact covered. The mortality of those who remain single, generally above the population average, is not represented, nor is the mortality of those who never marry a previously single spouse; orphanhood suffers from rather similar restrictions. The effect of these errors will be minimal, in a society where marriage is virtually universal, and most marriages take place between single partners, a situation closer to that of the developing world than the developed. Perhaps the most serious disadvantage is the apparent link between widowhood and reduced life expectancy of the surviving spouse, but the evidence for this link is based on studies in developed countries. There is certainly no evidence of a substantial underestimate of mortality, relative to orphanhood estimates, from the Honduras data.

No reports have been received from Honduras that the widowhood question posed problems in the field. Indeed, it is a simple enough question with only four possible answers (yes, no, don't know, and never married), presenting no coding or tabulation problems. The information needed for fitting purposes, male and female proportions ever-married by age, is collected as a matter of routine by demographic surveys, so there are no extra data collection needs other than the question itself. The proportions widowed reported in Honduras do rise with age, but not exactly smoothly; the mortality estimates jump around somewhat, but show no clear upward or downward trend with age. These irregularities can easily be explained in terms of sampling error and age misreporting. One of the greatest virtues of the widowhood method is that it has no equivalent of the adoption effect in orphanhood. The first, and in late marriage situations also the second, estimate is unreliable because of variations in exposure to risk, but thereafter all age groups seem to give satisfactory estimates. This has the advantage of obtaining a mortality estimate for a mean exposure to risk of as little as five or six years, whereas no reliable estimate can be obtained from orphanhood from an exposure of less than 20 years; this is particularly important when mortality is changing.

Widowhood probably does require somewhat larger samples than orphanhood, partly because not everyone marries, and partly because the analysis is only applied to respondents aged 25 and over, who may not be very numerous in a rapidly growing population. There is some danger that respondents may not know the fate of a spouse from whom they were separated originally other than by widowhood, though this is not a serious problem if they report themselves as 'don't knows' ; there is also some danger that a respondent who has remarried may report for the second husband rather than for the first. The Bangla Desh survey will make it possible to test for such effects, but it seems unlikely that they will be substantial, especially for fairly young respondents, under 40 say. The concept of marriage, and all its possible interpretations, is a possible source of trouble, but is unlikely to prove serious as long as marriage is defined as widely as possible, and reasonably consistently throughout.

6.4 Conclusions on Orphanhood and Widowhood

The attempt to develop satisfactory analyses of information on orphanhood of eldest surviving children and widowhood from first spouse was undertaken in the hope that a satisfactory indirect method of estimating adult mortality, particularly male mortality, in statistically underdeveloped countries would result. The development of the orphanhood method has proved disappointing, both theoretically and practically. The widowhood method, however, shows distinct promise for estimating male mortality, and seems likely to be almost as satisfactory at estimating female mortality; it is almost as satisfactory on data collection grounds as the original orphanhood method, can produce reasonable estimates for each sex, thus improving comparability, and is more robust to deviations from its assumptions than the original orphanhood method. It is also less affected than the all children orphanhood technique by the bias introduced by multiple reporting of the same event. The impact of a relationship between the mortality of the reporter and the mortality of the person reported for may be equally serious however.

It is obviously too early to assert that the widowhood method is an important advance. Many more applications are needed, in a wide range of cultures, before any such claim could be made. It appears, however, that the method has distinct promise, and is worth including, at first on an experimental basis, when planning a demographic survey, especially since its cost is low, both in data collection and tabulation terms.

It is perhaps too early to condemn the orphanhood of eldest surviving children technique out of hand, but it seems likely to cause data collection problems in obtaining results which are at best unconfirmed. The problems raised whilst developing the method are quite interesting in their own right, but the method itself can only be recommended for inclusion in a survery whose main aim is to be experimental.

CHAPTER SEVEN

The Effects of Changing Mortality and Age Misreporting

7.1 Introduction

The methods of analysis which have been described above are based on particular models of fertility, mortality and nuptiality. An actual population will deviate from these models in certain ways. It is straightforward to find out the effects of deviations from some aspects of these models. Thus the importance of assuming a particular fertility function can be examined simply by repeating all steps using a rather different function. Tests of this kind have been widely applied, and their results have been described in Chapters 3 and 4. However, there are some deviations whose effects are extremely difficult to assess, in their magnitude and even in their direction. The possibility that substantial biases may be introduced has been mentioned in the text, without any attempt at quantification. In an attempt to rectify this unsatisfactory situation, a particular case has been examined to throw some light on the importance of two effects commonly encountered in developing countries; this Chapter describes the calculations and the findings.

Of the two deviations to be examined, one is a real feature of the population, whereas the other is a case of misreporting. Declining mortality is a feature of almost all developing countries, the period of the decline varying from as long as forty or fity years to as short as twenty years. It is clear that the use of retrospective questions in such circumstances raises special problems. Age misreporting is a universal feature of survey data collected in developing countries, ranging from massive distortions common in Africa to minor age heaping in South East Asia and parts of Latin America. In the sections that follow, a particular example will be worked through to indicate how these two deviations from model assumptions are likely to affect mortality estimates derived from these indirect techniques.

7.2 The Effect of Declining Mortality.

The all children orphanhood method has been used to test the effect of declining mortality. This method was chosen because *declining* mortality would have a much smaller impact on widowhood, and the techniques developed would be unable to allow for decling mortality in the adjustment process for eldest surviving children.

To see the sort of effect declining mortality would have, the proportion of respondents with a surviving mother in a population experiencing declining mortality were estimated. The standard weights for converting such proportions into life table surviviorship probabilities were then applied. The survivorship probabilities were then compared with various period and cohort survivorship probabilities for the actual population to see what effect the declining mortality has.

The population experiencing declining mortality was based on a stable population having an expectation of life at birth of 40 years. For the 20 years preceeding the point in time being considered, mortality was assumed to decline linearly to give an expectation of life at birth of 50 years. The Brass model life table system was used throughout, and to reduce the preparatory work involved, the tabulations of the African Standard life table published by Carrier and Hobcraft were used (Carrier and Hobcraft; 1971). The initial stable population selected had a gross reproduction rate of 2.8, approximately in agreement with the assumed total fertility rate of 6.0, a growth rate of 1.9 per cent, and an average age pattern of mortality (the second life table parameter, beta, was put equal to 1.0). The mortality decline was simulated by dividing the 20 year period of decline into ten periods of 2½ years, so that during each period mortality was constant, dropping at the end of each period to a new life table having an expectation of life 1¼ years longer.

For each life table, survivorship probabilities from age a to age a + 2½ for all values of a were obtained from the Carrier-Hobcraft tables, interpolating linearly where necessary on the logit scale. These survivorship probabilities were then used to construct a composite survivorship function for ages at the time of investigation. Thus a person age 25 will have experienced the original mortality conditions to age five, then between 5 and 7½ he will have experienced a rather lighter mortality regime with an expectation of life at birth of 41¼ years, and between 7½ and 10 a somewhat lighter regime again, and so on until the period between 22½ and 25, when his mortality risks will have been associated with a life table having an expectation of life at birth of 50 years. The final probability of surviving to 25 is thus the product of a number of 2½ year survivorship probabilities drawn from a number of different life tables. The smallness of the steps used makes this a reasonable approximation, for practical purposes, to an actual mortality decline.

The proportion of respondents not orphaned is given by equation 2.1, but this can no longer be simplified into the form given in equation 2.2 since the stable age distribution can no longer be used. The age distribution of the population at various points in time was obtained by starting off with the stable age distribution already mentioned, and then projecting it forward at the decreasing mortality rates (but with constant fertility) to give the age distribution every 2½ years. The probability of surviving to age t+a is available from the composite life table described, and the probability of the mother surviving to age t can also be calculated from the sets of survivorship probabilities, though it has to be born in mind that the mortality experienced in surviving to age t is also a function of a, the age of the respondent. Where the respondent is 20 or over, the survival to age t will have been under the initial mortality conditions but for a respondent under 20 some part of the period t will have been during the period of falling mortality. Carrier and Hobcraft's age splitting coefficients were used to estimate numbers at exact ages from the stable population and its projection. The integrals forming the numerator and the denominator of equation 2.1 were then evaluated by the approximate method described in Chapter 3. The proportions not orphaned at point ages are thus obtained, and these can be weighted by age distribution factors into proportions not orphaned by age groups.

The proportions not orphaned by age group for this particular instance are shown in Table 7.1. The table also shows the weights to be applied for this value of the mean age of childbearing in the stable population, the life table survivorship probability thus estimated, and various other period and cohort probabilities obtained for the same population. It can be seen that orphanhood gives a poor estimate of period rates. Although the estimates agree at some central age or other (the period rate of five years earlier for age 35, the period rate of ten years earlier for age 50) the period rates show a slower rate of increase of mortality with age than the orphanhood estimates. The situation is rather different for cohorts. The mortality experienced right up to the last five years by the cohort is well estimated by orphanhood, but for periods longer ago in the past the estimates get progressively poorer, with orphanhood underestimating the cohort's mortality.

Table 7.1: Orphanhood Estimates in a Situation of Falling Mortality

Values of $l_{(N)} / l_{(25)}$

Central Age	Orphanhood Estimate	Period Rates			Cohort Rates			
		Now	5 years ago	10 years ago	Now Aged 35	45	55	65
35	.926	.932	.924	.916	.926	.910	.900	.900
40	.879	.894	.883	.871	-	.868	.850	.847
45	.824	.851	.835	.820	-	.825	.799	.788
50	.757	.798	.778	.759	-	-	.743	.724
55	.678	.731	.707	.684	-	-	.680	.652
60	.585	.648	.621	.595	-	-	-	.571
65	.472	.541	.512	.485	-	-	-	.475

The standard procedure for estimating the overall level of adult mortality was also applied to these synthetic orphanhood proportions. There is some difficulty in this as it is not clear what estimate of childhood mortality should be combined with the orphanhood information. Two values were used, the correct current value, and the average of the values in effect between 2½ years and 7½ years earlier. The estimate of beta, the shape determining parameter of the Brass life table system, was rather higher than the true value of 1.0, suggesting that falling mortality would lead to adult mortality being overestimated relative to child mortality. The pattern of overestimation, gently rising with age to around 40, and then falling somewhat, is consistent with patterns found in several practical applicatons. The error is smaller if the current level of childhood mortality is used rather than that of about five years earier.

Falling mortality does have an impact on the use of orphanhood information in estimating adult mortality. The estimation of period rates is particularly suspect, for although some earlier period rate will be adequately estimated, at least on average over the adult period, the duration and extent of the mortality decline would have to be known if the period were to be established. The orphanhood method gives a rather better estimate of cohort mortality rates, the estimate of the mortality of the cohort from the base age, here 25, to the present being virtually unaffected by the changing mortality.

4.3 The Effect of Age Misreporting

Nothing so elaborate was attempted for age misreporting as for changes in mortality. A simple model of age misreporting was developed as follows. The Indian female population of 1911 was plotted against a best fit stable population age distribution as described in the United Nations manual on analysing incomplete data (U.N.; 1967). The proportional deviations for each age group were read off the graph. A Coale-Demeny model stable population from the West family with an expectation of life at birth of 37 years and growth rate of one per cent per annum was used as a reference age distribution (Coale and Demeny; 1966). The deviations reported for India were applied to this age distribution to estimate the number of people reported in each age group. The numbers transferred from one age group to the next to obtain the reported age distribution from the stable one were calculated, on the assumption that all transfers were from an age group to an adjacent age group, but no further. The numbers transferred were then expressed as proportions of the reported size of the age group they were transferred to. It was assumed that those transferred had an orphanhood experience typical of the age group they were transferred from. Proportions surviving for the reported age group were then arrived at by multiplying the proportion not orphaned from the true age group by the proportion of the reported age group they represented, and dividing by the sum of the proportions. The proportions not orphaned in the reported age groups are shown in Table 7.2. Adjustment weights for the true value of the mean age at first childbearing in the stable population were applied to estimate the survivorship probabilities shown in the table. The true survivorship probabilities are also shown in the Table.

Table 7.2: The Effect of Age Misreporting

Age Group	Model Proportion not Orphaned	Adjustment for Age Misreporting	Reported Proportion not Orphaned	Estimated l(B+N)/l(B)	True l(B+N)/l(B
0 to 4	0.982	$.980f_1$	0.982		
5 to 9	0.938	$.023f_1 + f_2 + .087f_3$	0.936		
10 to 14	0.898	$.900f_3$	0.898		
15 to 19	0.855	$.006f_3 + .814f_4$	0.848		
20 to 24	0.815	$.204f_4 + .856f_5$	0.804	0.816	0.806
25 to 29	0.865	$.159f_5 + f_6 + .011f_7$	0.740	0.753	0.742
30 to 34	0.680	$.988f_7 + .263f_8$	0.639	0.654	0.665
35 to 39	0.588	$.705f_8 + .225f_9$	0.537	0.550	0.574

As can be seen, the individual survivorship probabilities are quite sereiously affected by the age misreporting, though the average level is not seriously biased. Patterns of age misreporting similar to the one used here may cause some variability in estimates of adult mortality, but seem unlikely to affect the overall level.

Appendix 3.1

A Computer Programme for Calculating Adjustment Weights for Use with Orphanhood Reports of Firstborn Children

Programme FBW1 calculates weights for the analysis of maternal orphanhood amongst firstborn children, and is reproduced overleaf. With minor changes it calculates weights for paternal orphanhood amongst firstborn children, and maternal and paternal orphanhood amongst all children. The calculations are described in detail in section 3.8, so only an outline will be given here. Briefly, the programme carries out the following steps. Fertility, mortality and growth rate parameters are read in (lines 3 to 8), and the relevant model life table is constructed (lines 10 to 18). A repeating loop calculates elements of the numerator of equation 3.1 over the range of the fertility distribution, and sums them to estimate the value of the integral. The mean age of childbearing is also calculated for each location of the fertility distribution (lines 29 to 34). It will be remembered that the numerator of equation 3.1 for a particular age location of fertility and period of survival will be the same as the denominator of equation 3.1 for some other older age location of fertility. Values of $l_{(25+N)}/l_{(25)}$ are calculated for different values of N (lines 37 to 42). For starting ages of 10 to 26 for the fertility distribution, values of $P_1(a)$ in equation 3.1 are calcualted. Age distribution factors for turning point values into averages for age groups are developed, and are used to turn proportions orphaned at point ages into proportions orphaned in five year age groups. These proportions are then used together with the values of $l_{(25+N)}/l_{(25)}$ to calculate weights according to equation 3.2 (lines 43 to 68). These weights are for round values of the starting age of fertility, which would only accidentally coincide with round values of the mean age of childbearing. The weights are linearly interpolated for round values of the mean age of childbearing. They are then printed out, and written to permanent disc file for use later with FBW2 (lines 69 to 90). The programme then returns to read new mortality and growth parameters, and goes through the same steps again. It continues to do this until it runs out of data, whereupon it stops itself.

Few changes are needed for the programme to work for maternal orphanhood amongst all children. A different file needs to be specified in line 1, and the fertility distribution runs over 33 years instead of 20 years in line 5. The repeating loop from line 22 to line 31 has to be executed for this new number of years. The lower limit on the first birth mean in lines 73 and 76 has to be raised to be suitable as a lower limit for the all birth mean, and the file name and range in line 90 has to be altered.

More changes are needed for paternal orphanhood. Adjustments have to be made for different fertility distributions, and their later age location. Different estimating equations are used, and the age distribution weights have to be adjusted for the fact that exposure to risk is $\frac{3}{4}$ of a year longer than age. The programme works in exactly the same way as before, given the differences in ranges and dimensions arising from using different fertility functions for males.

List of Main Variables

YS(I)	:	the standard logit values of the Brass model life table system.
FERT(I)	:	the model fertility distribution
BETA	:	the second parameter of the Brass model life table system

XL2	:	the life table survivors to age 2.
RATE	:	the rate of population growth.
XL(I)	:	the life table survivors to age I.
PROD(J)	:	elements of the numerator of equation 3.1.
SUMI(I)	:	the sum of the elements, approximating the value of the integral.
XMEAN(I)	:	the mean age at first birth in the stable population.
CONST(I)	:	$l_{(25+N)}/l_{(25)}$
PI(J)	:	the proportion not orphaned at exact age J when childbearing starts at age I.
W(J)	:	age distribution factors
PROD(J)	:	the proportion orphaned in an age group.
WEIGHT(JJ,I) :	:	the set of firstbirth weights for a given mortality model.
MEAN	:	integer values of the firstbirth mean
TERP(JJ)	:	firstbirth weights for integer values of MEAN.
RETERP(J,MEAN)	:	firstbirth weights for integer values of MEAN.

```
      PROGRAM F(W1)(INPUT,OUTPUT,DATA1,TAPES=INPUT,TAPE6=OUTPUT,TAPE8=DAT
     1A1)
      DIMENSION YS(100),FERT(13),XL(100),PROD(65),SUM1(100),W(100),WEIGH
     1T(65,30),CONST(65),PI(100),XMEAN(30),TERP(65),RETERP(13,38)
      READ(5,100)(YS(I),I=1,96)
  100 FORMAT(10F8.4)
      READ(5,100)(FERT(I),I=1,20)
   19 READ(5,100) BETA,XL2
      IF(EOF(5).NE.0)STOP
      READ(5,100) RATE
      IF(EOF(5).NE.0)STOP
      A = (1.0-XL2)/XL2
      ALPHA = ALOG(A)/2.0-BETA*YS(2)
      WRITE(6,203) ALPHA,BETA,XL2,(FERT(J),J=1,20)
  203 FORMAT(1H1,9X,8HALPHA = ,F8.4,4X,7HBETA = ,F8.4,4X,7H1(2) = ,F8.4,
     1/10X,18HFERTILITY RATES = ,10F8.4,/28X,10F8.4,/28X,10F8.4,/28X,3F8
     1.4)
      WRITE(6,201) RATE
  201 FORMAT(/10X,14HGROWTH RATE = ,F11.6)
      DO 1 I = 1,96
      Y = ALPHA + BETA*YS(I)
    1 XL(I) = 1.0/(1.0+EXP(2.0*Y))
      DO 2 I = 10,95
      SUM1(I) = 0.0
      SUM = 0.0
      DO 3 J=1,20
      K=I+J-1
      FJ=J
      IF (K-95) 5,5,3
    5 PROD(J) = FERT(J)*(XL(K)+XL(K+1))/(2.0*EXP(RATE*FJ))
      IF(I-26) 4,4,6
    4 FK = K
      SUM = SUM+PROD(J)*(FK+0.5)
    6 SUM1(I) = SUM1(I) + PROD(J)
    3 CONTINUE
      IF(I-26) 7,7,2
    7 XMEAN(I) = SUM/SUM1(I)
    2 CONTINUE
      WRITE(6,204)
  204 FORMAT(14H0FIRST BIRTHS ,4HMEAN,6X,2H10,6X,2H15,6X,2H20,6X,2H25,6X
     1,2H30,6X,2H35,6X,2H40,6X,2H45,6X,2H50,6X,2H55)
      DO 15 I = 5,55,5
      IF(I-66) 25,25,24
   25 CONST(I) = XL(I+30)/XL(25)
      GO TO 15
   24 CONST(I) = 0.0
   15 CONTINUE
      DO 8 I = 10,26
      DO 9 J = 1,60
      K = I+J
      PI(J) = SUM1(K)/SUM1(I)
      FJ = J
      W(J) = 2.0*XL(J)/EXP(RATE*FJ)
    9 CONTINUE
      DO 10 J = 5,55,5
      SUM = 0.0
      SUM2 = 0.0
      DO 11 L = 1,6
      M = J+L-1
      IF(L-1) 17,13,12
   12 IF(L-6) 14,13,17
   13 WEI = W(M)/2.0
      GO TO 18
   14 WEI = W(M)
   18 SUM = SUM+PI(M)*WEI
      SUM2 = SUM2+WEI
   11 CONTINUE
      PROD(J) = SUM/SUM2
   10 CONTINUE
      DO 16 JJ=5,50,5
      WEIGHT(JJ,I) = (CONST(JJ)-PROD(JJ+5))/(PROD(JJ)-PROD(JJ+5))
   16 CONTINUE
    8 CONTINUE
      DO 21 I=10,25
      IA = I+1
      DIFF = XMEAN(I+1)-XMEAN(I)
      MEAN = XMEAN(I+1)
      IF(I.NE.10.OR.MEAN.LE.17) GO TO 27
      DO 28 JJ=5,50,5
      J = JJ/5
      RETERP(J,17) = 20.0
   28 CONTINUE
   27 XM = MEAN
   22 DIF = XM-XMEAN(I)
      FAC = DIF/DIFF
      DO 20 JJ=5,50,5
      DIFF = WEIGHT(JJ,IA)-WEIGHT(JJ,I)
      TERP(JJ) = WEIGHT(JJ,I) + DIFF*FAC
      J = JJ/5
      RETERP(J,MEAN) = TERP(JJ)
   20 CONTINUE
      WRITE(6,202) MEAN,(TERP(JJ),JJ=5,50,5)
  202 FORMAT(//12X,I5,3X,10F8.4)
   21 CONTINUE
      WRITE(8,100)((RETERP(J,MEAN),MEAN=17,30),J=1,10)
      GO TO 19
   17 STOP
      END
```

Appendix 3.2

A Computer Programme for Interpolating between Firstbirth and Allbirth Weights

Programme FBW2 interpolates between firstbirth weights and allbirth weights to estimate the weights for eldest surviving children. The form given here is for maternal orphanhood, though only minor changes are required for its use with paternal orphanhood. The calculations are described in detail in sections 3.3 and 3.10, so only an outline of what is being done will be given here. The programme carries out two principal operations, initially estimating the birth order composition of eldest surviving children, and then using this to interpolate between first and allbirth weights. The basic mortality model, completed parity distribution, and birth interval are read in. Twelve sets of allbirth and firstbirth weights, for 12 different mortality levels and patterns, calculated by FBW1 , are read from disc. The rest of the programme, from line 9, is repeated 12 times. The mortality parameters and population growth rate are read in, and the mortality model defined (lines 10 to 14). The mean age of mother at which births occur is then calculated by taking each parity from 1 to 15 in turn (lines 22 to 34). Lines 37 to 76 are repeated 10 times, once for each age group of respondents. By once again taking each birth order in turn, the birth order composition of eldest surviving children is estimated (lines 41 to 57). The mean age of mother at the birth of an eldest surviving child is then estimated, and used to interpolate between the firstbirth and allbirth weights already read in for a range of firstbirth means (lines 58 to 72). The weights for this central age of respondents, and 10 values of the firstbirth mean, are then written out, and the programme continues to the next central age of respondents, and then on to another mortality pattern.

Few changes are needed to run the programmes for paternal orphanhood. All that it requires is to use a more realistic average value for the firstbirth mean, so 25 is substituted for 20 in lines 24, 28, 59, and 60.

List of Main Variables

YS(I)	: The standard logit values of the Brass model life table system.
P(I)	: the completed parity distribution
B(I)	: the birth interval.
W(I,J,K)	: the complete set of allbirth weights.
WI(I,J,K)	: the complete set of firstbirth weights.
BETA	: the second paramter of the Brass model life table system.
XL2	: the life table survivors to age 2.
RATE	: the rate of population growth
XMEAN	: the mean age at birth of all children.
YMEAN	: the mean age at birth of eldest surviving children.
S	: the amount added to firstbirth and allbirth means, determining the weights between which interpolation takes place.
XK	: the interpolation factor.
WEIGHT(J)	: the weight estimated for use with eldest surviving children.
N	: the central age around which the weights operate.

```
      PROGRAM FH42(INPUT,OUTPUT,DATA4,DATA1,TAPE5=INPUT,TAPE6=OUTPUT,TAP
     1E7=DATA4,TAPE8=DATA1)
      DIMENSION YS(95),W1(14,10,12),W(14,10,12),P(15),FIX(14),FAC(15),WE
     1IGHT(10),FIX1(14)
      READ(5,100)(YS(I),I=1,95)
  100 FORMAT(10F8.4)
      READ(5,100)(P(I),I=1,15)
      READ(5,100)BI
      READ(7,100)(((W(I,J,K),I=1,14),J=1,10),K=1,12)
      READ(8,100)(((W1(I,J,K),I=1,14),J=1,10),K=1,12)
      DO 11 L = 1,12
   10 READ(5,100) BETA,XL2
      READ(5,100) RATE
      A = (1.0-XL2)/XL2
      ALPHA = ALOG(A)/2.0-BETA*YS(2)
      WRITE(6,200) ALPHA,BETA,XL2,BI
  200 FORMAT(1H1,9X,8HALPHA = ,F8.4,3X,7HBETA = ,F8.4,3X,7HL(2) = ,F8.4,
     13X,17HBIRTH INTERVAL = ,F8.4)
      WRITE(6,204) RATE
  204 FORMAT(/10X,14HGROWTH RATE = ,F6.4)
       WRITE(6,203)(P(I),I=1,15)
  203 FORMAT(15F8.4)
      SUM=0.0
      SUM1=0.0
      DO 1 K=1,15
      FK=K
      T=20.0+(FK-1.0)*BI
      CALL TERP(T,YS,Y)
      Y=ALPHA + BETA*Y
      XL=1.0/(1.0+EXP(2.0*Y))
      Y=ALPHA + BETA*YS(20)
      XL20 = 1.0/(1.0+EXP(2.0*Y))
      FAC(K) = XL*P(K)/(XL20*EXP(RATE*(FK-1.0)*BI))
      SUM=SUM+FAC(K)*T
      SUM1=SUM1+FAC(K)
    1 CONTINUE
      XMEAN=SUM/SUM1
      WRITE(6,201)
  201 FORMAT(//6H  AGE ,6X,18HMEAN  EFF F/B MEAN,5X,2H17,8X,2H18,8X,2H19
     1,8X,2H20,8X,2H21,8X,2H22,8X,2H23,8X,2H24,8X,2H25,8X,2H26//)
      DO 2 I=1,10
      SUM = 0.0
      SUM1=0.0
      FAC1 = 1.0
      DO 3 J=1,15
      FJ=J
      FI=I
      T=10.0+(FI-1.0)*5.0+(FJ-1.0)*BI
      CALL TERP(T,YS,Y)
      Y=ALPHA+BETA*Y
      XL=1.0/(1.0+EXP(2.0*Y))
      IF(J-1)4,4,5
    4 FAC1= FAC1*XL
      FAC2=FAC1*FAC(J)
      GO TO 6
    5 FAC1=FAC1*(1.0-XL)
      FAC2=FAC1*FAC(J)
      IF(FAC2-1.0E-05)7,7,6
    6 SUM = SUM+FAC2*(FJ-1.0)*BI
      SUM1=SUM1+FAC2
    3 CONTINUE
    7 YMEAN=SUM/SUM1
      S=XMEAN+YMEAN-20.0
      XK=YMEAN/(XMEAN-20.0)
      DO 8 JJ=1,14
      FIX(JJ) = W(JJ,I,L)
      FIX1(JJ) = W1(JJ,I,L)
    8 CONTINUE
      DO 9 J=1,10
      FJ=J
      T=FJ+YMEAN
      CALL TERP(T,FIX1,W2)
      T=FJ+S-5.0
      CALL TERP(T,FIX,W3)
      WEIGHT(J)=W2+(W3-W2)*XK
    9 CONTINUE
      N=10+(I-1)*5
      WRITE(6,202)N,XMEAN,YMEAN,(WEIGHT(J),J=1,10)
  202 FORMAT(/I5,4X,12F10.4)
    2 CONTINUE
   11 CONTINUE
      STOP
      END

      SUBROUTINE TERP(A,B,C)
      DIMENSION B(1)
      IA=A
      AI=IA
      C=B(IA)+(B(IA+1)-B(IA))*(A-AI)
      RETURN
      END
```

Appendix 3.3

Full Weights for Maternal Orphanhood Reports of Eldest Surviving Children

Sets of weights for a variety of mortality and fertility conditions are reproduced in Table A.3.3. Three measures of mortality are given, the first and second parameters of the Brass model life table system, alpha and beta, and the life table survivors to age two of a radix of 1,000 births, $l_{(2)}$. Both the level and the age pattern of mortality are varied, from very high mortality, with an $l_{(2)}$ of 650 and beta of 1.3, to moderate mortality, with an $l_{(2)}$ of 900 and beta of 0.8; or from relatively heavy child mortality, with an $l_{(2)}$ of 650 and beta of 0.8, to relatively light child mortality, with an $l_{(2)}$ of 900 and beta of 1.3. The rate of population growth is varied to remain consistent with the mortality assumptions and a fixed fertility schedule with a total fertility rate of 6.0. Different estimating equations are used, on bases of 20 and 25 years. Different fertility levels, birth intervals, and parity distributions are also introduced as specified on the tables.

The two means that are given require some explanation. The mean age at birth of all children is the mean age at childbearing in the stable population, when firstbirths all occur at exact age 20, and secondbirths exactly one mean birth interval later, and so on. The mean age at birth of eldest surviving children is the difference between the mean age at bearing what is an eldest surviving child at a given central age (in the stable population), and the mean age at bearing first children in the stable population, which is 20 throughout. Thus the mean age of mother at the birth of eldest surviving children aged 35 is the value shown in the relevant column plus 20 years.

TABLE A.3.3. : MATERNAL ORPHANHOOD WEIGHTS FOR ELDEST SURVIVING CHILDREN

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0

$l_{(2)}$ = 650 Alpha = 0.4057 Growth Rate = 1.15% Mean Age at Birth of all Children = 27.33

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	1.6796	.4095	.4473	.4783	.5040	.5259	.5461	.5663	.5882	.6127	.6401
15	1.8575	.3838	.4336	.4786	.5200	.5595	.5988	.6395	.6828	.7291	.7667
20	2.0918	.3399	.4102	.4771	.5416	.6053	.6695	.7352	.8031	.8735	.8843
25	2.3350	.2945	.3903	.4831	.5739	.6639	.7541	.8452	.9379	1.0322	.9645
30	2.5916	.2600	.3811	.4992	.6154	.7306	.8457	.9616	1.0789	1.1980	.9846
35	2.8818	.2761	.4179	.5575	.6957	.8338	.9728	1.1135	1.2571	1.2951	1.0199
40	3.2274	.2992	.4588	.6178	.7774	.9391	1.1045	1.2753	1.4531	1.2486	1.0538
45	3.6553	.3858	.5591	.7359	.9181	1.1080	1.3081	1.5214	1.7513	1.0464	1.0907
50	4.1868	.4482	.6358	.8340	1.0463	1.2773	1.5326	1.8191	1.4735	1.0420	.8886
55	4.8223	.5216	.7255	.9527	1.2103	1.5072	1.8544	2.0088	.9929	1.0328	.3319

$l_{(2)}$ = 700 Alpha = 0.2916 Growth Rate = 1.35% Mean Age at Birth of all Children = 27.31

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	1.3676	.3747	.4178	.4536	.4833	.5085	.5311	.5531	.5761	.6014	.6294
15	1.5152	.3308	.3864	.4367	.4826	.5258	.5679	.6107	.6555	.7029	.7532
20	1.7178	.2647	.3413	.4139	.4834	.5511	.6184	.6866	.7564	.8284	.8985
25	1.9315	.1946	.2974	.3964	.4926	.5870	.6806	.7744	.8691	.9650	1.0108
30	2.1599	.1349	.2637	.3886	.5104	.6300	.7486	.8668	.9856	1.1052	1.0798
35	2.4212	.1291	.2786	.4244	.5675	.7091	.8501	.9915	1.1342	1.2792	1.1047
40	2.7398	.1354	.3010	.4644	.6265	.7889	.9529	1.1202	1.2923	1.4394	1.0468
45	3.1466	.2137	.3694	.5663	.7462	.9312	1.1235	1.3257	1.5408	1.3841	1.0904
50	3.6751	.2758	.4597	.6509	.8525	1.0684	1.3032	1.5625	1.8545	1.0451	1.1089
55	4.3428	.3664	.5588	.7698	1.0055	1.2737	1.5833	1.9476	1.3726	1.0406	.7370

TABLE A.1.1. 1 (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0

$l_{(2)}$ = 750 Alpha = 0.1659 Growth Rate = 1.62% Mean Age at Birth of all Children = 27.27

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.0804	.3371	.3856	.4264	.4605	.4893	.5147	.5388	.5635	.5901	.6192
15	1.1974	.2736	.3356	.3916	.4426	.4901	.5357	.5812	.6281	.6774	.7233
20	1.3649	.1833	.2672	.3464	.4218	.4946	.5661	.6376	.7102	.7845	.8634
25	1.5441	.0859	.1971	.3039	.4069	.5071	.6056	.7033	.8011	.8994	.9583
30	1.7372	-.0011	.1373	.2707	.3999	.5256	.6490	.7711	.8924	1.0134	1.1328
35	1.9605	-.0307	.1290	.2832	.4332	.5800	.7247	.8682	1.0115	1.1554	1.2157
40	2.2373	-.0456	.1292	.2997	.4671	.6324	.7973	.9631	1.1314	1.3039	1.2255
45	2.6016	.0195	.2007	.3804	.5605	.7428	.9292	1.1222	1.3242	1.5384	1.1456
50	3.0971	.0794	.2628	.4502	.6440	.8475	1.0647	1.3005	1.5608	1.4871	1.0552
55	3.7650	.1821	.3639	.5588	.7721	1.0105	1.2816	1.5952	1.9147	1.0234	1.1148

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 27.18

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2951	.3492	.3953	.4343	.4673	.4963	.5233	.5503	.5783	.6097
15	.9050	.2114	.2801	.3424	.3992	.4516	.5016	.5507	.6007	.6525	.7067
20	1.0358	.0958	.1879	.2746	.3568	.4355	.5122	.5882	.6644	.7419	.8205
25	1.1774	-.0309	.0903	.2062	.3174	.4247	.5293	.6322	.7341	.8359	.9373
30	1.3307	-.1482	.0019	.1460	.2845	.4183	.5484	.6757	.8010	.9243	1.0479
35	1.5094	-.2048	-.0326	.1329	.2925	.4471	.5978	.7455	.8912	1.0355	1.1795
40	1.7329	-.2450	-.0573	.1240	.2998	.4713	.6397	.8064	.9730	1.1409	1.3215
45	2.0334	-.1971	-.0056	.1814	.3657	.5489	.7328	.9196	1.1113	1.3105	1.3922
50	2.4605	-.1473	.0405	.2284	.4187	.6139	.8171	1.0323	1.2644	1.5193	1.2762
55	3.0779	-.0330	.1427	.3260	.5209	.7328	.9681	1.2344	1.5414	1.5911	1.0141

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 2.55% Mean Age at Birth of all Children = 27.06

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.5779	.2491	.3091	.3608	.4049	.4426	.4757	.5062	.5361	.5671	.6102
15	.6343	.1428	.2189	.2883	.3516	.4101	.4654	.5191	.5730	.6282	.6555
20	.7328	-.0000	.1014	.1968	.2871	.3733	.4565	.5382	.6193	.7008	.7831
25	.8359	-.1573	-.0245	.1023	.2234	.3396	.4519	.5613	.6688	.7750	.8801
30	.9481	-.3068	-.1471	.0151	.1653	.3093	.4480	.5823	.7132	.8412	.9568
35	1.0788	-.3936	-.2045	-.0242	.1483	.3136	.4729	.6271	.7769	.9235	1.0573
40	1.2423	-.4651	-.2587	-.0614	.1277	.3094	.4851	.6561	.8239	.9897	1.1550
45	1.4647	-.4412	-.2318	-.0306	.1640	.3537	.5401	.7252	.9110	1.0994	1.2932
50	1.7897	-.4080	-.2073	-.0109	.1829	.3763	.5718	.7727	.9826	1.2066	1.4500
55	2.2912	-.2895	-.1114	.0678	.2515	.4438	.6498	.8756	1.1282	1.4166	1.4448

$l_{(2)}$ = 900 Alpha = -0.3834 Growth Rate = 3.15% Mean Age at Birth of all Children = 26.91

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH IF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.3638	.2003	.2665	.3239	.3735	.4162	.4538	.4882	.5216	.5556	.5914
15	.4007	.0699	.1540	.2309	.3014	.3667	.4280	.4872	.5458	.6053	.6663
20	.4610	-.1024	.0095	.1150	.2147	.3095	.4005	.4890	.5762	.6630	.7497
25	.5273	-.2932	-.1465	-.0068	.1263	.2534	.3754	.4933	.6078	.7198	.8295
30	.5994	-.4792	-.2963	-.1225	.0428	.2000	.3501	.4940	.6324	.7662	.8555
35	.6833	-.6002	-.3884	-.1878	.0022	.1825	.3541	.5178	.6747	.8254	.9706
40	.7877	-.7077	-.4739	-.2529	-.0438	.1542	.3423	.5219	.6942	.8608	1.0229
45	.9291	-.7130	-.4737	-.2478	-.0336	.1706	.3665	.5558	.7404	.9224	1.1037
50	1.1374	-.7082	-.4788	-.2601	-.0503	.1528	.3512	.5476	.7454	.9483	1.1608
55	1.4696	-.5955	-.3979	-.2069	-.0196	.1676	.3587	.5585	.7726	1.0075	1.2708

TABLE A.3.3. 9 (Continued)

FUNCTION ESTIMATED : $l_{(25+x)}/l_{(25)}$ BETA = 1.3

$l_{(2)}$ = 650 Alpha = 0.6202 Growth Rate = 0.69% Mean Age at Birth of all Children = 27.25

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.8668	.4019	.4417	.4742	.5021	.5266	.5497	.5731	.5981	.6256	.6561
15	2.1253	.3858	.4381	.4860	.5308	.5741	.6175	.6624	.7097	.7598	.7847
20	2.4634	.3678	.4405	.5105	.5787	.6466	.7153	.7857	.8586	.9339	.8823
25	2.8136	.3528	.4595	.5543	.6481	.7420	.8371	.9340	1.0333	1.1154	.9198
30	3.1809	.3757	.4960	.6152	.7342	.8543	.9763	1.1013	1.2300	1.1568	.9750
35	3.5874	.4375	.5782	.7198	.8634	1.0106	1.1625	1.3208	1.4868	1.0795	1.0227
40	4.0526	.4999	.6601	.8249	.9963	1.1765	1.3680	1.5734	1.5057	1.0093	.9831
45	4.5874	.6075	.7891	.9828	1.1917	1.4202	1.6733	1.9572	1.1662	1.0238	.5089
50	5.1790	.6578	.8641	1.0947	1.3571	1.6608	2.0182	1.7011	.9847	.8647	.2641
55	5.7824	.6728	.9071	1.1860	1.5239	1.9399	2.3920	.9572	.9510	.5227	.3547

$l_{(2)}$ = 700 Alpha = 0.5061 Growth Rate = 1.00% Mean Age at Birth of all Children = 27.20

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.5196	.4603	.4057	.4444	.4772	.5058	.5320	.5578	.5845	.6132	.6443
15	1.7367	.3233	.3829	.4369	.4870	.5346	.5813	.6288	.6781	.7298	.7841
20	2.0348	.2424	.3622	.4384	.5119	.5840	.6561	.7291	.8040	.8810	.9218
25	2.3517	.2514	.3566	.4569	.5561	.6543	.7526	.8518	.9527	1.0556	1.0070
30	2.6922	.2412	.3685	.4934	.6169	.7401	.8641	.9898	1.1181	1.2496	1.0077
35	3.0733	.2462	.4320	.5771	.7227	.8701	1.0207	1.1758	1.3369	1.3310	1.0242
40	3.5384	.3383	.5001	.6645	.8333	1.0085	1.1924	1.3876	1.5468	1.1830	1.0557
45	4.0932	.4454	.6237	.8102	1.0090	1.2238	1.4588	1.7194	1.6548	1.0340	.9630
50	4.7322	.5092	.7040	.9180	1.1592	1.4349	1.7557	2.1353	1.0682	1.0254	.4032
55	5.4197	.5539	.7717	1.0283	1.3368	1.7139	2.1825	1.4945	.9702	.7057	.3113

TABLE A.3.3.1 (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.3

$l_{(2)}$ = 750 Alpha = 0.3805 Growth Rate = 1.35% Mean Age at Birth of all Children = 27.15

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	[illegible]	[illegible]	.3065	.4112	.4494	.4826	.5126	.5413	.5704	.6012	.6341
15	1.374[illegible]	.2546	.3214	.3826	.4390	.4920	.5433	.5945	.6467	.7010	.7575
20	1.6250	.1465	.2769	.3589	.4394	.5175	.5946	.6717	.7499	.8296	.9109
25	1.8879	.1240	.2414	.3509	.4572	.5614	.6644	.7674	.8711	.9760	1.0705
30	2.1973	.0910	.2276	.3606	.4907	.6190	.7467	.8747	1.0039	1.1353	1.1444
35	2.5445	.1151	.2686	.4197	.5696	.7194	.8705	1.0243	1.1819	1.3449	1.1471
40	2.9752	.1541	.3200	.4863	.6544	.8264	1.0042	1.1903	1.3871	1.5017	1.0547
45	3.5135	.2596	.4344	.6154	.8054	1.0074	1.2251	1.4630	1.7265	1.3001	1.0331
50	4.1922	.3393	.5200	.7203	.9415	1.1902	1.4752	1.8078	1.6928	1.0316	.8355
55	4.9612	.4074	.6055	.8355	1.1083	1.4381	1.8437	2.1326	.9766	1.0119	.2703

$l_{(2)}$ = 800 Alpha = 0.2366 Growth Rate = 1.75% Mean Age at Birth of all Children = 27.09

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.9103	.2635	.3225	.3737	.4179	.4565	.4910	.5235	.5559	.5895	.6249
15	1.0410	.1785	.2538	.3229	.3867	.4462	.5030	.5589	.6152	.6731	.7327
20	1.2397	.0806	.1791	.2725	.3616	.4472	.5307	.6133	.6961	.7796	.8641
25	1.4604	-.0098	.1152	.2352	.3510	.4634	.5733	.6819	.7900	.8981	1.0047
30	1.7063	-.0771	.0719	.2158	.3552	.4912	.6249	.7572	.8893	1.0218	1.1553
35	1.9998	-.0772	.0876	.2480	.4052	.5601	.7142	.8687	1.0248	1.1837	1.3077
40	2.3732	-.0577	.1165	.2886	.4599	.6321	.8070	.9868	1.1737	1.3702	1.2932
45	2.8711	.0416	.2174	.3959	.5796	.7710	.9733	1.1900	1.4255	1.6853	1.1053
50	3.5359	.1278	.3041	.4912	.6930	.9149	1.1637	1.4480	1.7796	1.3635	1.0543
55	4.3661	.2336	.4125	.6158	.8521	1.1329	1.4733	1.8935	1.6172	1.0211	.7172

TABLE A.3.1. 1 (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.3

$l_{(2)}$ = 850 Alpha = 0.0625 Growth Rate = 2.35% Mean Age at Birth of all Children = 26.97

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	[illegible]	.2030	.2716	.3299	.3810	.4257	.4659	.5034	.5401	.5773	.6161
15	.7363	.0417	.1767	.2550	.3274	.3949	.4589	.5212	.5830	.6456	.7396
20	.8747	-.3365	.0720	.1766	.2760	.3710	.4628	.5527	.6417	.7305	.8195
25	1.0415	[illegible]	-.0250	.1083	.2361	.3591	.4781	.5943	.7085	.8216	.9338
30	1.2253	-.2661	-.1026	.0561	.2086	.3556	.4983	.6376	.7746	.9102	1.0449
35	1.4468	-.2999	-.1181	.0569	.2261	.3905	.5514	.7100	.8674	1.0250	1.1339
40	1.7356	-.3665	-.1175	.0664	.2461	.4232	.5992	.7762	.9561	1.1413	1.2341
45	2.1359	-.2209	-.0370	.1455	.3285	.5144	.7058	.9057	1.1175	1.3453	1.5186
50	2.7240	-.1313	.0415	.2196	.4058	.6041	.8193	1.0577	1.3277	1.6398	1.2399
55	3.5459	.0067	.1669	.3422	.5392	.7662	1.0339	1.3568	1.7537	1.4820	1.0358

$l_{(2)}$ = 900 Alpha = -0.1689 Growth Rate = 3.00% Mean Age at Birth of all Children = 26.85

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.4056	.1407	.2155	.2817	.3402	.3920	.4386	.4818	.5236	.5656	.6085
15	.4607	-.0043	.0917	.1806	.2630	.3399	.4126	.4827	.5514	.6201	.6895
20	.5528	-.1717	-.0467	.0717	.1839	.2908	.3933	.4926	.5897	.6855	.7803
25	.6585	-.3382	-.1802	-.0297	.1138	.2509	.3822	.5090	.6320	.7520	.8694
30	.7777	-.4431	-.2947	-.1154	.0552	.2180	.3738	.5237	.6687	.8097	.9473
35	.9224	-.5514	-.3418	-.1464	.0418	.2218	.3947	.5618	.7242	.8831	1.0357
40	1.1119	-.5945	-.3787	-.1726	.0250	.2153	.3998	.5804	.7589	.9375	1.1181
45	1.3835	-.5324	-.3262	-.1273	.0664	.2571	.4471	.6389	.8353	1.0395	1.2553
50	1.8057	-.4483	-.2651	-.0832	.0996	.2861	.4798	.6850	.9074	1.1542	1.4345
55	2.4865	-.2789	-.1267	.0309	.1981	.3807	.5858	.8226	1.1031	1.4427	1.4971

TABLE A.1.3 : (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 0.8

$l_{(2)}$ = 650 Alpha = 0.2626 Growth Rate = 1.42% Mean Age at Birth of all Children = 27.38

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.5649	.4197	.4555	.4844	.5076	.5268	.5440	.5612	.5801	.6017	.6264
15	1.6960	.3908	.4376	.4792	.5171	.5527	.5881	.6248	.6642	.7067	.7487
20	1.8692	.3329	.3997	.4628	.5233	.5828	.6425	.7038	.7674	.8337	.8726
25	2.0472	.2626	.3557	.4453	.5327	.6186	.7045	.7910	.8788	.9682	.9721
30	2.2338	.1950	.3151	.4316	.5453	.6570	.7678	.8784	.9893	1.1009	1.0341
35	2.4441	.1747	.3176	.4567	.5928	.7268	.8597	.9923	1.1252	1.2589	1.0622
40	2.6961	.1614	.3235	.4821	.6383	.7931	.9478	1.1036	1.2616	1.3819	1.0421
45	3.0146	.2183	.3929	.5661	.7395	.9145	1.0929	1.2764	1.4670	1.3779	1.0866
50	3.4300	.2617	.4464	.6338	.8263	1.0265	1.2376	1.4633	1.7082	1.1822	1.1084
55	3.9729	.3438	.5349	.7369	.9540	1.1913	1.4544	1.7502	1.6276	1.0459	1.1156

$l_{(2)}$ = 700 Alpha = 0.1485 Growth Rate = 1.70% Mean Age at Birth of all Children = 27.32

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.2674	.3491	.4296	.4627	.4893	.5111	.5302	.5485	.5680	.5899	.6149
15	1.3746	.3442	.3961	.4421	.4837	.5222	.5597	.5978	.6381	.6814	.7279
20	1.5219	.2651	.3375	.4055	.4703	.5332	.5956	.6589	.7240	.7914	.8511
25	1.6747	.1702	.2697	.3651	.4574	.5476	.6368	.7260	.8159	.9068	.9387
30	1.8361	.0773	.2050	.3282	.4475	.5640	.6785	.7919	.9049	1.0180	1.0339
35	2.0185	.0341	.1853	.3314	.4733	.6119	.7482	.8830	1.0169	1.1507	1.1718
40	2.2394	-.0012	.1692	.3347	.4962	.6546	.8112	.9672	1.1235	1.2814	1.1904
45	2.5238	.0397	.2209	.3987	.5746	.7498	.9261	1.1049	1.2880	1.4775	1.1540
50	2.9058	.0743	.2617	.4493	.6389	.8328	1.0337	1.2449	1.4703	1.5277	1.0345
55	3.4276	.1586	.3454	.5390	.7432	.9622	1.2011	1.4657	1.7632	1.2517	1.1161

TABLE A.3.3. [illegible] (Continued)

FUNCTION ESTIMATED : $l_{(25+x)}/l_{(25)}$ BETA = 0.8

$l_{(2)}$ = 750 Alpha = 0.0229 Growth Rate = 1.95% Mean Age at Birth of all Children = 27.27

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.0075	.3447	.4039	.4411	.4714	.4962	.5174	.5374	.5579	.5807	.6062
15	1.0930	.2977	.3547	.4056	.4513	.4933	.5334	.5736	.6154	.6599	.7275
20	1.2145	.1978	.2762	.3497	.4194	.4864	.5522	.6182	.6855	.7547	.8260
25	1.3629	.0787	.1654	.2874	.3856	.4809	.5743	.6670	.7596	.8528	.9464
30	1.4777	-.0349	.0966	.2276	.3540	.4764	.5958	.7132	.8293	.9445	1.0590
35	1.6315	-.1063	.0548	.2097	.3591	.5040	.6451	.7836	.9199	1.0547	1.1585
40	1.8149	-.1679	.0182	.1928	.3617	.5257	.6861	.8441	1.0006	1.1568	1.2516
45	2.0633	-.1372	.0537	.2392	.4203	.5986	.7754	.9523	1.1309	1.3130	1.2908
50	2.4009	-.1140	.0804	.2723	.4631	.6550	.8503	1.0519	1.2632	1.4881	1.2367
55	2.8428	-.0261	.1612	.3513	.5477	.7539	.9746	1.2148	1.4805	1.5536	1.0910

$l_{(2)}$ = 800 Alpha = -0.1210 Growth Rate = 2.17% Mean Age at Birth of all Children = 27.24

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.7601	.3290	.3792	.4214	.4563	.4853	.5101	.5328	.5554	.5795	.6062
15	.8237	.2521	.3151	.3715	.4225	.4692	.5133	.5566	.6008	.6472	.6963
20	.9180	.1319	.2172	.2972	.3729	.4451	.5154	.5851	.6554	.7270	.8003
25	1.0177	-.0115	.1036	.2134	.3187	.4201	.5188	.6158	.7121	.8081	.9040
30	1.1233	-.1567	-.0100	.1303	.2650	.3947	.5203	.6427	.7626	.8806	.9970
35	1.2435	-.2486	-.0754	.0902	.2490	.4018	.5494	.6926	.8323	.9692	1.1035
40	1.3901	-.3310	-.1364	.0499	.2287	.4008	.5671	.7289	.8872	1.0431	1.1974
45	1.5824	-.3276	-.1227	.0741	.2641	.4484	.6286	.8060	.9822	1.1588	1.3375
50	1.8521	-.3232	-.1170	.0834	.2793	.4726	.6653	.8598	1.0591	1.2665	1.4370
55	2.2516	-.2467	-.0537	.1376	.3301	.5270	.7321	.9497	1.1847	1.4428	1.3536

TABLE A.?.?. ? (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 0.8

$l_{(2)}$ = 850 Alpha = -0.2951 Growth Rate = 2.70% Mean Age at Birth of all Children = 27.09

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.5471	[illegible]	.3398	.3861	.4247	.4567	.4839	.5086	.5329	.5586	.5466
15	.5811	[illegible]	.2575	.3191	.3746	.4253	.4729	.5192	.5660	.6147	.6661
20	.6447	.0441	.1367	.2233	.3048	.3824	.4574	.5312	.6052	.6800	.7563
25	.7213	-.1279	-.0035	.1150	.2280	.3365	.4415	.5440	.6449	.7450	[illegible]
30	.7477	-.3035	-.1446	.0069	.1516	.2901	.4234	.5523	.6776	.8000	.9197
35	.8844	-.4238	-.2356	-.0565	.1141	.2771	.4332	.5833	.7283	.8686	1.0048
40	.9471	-.5353	-.3233	-.1209	.0716	.2549	.4300	.5981	.7602	.9173	1.0703
45	1.1244	-.5576	-.3326	-.1188	.0848	.2794	.4666	.6475	.8237	.9966	1.1678
50	1.3233	-.5761	-.3512	-.1343	.0738	.2749	.4707	.6635	.8558	1.0505	1.2513
55	1.6172	-.5384	-.2992	-.0973	.1000	.2955	.4929	.6959	.9087	1.1359	1.3829

$l_{(2)}$ = 900 Alpha = -0.5265 Growth Rate = 3.25% Mean Age at Birth of all Children = 26.93

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.3382	.2459	.3057	.3567	.3995	.4354	.4659	.4934	.5201	.5478	.5776
15	.3652	.1308	.2056	.2731	.3342	.3899	.4419	.4920	.5422	.5939	.6479
20	.4083	-.0378	.0627	.1569	.2455	.3296	.4104	.4894	.5678	.6466	.7263
25	.4547	-.2379	-.1029	.0255	.1478	.2647	.3772	.4862	.5928	.6977	.8010
30	.5039	-.4445	-.2714	-.1068	.0498	.1990	.3416	.4784	.6104	.7379	.8615
35	.5594	-.5955	-.3887	-.1931	-.0077	.1681	.3351	.4941	.6458	.7909	.9297
40	.6264	-.7422	-.5054	-.2820	-.0713	.1273	.3148	.4922	.6605	.8208	.9740
45	.7138	-.7930	-.5387	-.3001	-.0760	.1350	.3342	.5231	.7029	.8751	1.0412
50	.8362	-.8455	-.5849	-.3404	-.1102	.1071	.3133	.5106	.7015	.8886	1.0752
55	1.0192	-.7971	-.5552	-.3279	-.1127	.0935	.2939	.4924	.6926	.8986	1.1145

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0 $l_{(2)}$ = 800 ALPHA = 0.0221 GROWTH RATE = 2.00% ALL BIRTH MEAN = 27.18

Firstbirth Function with Early Peak, 17½ Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2979	.3521	.3982	.4368	.4692	.4973	.5236	.5500	.5787	.6[illegible]
15	.9050	.2136	.2825	.3447	.4012	.4529	.5021	.5506	.6000	.6517	.7[illegible]
20	1.0354	.0976	.1697	.2762	.3581	.4363	.5123	.5877	.6637	.7410	.81[illegible]
25	1.1774	-.0247	.0915	.2072	.3181	.4250	.5291	.6316	.7334	.8350	.93[illegible]
30	1.3307	-.1475	.0027	.1466	.2849	.4184	.5481	.6751	.8002	.9242	1.04[illegible]
35	1.5094	-.2043	-.0321	.1332	.2925	.4469	.5973	.7449	.8904	1.0348	1.17[illegible]
40	1.7329	-.2451	-.0574	.1240	.2997	.4710	.6392	.8057	.9722	1.1400	1.310[illegible]
45	2.0334	-.1968	-.0054	.1814	.3655	.5484	.7321	.9188	1.1104	1.3095	1.3[illegible]
50	2.4605	-.1475	.0403	.2283	.4186	.6136	.8167	1.0316	1.2634	1.5179	1.27[illegible]
55	3.0779	-.0320	.1438	.3269	.5216	.7332	.9682	1.2343	1.5412	1.5907	1.0[illegible]

Firstbirth Function with Late Peak, 17½ Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2925	.3459	.3915	.4304	.4640	.4939	.5218	.5497	.5787	.6[illegible]
15	.9050	.2048	.2769	.3369	.3958	.4489	.4996	.5496	.6003	.6524	.7[illegible]
20	1.0354	.0936	.1651	.2717	.3540	.4333	.5108	.5875	.6643	.7420	.8[illegible]
25	1.1774	-.0326	.0884	.2042	.3156	.4235	.5286	.6320	.7344	.8362	.9[illegible]
30	1.3307	-.1491	.0008	.1448	.2834	.4176	.5481	.6758	.8013	.9254	1.0[illegible]
35	1.5094	-.2055	-.0333	.1323	.2923	.4473	.5982	.7462	.8920	1.0365	1.1[illegible]
40	1.7329	-.2443	-.0567	.1245	.3003	.4719	.6404	.8074	.9741	1.1419	1.3[illegible]
45	2.0334	-.1967	-.0052	.1820	.3666	.5500	.7341	.9209	1.1127	1.3119	1.3[illegible]
50	2.4605	-.1457	.0421	.2300	.4201	.6151	.8183	1.0335	1.2658	1.5209	1.2[illegible]
55	3.0779	-.0332	.1422	.3253	.5202	.7322	.9675	1.2338	1.5406	1.5900	1.0[illegible]

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(25+x)}/l_{(25)}$ BETA = 1.0 $l_{(2)}$ = 800 ALPHA = 0.0221 GROWTH RATE = 2.00% ALL BIRTH MEAN = 27.8

Standard Firstbirth Function over 15 Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.3074	.3595	.4028	.4343	.4679	.4940	.5189	.5447	.5727	.6034
15	.9050	.2189	.2854	.3449	.3986	.4480	.4954	.5427	.5917	.6433	.6975
20	1.0358	.0975	.1676	.2718	.3513	.4276	.5024	.5772	.6530	.7304	.8093
25	1.1774	-.0352	.0665	.1988	.3082	.4140	.5176	.6198	.7217	.8236	.9255
30	1.3307	-.1301	-.0067	.1363	.2738	.4066	.5361	.6631	.7886	.9130	1.0364
35	1.5094	-.2144	-.0427	.1223	.2815	.4359	.5865	.7344	.8803	1.0250	1.1691
40	1.7329	-.2531	-.0650	.1165	.2922	.4635	.6318	.7986	.9654	1.1335	1.3042
45	2.0334	-.2001	-.0088	.1781	.3623	.5457	.7299	.9168	1.1085	1.3075	1.388
50	2.4605	-.1440	.0446	.2332	.4239	.6191	.8223	1.0376	1.2699	1.5254	1.283
55	3.0779	-.0209	.1545	.3373	.5321	.7441	.9799	1.2474	1.5561	1.6080	1.1039

Standard Firstbirth Function over 20 Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2833	.3395	.3882	.4302	.4665	.4984	.5278	.5563	.5857	.616
15	.9050	.2047	.2756	.3406	.4002	.4558	.5083	.5593	.6105	.6629	.717
20	1.0358	.0957	.1897	.2787	.3633	.4444	.5230	.6003	.6772	.7547	.833
25	1.1774	-.0246	.0979	.2152	.3280	.4369	.5426	.6461	.7482	.8497	.950
30	1.3307	-.1360	.0129	.1578	.2971	.4318	.5623	.6898	.8150	.9386	1.061
35	1.5094	-.1931	-.0206	.1451	.3050	.4599	.6106	.7582	.9036	1.0477	1.191
40	1.7329	-.2354	-.0442	.1329	.3087	.4801	.6485	.8151	.9815	1.1491	1.319
45	2.0334	-.1934	-.0021	.1848	.3689	.5519	.7357	.9223	1.1139	1.3132	1.395
50	2.4605	-.1518	.0353	.2227	.4127	.6076	.8107	1.0257	1.2574	1.5114	1.266
55	3.0779	-.0465	.1294	.3129	.5079	.7195	.9540	1.2190	1.5240	1.5711	1.060

TABLE A.3.3.1 (Continued)

FUNCTION ESTIMATED : $l_{(25+x)}/l_{(25)}$ BETA = 1.0 $l_{(2)}$ = 800 ALPHA = 0.0221

High Fertility Model. Birth Interval = 2.2 years Growth Rate = 2.72% All Birth Mean = 26.18

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.6779	.2814	.3371	.3843	.4238	.4565	.4848	.5108	.5369	.5645	.5943
15	.7474	.1894	.2595	.3226	.3798	.4319	.4811	.5293	.5783	.6295	.6833
20	.8567	.0614	.1547	.2473	.3250	.4036	.4799	.5552	.6310	.7081	.766
25	.9764	-.0808	.0420	.1591	.2711	.3787	.4834	.5862	.6881	.7899	.891
30	1.1057	-.2165	-.0641	.0819	.2219	.3566	.4872	.6148	.7403	.8644	.987
35	1.2546	-.2927	-.1178	.0499	.2111	.3668	.5181	.6660	.8115	.9552	1.0963
40	1.4387	-.3559	-.1653	.0183	.1956	.3676	.5357	.7012	.8656	1.0303	1.1963
45	1.6825	-.3319	-.1388	.0487	.2321	.4130	.5933	.7746	.9591	1.1487	1.3459
50	2.0235	-.3100	-.1237	.0609	.2453	.4320	.6230	.8218	1.0323	1.2594	1.5093
55	2.5107	-.2238	-.0561	.1147	.2917	.4793	.6826	.9075	1.1612	1.4525	1.7923

Low Fertility Model. Birth Interval = 3.0 years Growth Rate = 1.63% All Birth Mean = 27.36

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.9262	.3057	.3580	.4027	.4410	.4742	.5041	.5321	.5603	.5896	.621
15	1.0284	.2281	.2953	.3566	.4131	.4660	.5167	.5670	.6179	.6705	.725
20	1.1755	.1222	.2129	.2988	.3807	.4599	.5373	.6141	.6911	.7689	.847
25	1.3319	.0084	.1282	.2429	.3535	.4608	.5655	.6686	.7707	.8724	.973
30	1.5016	-.0940	.0542	.1965	.3338	.4669	.5966	.7237	.8488	.9726	1.095
35	1.7003	-.1360	.0339	.1977	.3560	.5098	.6599	.8073	.9530	1.0977	1.223
40	1.9[illegible]7	-.1595	.0257	.2050	.3795	.5503	.7187	.8862	1.0541	1.2239	1.262
45	2.2855	-.0991	.0910	.2777	.4626	.6473	.8339	1.0242	1.2209	1.4268	1.242
50	2.7571	-.0361	.1524	.3422	.5358	.7362	.9468	1.1721	1.4175	1.5876	1.08
55	3.4236	.0799	.2607	.4519	.6581	.8850	1.1398	1.4310	1.7698	1.2031	1.10

TABLE A.3.1. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 650 Alpha = 0.4057 Growth Rate = 1.15% Mean Age at Birth of all Children = 27.33

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN									
		17	18	19	20	21	22	23	24	25	26
10	1.6796	.4308	.4763	.5071	.5324	.5539	.5736	.5934	.6148	.6387	.655
15	1.8575	.5007	.5486	.5914	.6304	.6672	.7039	.7417	.7821	.8254	.656
20	2.0918	.5793	.6434	.7039	.7619	.8188	.8761	.9351	.9963	1.0601	1.047
25	2.3350	.6764	.7601	.8410	.9201	.9986	1.0775	1.1578	1.2401	1.3247	1.196
30	2.5916	.7871	.8915	.9936	1.0944	1.1950	1.2965	1.3996	1.5052	1.6134	1.260
35	2.8818	.9070	1.0325	1.1569	1.2811	1.4065	1.5341	1.6650	1.8003	1.7869	1.339
40	3.2274	1.0685	1.2172	1.3673	1.5205	1.6786	1.8432	2.0164	2.1998	1.7970	1.44
45	3.6553	1.2483	1.4286	1.6160	1.8133	2.0230	2.2484	2.4935	2.7627	1.4796	1.527
50	4.1868	1.5261	1.7580	2.0100	2.2879	2.5988	2.9513	3.3562	2.5038	1.5604	1.33
55	4.8223	1.8520	2.1800	2.5576	2.9976	3.5164	4.1345	4.2531	1.5401	1.6493	.44

$l_{(2)}$ = 700 Alpha = 0.2916 Growth Rate = 1.35% Mean Age at Birth of all Children = 27.31

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN									
		17	18	19	20	21	22	23	24	25	26
10	1.3676	.4191	.4617	.4972	.5264	.5510	.5729	.5941	.6163	.6407	.6
15	1.5152	.4702	.5235	.5711	.6141	.6541	.6929	.7323	.7734	.8172	.8
20	1.7178	.5337	.6032	.6683	.7301	.7901	.8495	.9097	.9717	1.0359	1.0
25	1.9315	.6123	.7014	.7868	.8693	.9502	1.0307	1.1119	1.1945	1.2784	1.2
30	2.1599	.7017	.8111	.9171	1.0206	1.1230	1.2251	1.3279	1.4323	1.5386	1.4
35	2.4212	.7781	.9274	1.0542	1.1797	1.3049	1.4310	1.5590	1.6899	1.8249	1.5
40	2.7378	.9347	1.0843	1.2337	1.3843	1.5377	1.6956	1.8598	2.0318	2.1662	1.4
45	3.1466	1.0868	1.2630	1.4440	1.6320	1.8294	2.0390	2.2641	2.5087	2.1396	1.5
50	3.6751	1.3282	1.5468	1.7803	2.0341	2.3142	2.6281	2.9842	3.3950	1.6399	1.7
55	4.3428	1.6216	1.9198	2.2595	2.6517	3.1102	3.6516	4.3006	2.6420	1.7365	1.2

TABLE A.3.1. : (Continued)

FUNCTION ESTIMATED : $l_{(20+8)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 750 Alpha = 0.1659 Growth Rate = 1.62% Mean Age at Birth of all Children = 27.27

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	1.0804	.3980	.4460	.4862	.5196	.5475	.5719	.5950	.6185	.6439	.6716
15	1.1974	.4170	.4969	.5496	.5971	.6408	.6823	.7236	.7662	.8110	.8535
20	1.3649	.4852	.5608	.6314	.6979	.7614	.8237	.8859	.9493	1.0144	1.0813
25	1.5441	.5441	.6395	.7303	.8174	.9019	.9851	1.0679	1.1513	1.2359	1.3216
30	1.7372	.6117	.7271	.8381	.9456	1.0506	1.1543	1.2577	1.3614	1.4662	1.5695
35	1.9605	.6843	.8187	.9492	1.0769	1.2029	1.3282	1.4540	1.5812	1.7108	1.7271
40	2.2373	.7933	.9457	1.0959	1.2454	1.3954	1.5478	1.7040	1.8659	2.0349	1.8333
45	2.6016	.9124	1.0861	1.2619	1.4417	1.6277	1.8223	2.0283	2.2490	2.4882	1.7423
50	3.0971	1.1153	1.3210	1.5377	1.7692	2.0204	2.2977	2.6083	2.9614	2.6610	1.7830
55	3.7650	1.3563	1.6229	1.9217	2.2616	2.6547	3.1149	3.6600	4.1948	1.7979	1.9850

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 27.18

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.8174	.3743	.4277	.4729	.5108	.5427	.5703	.5959	.6213	.6481	.677…
15	.9050	.4031	.4683	.5266	.5791	.6269	.6719	.7159	.7605	.8070	.85…
20	1.0358	.4347	.5171	.5935	.6652	.7332	.7989	.8638	.9290	.9956	1.06…
25	1.1774	.4737	.5762	.6732	.7657	.8545	.9410	1.0262	1.1112	1.1964	1.28…
30	1.3307	.5185	.6411	.7583	.8709	.9796	1.0859	1.1904	1.2942	1.3980	1.50…
35	1.5094	.5558	.7068	.8427	.9741	1.1022	1.2280	1.3526	1.4768	1.6017	1.72…
40	1.7329	.6458	.8037	.9566	1.1064	1.2546	1.4025	1.5518	1.7041	1.8608	2.02…
45	2.0314	.7308	.9044	1.0773	1.2510	1.4275	1.6088	1.7972	1.9955	2.2068	2.23…
50	2.4605	.8858	1.0920	1.2844	1.4960	1.7208	1.9635	2.2300	2.5277	2.8651	2.25…
55	3.0779	1.0684	1.3061	1.5664	1.8569	2.1864	2.5661	3.0096	3.5341	3.4268	2.03…

TABLE A.3.1.1 (Continued)

FUNCTION ESTIMATED : $l_{(20+X)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 2.55% Mean Age at Birth of all Children = 27.06

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.5779	.3486	.4075	.4579	.5006	.5367	.5681	.5966	.6245	.6532	[illegible]
15	.6393	.3653	.4370	.5015	.5595	.6123	.6615	.7090	.7564	.8050	[illegible]
20	.7324	.3808	.4704	.5537	.6314	.7047	.7749	.8434	.9115	.9801	[illegible]
25	.8353	.4006	.5111	.6154	.7142	.8083	.8990	.9874	1.0745	1.1610	[illegible]
30	.9481	.4241	.5552	.6796	.7982	.9117	1.0212	1.1276	1.2320	1.3350	[illegible]
35	1.0788	.4470	.5964	.7389	.8754	1.0067	1.1338	1.2578	1.3795	1.4999	[illegible]
40	1.2423	.4994	.6635	.8211	.9733	1.1212	1.2662	1.4098	1.5533	1.6982	[illegible]
45	1.4647	.5467	.7241	.8972	1.0677	1.2372	1.4076	1.5807	1.7589	1.9447	[illegible]
50	1.7897	.6515	.8426	1.0348	1.2305	1.4326	1.6449	1.8719	2.1191	2.3936	[illegible]
55	2.2912	.7636	.9777	1.2048	1.4506	1.7218	2.0266	2.3751	2.7793	3.2547	[illegible]

$l_{(2)}$ = 900 Alpha = -0.3834 Growth Rate = 3.15% Mean Age at Birth of all Children = 26.91

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.3638	.3225	.3870	.4427	.4903	.5309	.5661	.5980	.6286	.6597	[illegible]
15	.4007	.3271	.4056	.4764	.5403	.5985	.6524	.7039	.7546	.8060	[illegible]
20	.4510	.3265	.4240	.5146	.5991	.6783	.7536	.8264	.8979	.9691	[illegible]
25	.5273	.3272	.4467	.5592	.6653	.7657	.8615	.9538	1.0437	1.1318	[illegible]
30	.5994	.3297	.4709	.6041	.7300	.8494	.9631	1.0723	1.1778	1.2802	[illegible]
35	.6833	.3307	.4907	.6419	.7849	.9207	1.0502	1.1742	1.2937	1.4096	[illegible]
40	.7877	.3594	.5335	.6984	.8549	1.0041	1.1473	1.2856	1.4206	1.5536	[illegible]
45	.9291	.3753	.5607	.7379	.9081	1.0730	1.2342	1.3934	1.5524	1.7135	[illegible]
50	1.1374	.4338	.6269	.8153	1.0010	1.1864	1.3744	1.5684	1.7726	1.9921	[illegible]
55	1.4696	.4726	.6748	.8802	1.0930	1.3184	1.5625	1.8323	2.1362	2.4842	[illegible]

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.3

$l_{(2)}$ = 650 Alpha = 0.6202 Growth Rate = 0.69% Mean Age at Birth of all Children = 27.25

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.8668	.4495	.4884	.5209	.5483	.5721	.5945	.6171	.6412	.6677	.69[illegible]
15	2.1253	.5235	.5735	.6189	.6610	.7013	.7417	.7834	.8275	.8744	.88[illegible]
20	2.4634	.6246	.6913	.7550	.8169	.8783	.9406	1.0047	1.0714	1.1400	1.04[illegible]
25	2.8136	.7551	.8418	.9266	1.0107	1.0953	1.1815	1.2702	1.3619	1.4297	1.12[illegible]
30	3.1809	.9091	1.0183	1.1270	1.2366	1.3482	1.4629	1.5818	1.7057	1.5390	1.23[illegible]
35	3.5874	1.0927	1.2179	1.3554	1.4968	1.6436	1.7973	1.9597	2.1327	1.4377	1.32[illegible]
40	4.0526	1.3136	1.4835	1.6617	1.8505	2.0530	2.2722	2.5117	2.2868	1.3683	1.33[illegible]
45	4.5874	1.5794	1.8040	2.0487	2.3182	2.6186	2.9573	3.3439	1.7075	1.4166	.67[illegible]
50	5.1790	1.9707	2.2933	2.6641	3.0969	3.6093	4.2241	3.2313	1.4146	1.2530	.20[illegible]
55	5.7824	2.4051	2.9053	3.5163	4.2718	5.2170	6.2055	1.3590	1.4276	.6301	.35[illegible]

$l_{(2)}$ = 800 Alpha = 0.2366 Growth Rate = 1.75% Mean Age at Birth of all Children = 27.09

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.9103	.3764	.4341	.4838	.5264	.5630	.5955	.6258	.6558	.6868	.7[illegible]
15	1.0410	.4109	.4817	.5459	.6043	.6580	.7089	.7585	.8086	.8600	.9[illegible]
20	1.2337	.4576	.5456	.6281	.7058	.7801	.8520	.9232	.9947	1.0671	1.1[illegible]
25	1.4604	.5209	.6282	.7306	.8289	.9241	1.0175	1.1101	1.2029	1.2967	1.3[illegible]
30	1.7063	.5985	.7250	.8472	.9661	1.0827	1.1982	1.3139	1.4306	1.5493	1.6[illegible]
35	1.9998	.6876	.8326	.9750	1.1158	1.2562	1.3977	1.5418	1.6898	1.8433	1.9[illegible]
40	2.3732	.8225	.9874	1.1532	1.3214	1.4942	1.6738	1.8629	2.0643	2.2807	2.0[illegible]
45	2.8711	.9806	1.1733	1.3744	1.5869	1.8144	2.0611	2.3321	2.6337	2.9741	1.7[illegible]
50	3.5359	1.2489	1.4933	1.7626	2.0641	2.4076	2.8056	3.2744	3.8349	2.6395	1.9[illegible]
55	4.3661	1.5802	1.9319	2.3498	2.8543	3.4722	4.2390	5.2027	3.9641	1.9079	1.[illegible]

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.3

$l_{(2)}$ = 900 Alpha = -0.1689 Growth Rate = 3.00% Mean Age at Birth of all Children = 26.85

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.4056	.3149	.3866	.4496	.5047	.5528	.5954	.6345	.6719	.7092	.74
15	.4607	.3188	.4067	.4869	.5601	.6274	.6902	.7500	.8085	.8667	.92
20	.5526	.3251	.4326	.5330	.6270	.7154	.7995	.8805	.9595	1.0376	1.1
25	.6585	.3394	.4678	.5890	.7036	.8123	.9161	1.0163	1.1138	1.2094	1.3
30	.7777	.3603	.5080	.6481	.7812	.9081	1.0300	1.1480	1.2631	1.3761	1.4
35	.9224	.3830	.5469	.7032	.8529	.9970	1.1368	1.2733	1.4079	1.5418	1.6
40	1.1119	.4362	.6122	.7821	.9472	1.1089	1.2690	1.4296	1.5926	1.7603	1.9
45	1.3835	.4843	.6714	.8565	1.0418	1.2295	1.4225	1.6238	1.8366	2.0654	2.3
50	1.8057	.5988	.8001	1.0081	1.2264	1.4598	1.7140	1.9967	2.3177	2.6894	3.1
55	2.4865	.7413	.9734	1.2313	1.5245	1.8656	2.2702	2.7589	3.3584	4.1046	3.9

BETA = 0.8

$l_{(2)}$ = 650 Alpha = 0.2626 Growth Rate = 1.42% Mean Age at Birth of all Children = 27.38

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.5649	.4317	.4675	.4963	.5194	.5384	.5554	.5725	.5912	.6125	.
15	1.6960	.4864	.5317	.5715	.6074	.6410	.6741	.7085	.7454	.7855	.
20	1.8692	.5514	.6125	.6696	.7240	.7770	.8303	.8851	.9423	1.0021	1.
25	2.0472	.6287	.7094	.7867	.8617	.9356	1.0095	1.0845	1.1611	1.2396	1.
30	2.2338	.7128	.8139	.9119	1.0076	1.1019	1.1962	1.2910	1.3871	1.4845	1.
35	2.4441	.7992	.9201	1.0381	1.1542	1.2693	1.3845	1.5005	1.6182	1.7382	1.
40	2.6961	.9182	1.0579	1.1960	1.3334	1.4716	1.6118	1.7553	1.9033	1.9979	1.
45	3.0146	1.0433	1.2052	1.3683	1.5344	1.7051	1.8822	2.0679	2.2646	2.0350	1.
50	3.4300	1.2411	1.4332	1.6334	1.8445	2.0704	2.3153	2.5845	2.8840	1.8333	1.
55	3.9729	1.4682	1.7138	1.9828	2.2816	2.6173	2.9989	3.4374	2.9973	1.6600	1.

TABLE A.3.3.1 (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 0.8

$l_{(2)}$ = 800 Alpha = -0.1210 Growth Rate = 2.17% Mean Age at Birth of all Children = 27.24

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.7601	.3801	.4301	.4718	.5062	.5345	.5585	.5804	.6020	.6250	.653
15	.8237	.4073	.4677	.5211	.5688	.6119	.6521	.6914	.7314	.7735	.81
20	.9180	.4319	.5088	.5799	.6463	.7091	.7696	.8295	.8899	.9517	1.015
25	1.0177	.4590	.5563	.6482	.7355	.8192	.9003	.9802	1.0597	1.1394	1.21
30	1.1233	.4869	.6052	.7178	.8253	.9288	1.0291	1.1271	1.2238	1.3197	1.415
35	1.2435	.5125	.6501	.7816	.9077	1.0292	1.1471	1.2622	1.3754	1.4872	1.59
40	1.3901	.5663	.7198	.8672	1.0094	1.1472	1.2818	1.4144	1.5462	1.6780	1.817
45	1.5824	.6138	.7821	.9455	1.1052	1.2626	1.4188	1.5756	1.7345	1.8972	2.05
50	1.8521	.7156	.8980	1.0788	1.2600	1.4436	1.6323	1.8292	2.0381	2.2631	2.42
55	2.2516	.8142	1.0168	1.2260	1.4455	1.6799	1.9341	2.2143	2.5269	2.8804	2.54

$l_{(2)}$ = 900 Alpha = -0.5265 Growth Rate = 3.25% Mean Age at Birth of all Children = 26.93

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH IF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.3382	.3290	.3880	.4380	.4798	.5145	.5437	.5697	.5946	.6205	.64
15	.3652	.3357	.4066	.4698	.5261	.5767	.6232	.6676	.7119	.7574	.80
20	.4083	.3322	.4212	.5034	.5796	.6510	.7168	.7846	.8498	.9154	.9
25	.4547	.3257	.4370	.5415	.6399	.7330	.8220	.9080	.9922	1.0752	1.15
30	.5039	.3179	.4521	.5785	.6979	.8110	.9188	1.0221	1.1220	1.2189	1.3
35	.5594	.3063	.4612	.6072	.7450	.8752	.9987	1.1163	1.2288	1.3369	1.4
40	.6254	.3217	.4928	.6539	.8054	.9484	1.0837	1.2125	1.3357	1.4543	1.5
45	.7138	.3232	.5079	.6817	.8458	1.0014	1.1495	1.2916	1.4289	1.5627	1.6
50	.8362	.3666	.5592	.7420	.9163	1.0840	1.2470	1.4076	1.5686	1.7328	1.9
55	1.0192	.3771	.5763	.7693	.9589	1.1486	1.3418	1.5425	1.7548	1.9832	2.2

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0 Low Fertility Model

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 1.85% Mean Age at Birth of all Children = 26.44

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.5727	.3503	.4093	.4599	.5028	.5393	.5709	.5997	.6277	.6565	.6
15	.6317	.3672	.4390	.5037	.5629	.6151	.6646	.7122	.7598	.8085	.85
20	.7242	.3830	.4728	.5562	.6342	.7077	.7781	.8467	.9149	.9835	1.0
25	.8268	.4031	.5137	.6180	.7170	.8113	.9020	.9905	1.0775	1.1640	1.2
30	.9337	.4263	.5574	.6819	.8006	.9141	1.0235	1.1299	1.2342	1.3370	1.4
35	1.0595	.4482	.5976	.7400	.8764	1.0076	1.1345	1.2583	1.3798	1.4999	1.6
40	1.2160	.4980	.6618	.8192	.9712	1.1188	1.2633	1.4064	1.5493	1.6935	1.8
45	1.4256	.5388	.7156	.8842	1.0580	1.2265	1.3957	1.5675	1.7439	1.9274	2.1
50	1.7270	.6299	.8196	1.0100	1.2033	1.4024	1.6107	1.8324	2.0728	2.3382	2.6
55	2.1800	.7103	.9188	1.1385	1.3747	1.6333	1.9221	2.2500	2.6280	3.0694	3.5

$l_{(2)}$ = 875 Alpha = -0.2578 Growth Rate = 2.07% Mean Age at Birth of all Children = 26.41

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.4652	.3378	.3996	.4528	.4982	.5368	.5703	.6007	.6301	.6601	.
15	.5129	.3489	.4241	.4918	.5530	.6087	.6604	.7101	.7592	.8093	.
20	.5887	.3569	.4505	.5374	.6186	.6951	.7679	.8386	.9084	.9782	1.
25	.6718	.3676	.4826	.5909	.6933	.7906	.8838	.9741	1.0625	1.1497	1.
30	.7613	.3808	.5167	.6453	.7674	.8837	.9952	1.1029	1.2076	1.3101	1.
35	.8660	.3923	.5466	.6930	.8324	.9657	1.0937	1.2175	1.3379	1.4559	1.
40	.9957	.4317	.6000	.7606	.9144	1.0624	1.2060	1.3465	1.4854	1.6239	1.
45	1.1698	.4580	.6384	.8125	.9820	1.1483	1.3132	1.4785	1.6462	1.8184	1.
50	1.4223	.5297	.7199	.9083	1.0969	1.2883	1.4856	1.6925	1.9137	2.1548	2.
55	1.8113	.5832	.7862	.9962	1.2178	1.4566	1.7191	2.0132	2.3481	2.7351	3.

TABLE A.1.3.1 (Continued)

FUNCTION ESTIMATED : $l_{(20+x)}/l_{(20)}$ BETA = 1.0 Low Fertility Model

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 1.85% Mean Age at Birth of all Children = 26.44

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.5727	[illegible]	.4091	.4599	.5028	.5393	.5709	.5947	.6277	.6565	.63
15	.6417	.3672	.4390	.5037	.5629	.6151	.6646	.7122	.7598	.8085	.85
20	.7742	.3430	.4728	.5562	.6342	.7077	.7781	.8467	.9149	.9835	1.05
25	[illegible]	.4331	.5137	.6180	.7170	.8113	.9020	.9905	1.0775	1.1640	1.25
30	.9337	.4251	.5574	.6819	.9006	.9141	1.0215	1.1299	1.2342	1.3370	1.43
35	1.0595	.4442	.5976	.7400	.8764	1.0076	1.1345	1.2583	1.3798	1.4999	1.61
40	1.2140	.4940	.6618	.8192	.9712	1.1188	1.2633	1.4064	1.5493	1.6935	1.84
45	1.4256	.5388	.7156	.8842	1.0580	1.2265	1.3957	1.5675	1.7439	1.9274	2.13
50	. .7270	.6239	.8196	1.0100	1.2033	1.4024	1.6107	1.8324	2.0728	2.3387	2.63
55	2.1896	.7103	.9188	1.1385	1.3747	1.6333	1.9221	2.2500	2.6280	3.0694	3.5

$l_{(2)}$ = 875 Alpha = -0.2578 Growth Rate = 2.07% Mean Age at Birth of all Children = 26.41

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.4652	.3374	.3996	.4529	.4982	.5368	.5703	.6007	.6301	.6601	.6
15	.5129	.3444	.4241	.4918	.5530	.6087	.6604	.7101	.7592	.8093	.
20	.5837	.3569	.4505	.5374	.6186	.6951	.7679	.8386	.9084	.9782	1.
25	.6719	.3676	.4826	.5909	.6933	.7906	.8838	.9741	1.0625	1.1497	1.
30	.7513	.3804	.5167	.6453	.7674	.8837	.9952	1.1029	1.2076	1.3101	1.
35	.8660	.3923	.5466	.6930	.8324	.9657	1.0937	1.2175	1.3379	1.4559	1.
40	.9957	.4317	.6000	.7606	.9144	1.0624	1.2060	1.3465	1.4854	1.6239	1.
45	1.1698	.4580	.6384	.8125	.9820	1.1483	1.3132	1.4785	1.6462	1.8184	1.
50	1.4223	.5297	.7199	.9083	1.0969	1.2883	1.4856	1.6925	1.9137	2.1548	2.
55	1.9113	.5432	.7862	.9962	1.2178	1.4566	1.7191	2.0132	2.3481	2.7351	3.

TABLE A.[illegible] (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 0.8

$l_{(2)}$ = 850 Alpha = -0.2951 Growth Rate = 2.70% Mean Age at Birth of all Children = 27.09

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.5371	[illegible]	.3148	.3861	.4247	.4567	.4839	.5086	.5329	.5586	.5466
15	.5811	[illegible]	.2575	.3191	.3745	.4253	.4729	.5192	.5660	.6147	.6661
20	.6447	.0441	.1307	.2233	.3048	.3824	.4574	.5312	.6052	.6800	.7563
25	[illegible]	[illegible]	-.0035	.1150	.2280	.3365	.4415	.5440	.6449	.7450	.8444
30	.7977	[illegible]	-.1446	.0069	.1516	.2901	.4234	.5523	.6776	.8000	.9197
35	[illegible]	-.4438	-.2356	-.0565	.1141	.2771	.4332	.5833	.7283	.8686	1.0048
40	.9951	[illegible]	-.3233	-.1209	.0716	.2549	.4300	.5981	.7602	.9173	1.0703
45	1.1244	-.5376	-.3326	-.1188	.0848	.2794	.4666	.6475	.8237	.9966	1.1678
50	1.3213	-.5701	-.3512	-.1343	.0738	.2749	.4707	.6635	.8558	1.0505	1.2513
55	1.6172	-.5384	-.2992	-.0973	.1000	.2955	.4929	.6959	.9087	1.1359	1.3829

$l_{(2)}$ = 900 Alpha = -0.5265 Growth Rate = 3.25% Mean Age at Birth of all Children = 26.93

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.3382	.2459	.3057	.3567	.3995	.4354	.4659	.4934	.5201	.5478	.5776
15	.3652	.1308	.2056	.2731	.3342	.3899	.4419	.4920	.5422	.5939	.6479
20	.4083	-.0378	.0627	.1569	.2455	.3296	.4104	.4894	.5678	.6466	.7263
25	.4547	-.2379	-.1029	.0255	.1478	.2647	.3772	.4862	.5928	.6977	.8010
30	.5039	-.4445	-.2714	-.1068	.0498	.1990	.3416	.4784	.6104	.7379	.8615
35	.5594	-.5955	-.3887	-.1931	-.0077	.1681	.3351	.4941	.6458	.7909	.9297
40	.6264	-.7422	-.5054	-.2820	-.0713	.1273	.3148	.4922	.6605	.8208	.9740
45	.7138	-.7930	-.5387	-.3001	-.0760	.1350	.3342	.5231	.7029	.8751	1.0412
50	.8362	-.8455	-.5849	-.3404	-.1102	.1071	.3133	.5106	.7015	.8886	1.0752
55	1.0192	-.7971	-.5552	-.3279	-.1127	.0935	.2939	.4924	.6926	.8986	1.1145

TABLE A.3.3. 1 (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0 $l_{(2)}$ = 800 ALPHA = 0.0221 GROWTH RATE = 2.00% ALL BIRTH MEAN = 27.19

Firstbirth Function with Early Peak, 17½ Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2979	.3521	.3982	.4368	.4692	.4973	.5236	.5500	.5782	.6091
15	.9050	.2136	.2825	.3447	.4012	.4529	.5021	.5506	.6000	.6517	.7050
20	1.0358	.0976	.1697	.2762	.3581	.4363	.5123	.5877	.6637	.7410	.8197
25	1.1774	-.0297	.0915	.2072	.3181	.4250	.5291	.6316	.7334	.8350	.9355
30	1.[illegible]07	-.1475	.0027	.1466	.2849	.4184	.5481	.6751	.8002	.9242	1.0472
35	1.5094	-.2043	-.0321	.1332	.2925	.4469	.5973	.7449	.8904	1.0348	1.1787
40	1.7329	-.2451	-.0574	.1240	.2997	.4710	.6392	.8057	.9722	1.1400	1.3105
45	2.0334	-.1968	-.0054	.1814	.3655	.5484	.7321	.9188	1.1104	1.3095	1.3408
50	2.4605	-.1475	.0403	.2283	.4186	.6136	.8167	1.0316	1.2634	1.5179	1.2745
55	3.6779	-.0320	.1438	.3269	.5216	.7332	.9682	1.2343	1.5412	1.5907	1.0833

Firstbirth Function with Late Peak, 17½ Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2925	.3459	.3915	.4304	.4640	.4939	.5218	.5497	.5787	.6097
15	.9050	.2088	.2769	.3389	.3958	.4489	.4996	.5496	.6003	.6524	.7068
20	1.0358	.0936	.1651	.2717	.3540	.4333	.5108	.5875	.6643	.7420	.8207
25	1.1774	-.0326	.0884	.2042	.3156	.4235	.5286	.6320	.7344	.8362	.9378
30	1.3307	-.1491	.0008	.1448	.2834	.4176	.5481	.6758	.8013	.9254	1.0483
35	1.5094	-.2055	-.0333	.1323	.2923	.4473	.5982	.7462	.8920	1.0365	1.1605
40	1.7329	-.2443	-.0567	.1245	.3003	.4719	.6404	.8074	.9741	1.1419	1.3124
45	2.0334	-.1967	-.0052	.1820	.3666	.5500	.7341	.9209	1.1127	1.3119	1.3437
50	2.4605	-.1457	.0421	.2300	.4201	.6151	.8183	1.0335	1.2658	1.5209	1.2779
55	3.6779	-.0332	.1422	.3253	.5202	.7322	.9675	1.2338	1.5406	1.5900	1.0827

TABLE A.3.3.1 (Continued)

FUNCTION ESTIMATED : $l_{(25+X)}/l_{(25)}$ BETA = 1.0 $l_{(2)}$ = 800 ALPHA = 0.0221 GROWTH RATE = 2.00% ALL BIRTH MEAN = 27.[illegible]

Standard Firstbirth Function over 15 Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.3074	.3595	.4028	.4383	.4679	.4940	.5189	.5447	.5727	.6034
15	.9050	.2149	.2654	.3449	.3986	.4480	.4954	.5427	.5917	.6433	.6975
20	1.0359	.0475	.1674	.2718	.3513	.4276	.5024	.5772	.6530	.7304	.8093
25	1.1774	-.0152	.0665	.1988	.3082	.4140	.5176	.6198	.7217	.8236	.9255
30	1.3307	-.1061	-.0667	.1363	.2738	.4066	.5361	.6631	.7886	.9130	1.0364
35	1.5094	-.2144	-.0427	.1223	.2815	.4359	.5865	.7344	.8803	1.0250	1.1691
40	1.7329	-.2531	-.0650	.1165	.2922	.4635	.6318	.7986	.9654	1.1335	1.3042
45	2.0334	-.2001	-.0088	.1781	.3623	.5457	.7299	.9168	1.1085	1.3075	1.3885
50	2.4605	-.1440	.0446	.2332	.4239	.6191	.8223	1.0376	1.2699	1.5254	1.2835
55	3.0779	-.0209	.1545	.3373	.5321	.7441	.9799	1.2474	1.5561	1.6080	1.1039

Standard Firstbirth Function over 20 Year Range

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.2833	.3395	.3882	.4302	.4665	.4984	.5278	.5563	.5857	.6168
15	.9050	.2047	.2756	.3406	.4002	.4558	.5083	.5593	.6105	.6629	.7172
20	1.0359	.0957	.1897	.2787	.3633	.4444	.5230	.6003	.6772	.7547	.8332
25	1.1774	-.0246	.0979	.2152	.3280	.4369	.5426	.6461	.7482	.8497	.9508
30	1.3307	-.1360	.0129	.1578	.2971	.4316	.5623	.6898	.8150	.9386	1.0612
35	1.5094	-.1931	-.0206	.1451	.3050	.4599	.6106	.7582	.9036	1.0477	1.1913
40	1.7329	-.2354	-.0482	.1329	.3087	.4801	.6485	.8151	.9815	1.1491	1.3196
45	2.0334	-.1934	-.0021	.1848	.3689	.5519	.7357	.9223	1.1139	1.3132	1.3951
50	2.4605	-.1518	.0353	.2227	.4127	.6076	.8107	1.0257	1.2574	1.5114	1.2669
55	3.0779	-.0465	.1294	.3129	.5079	.7195	.9540	1.2190	1.5240	1.5711	1.0609

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(25+N)}/l_{(25)}$ BETA = 1.0 $l_{(2)}$ = 800 ALPHA = 0.0221

High Fertility Model. Birth Interval = 2.2 years Growth Rate = 2.72% All Birth Mean = 26.18

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.6779	.2814	.3371	.3843	.4238	.4565	.4848	.5108	.5369	.5645	.5943
15	.7474	.1894	.2595	.3226	.3798	.4319	.4811	.5293	.5783	.6295	.6833
20	.8567	.0614	.1547	.2473	.3250	.4036	.4799	.5552	.6310	.7081	.7665
25	.9764	-.0808	.0420	.1591	.2711	.3787	.4834	.5862	.6881	.7899	.8915
30	1.1057	-.2165	-.0641	.0819	.2219	.3566	.4872	.6148	.7403	.8644	.9874
35	1.2546	-.2927	-.1178	.0499	.2111	.3668	.5181	.6660	.8115	.9552	1.0983
40	1.4347	-.3559	-.1653	.0183	.1956	.3676	.5357	.7012	.8656	1.0303	1.1963
45	1.6825	-.3319	-.1388	.0487	.2321	.4130	.5933	.7746	.9591	1.1487	1.3459
50	2.0235	-.3100	-.1237	.0609	.2453	.4320	.6230	.8218	1.0323	1.2594	1.5093
55	2.5107	-.2238	-.0561	.1147	.2917	.4793	.6826	.9075	1.1612	1.4525	1.7923

Low Fertility Model. Birth Interval = 3.0 years Growth Rate = 1.43% All Birth Mean = 27.36

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.9262	.3057	.3580	.4027	.4410	.4742	.5041	.5321	.5603	.5896	.6213
15	1.0284	.2281	.2953	.3566	.4131	.4660	.5167	.5670	.6179	.6705	.7252
20	1.1755	.1222	.2129	.2988	.3807	.4599	.5373	.6141	.6911	.7689	.8475
25	1.3319	.0084	.1282	.2429	.3535	.4608	.5655	.6686	.7707	.8724	.9733
30	1.5016	-.0940	.0542	.1965	.3338	.4669	.5966	.7237	.8488	.9726	1.095-
35	1.7003	-.1360	.0339	.1977	.3560	.5098	.6599	.8073	.9530	1.0977	1.2239
40	1.9.47	-.1595	.0257	.2050	.3795	.5503	.7187	.8862	1.0541	1.2239	1.2625
45	2.2855	-.0991	.0910	.2777	.4626	.6473	.8339	1.0242	1.2209	1.4268	1.2423
50	2.7571	-.0361	.1524	.3422	.5358	.7362	.9468	1.1721	1.4175	1.5876	1.0843
55	3.4236	.0799	.2607	.4519	.6581	.8850	1.1398	1.4310	1.7698	1.2031	1.1013

TABLE A.3.1. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 650 Alpha = 0.4057 Growth Rate = 1.15% Mean Age at Birth of all Children = 27.33

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.6796	.4308	.4763	.5071	.5324	.5539	.5736	.5934	.6148	.6387	.6654
15	1.8575	.5007	.5486	.5914	.6304	.6672	.7039	.7417	.7821	.8254	.8565
20	2.0918	.5793	.6434	.7039	.7619	.8188	.8761	.9351	.9963	1.0601	1.0471
25	2.3350	.6764	.7601	.8410	.9201	.9986	1.0775	1.1578	1.2401	1.3247	1.1965
30	2.5916	.7871	.8915	.9936	1.0944	1.1950	1.2965	1.3996	1.5052	1.6134	1.2681
35	2.8818	.9070	1.0325	1.1569	1.2811	1.4065	1.5341	1.6650	1.8003	1.7869	1.3396
40	3.2274	1.0685	1.2172	1.3673	1.5205	1.6786	1.8432	2.0164	2.1998	1.7970	1.4426
45	3.6553	1.2483	1.4286	1.6160	1.8133	2.0230	2.2484	2.4935	2.7627	1.4796	1.5272
50	4.1868	1.5261	1.7580	2.0100	2.2879	2.5988	2.9513	3.3562	2.5038	1.5604	1.3367
55	4.8223	1.8520	2.1800	2.5576	2.9976	3.5164	4.1345	4.2531	1.5401	1.6493	.4439

$l_{(2)}$ = 700 Alpha = 0.2916 Growth Rate = 1.35% Mean Age at Birth of all Children = 27.31

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.3676	.4191	.4617	.4972	.5264	.5510	.5729	.5941	.6163	.6407	.6578
15	1.5152	.4702	.5235	.5711	.6141	.6541	.6929	.7323	.7734	.8172	.8539
20	1.7179	.5337	.6032	.6683	.7301	.7901	.8495	.9097	.9717	1.0359	1.0374
25	1.9315	.6123	.7014	.7868	.8693	.9502	1.0307	1.1119	1.1945	1.2768	1.2376
30	2.1599	.7017	.8111	.9171	1.0206	1.1230	1.2251	1.3279	1.4323	1.5387	1.4486
35	2.4212	.7381	.9274	1.0542	1.1797	1.3049	1.4310	1.5590	1.6899	1.8249	1.5124
40	2.7378	.9347	1.0843	1.2337	1.3843	1.5377	1.6956	1.8598	2.0318	2.1662	1.4331
45	3.1466	1.0868	1.2630	1.4440	1.6320	1.8294	2.0390	2.2641	2.5087	2.1396	1.5796
50	3.4751	1.3282	1.5468	1.7803	2.0341	2.3142	2.6281	2.9842	3.3950	1.6399	1.7337
55	4.3428	1.6214	1.9198	2.2595	2.6517	3.1102	3.6516	4.3006	2.6420	1.7365	1.2315

TABLE A.3.3. 1 (Continued)

FUNCTION ESTIMATED : $l_{(20+x)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 750 Alpha = 0.1659 Growth Rate = 1.62% Mean Age at Birth of all Children = 27.27

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.0804	.3980	.4460	.4862	.5196	.5475	.5719	.5950	.6185	.6439	.6716
15	1.1974	.4378	.4969	.5496	.5971	.6408	.6823	.7236	.7662	.8110	.8585
20	1.3649	.4852	.5608	.6314	.6979	.7614	.8237	.8859	.9493	1.0144	1.0813
25	1.5441	.5441	.6395	.7303	.8174	.9019	.9851	1.0679	1.1513	1.2359	1.3216
30	1.7372	.6117	.7271	.8381	.9456	1.0506	1.1543	1.2577	1.3614	1.4662	1.5635
35	1.9605	.6843	.8187	.9492	1.0769	1.2029	1.3282	1.4540	1.5812	1.7108	1.7271
40	2.2373	.7433	.9457	1.0959	1.2454	1.3954	1.5478	1.7040	1.8659	2.0349	1.8333
45	2.6016	.9124	1.0861	1.2619	1.4417	1.6277	1.8223	2.0283	2.2490	2.4882	1.7423
50	3.0971	1.1153	1.3210	1.5377	1.7692	2.0204	2.2977	2.6083	2.9614	2.6610	1.7830
55	3.7650	1.3563	1.6229	1.9217	2.2616	2.6547	3.1149	3.6600	4.1948	1.7979	1.9858

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 27.18

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.8174	.3743	.4277	.4729	.5108	.5427	.5703	.5959	.6213	.6481	.6771
15	.9050	.4031	.4683	.5266	.5791	.6269	.6719	.7159	.7605	.8070	.8557
20	1.0358	.4347	.5171	.5935	.6652	.7332	.7989	.8638	.9290	.9956	1.0636
25	1.1774	.4737	.5762	.6732	.7657	.8545	.9410	1.0262	1.1112	1.1964	1.2822
30	1.3307	.5185	.6411	.7583	.8709	.9796	1.0858	1.1904	1.2942	1.3980	1.5020
35	1.5094	.5658	.7068	.8427	.9741	1.1022	1.2280	1.3526	1.4768	1.6017	1.7231
40	1.7329	.6468	.8037	.9566	1.1064	1.2546	1.4025	1.5518	1.7041	1.8608	2.0234
45	2.0314	.7308	.9044	1.0773	1.2510	1.4275	1.6088	1.7972	1.9955	2.2068	2.2318
50	2.4605	.8858	1.0520	1.2844	1.4960	1.7208	1.9635	2.2300	2.5277	2.8651	2.2519
55	3.0779	1.0684	1.3061	1.5664	1.8569	2.1864	2.5661	3.0096	3.5341	3.4268	2.0317

TABLE A.3.1. 1 (Continued)

FUNCTION ESTIMATED : $l_{(20+X)}/l_{(20)}$ BETA = 1.0

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 2.55% Mean Age at Birth of all Children = 27.06

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.5779	.3486	.4075	.4579	.5006	.5367	.5681	.5966	.6245	.6532	.6838
15	.6393	.3653	.4370	.5015	.5595	.6123	.6615	.7090	.7564	.8050	.8556
20	.7324	.3808	.4704	.5537	.6314	.7047	.7749	.8434	.9115	.9801	1.0496
25	.8353	.4006	.5111	.6154	.7142	.8083	.8990	.9874	1.0745	1.1610	1.2472
30	.9481	.4241	.5552	.6796	.7982	.9117	1.0212	1.1276	1.2320	1.3356	1.4370
35	1.0789	.4470	.5964	.7389	.8754	1.0067	1.1338	1.2578	1.3795	1.4999	1.6198
40	1.2423	.4994	.6635	.8211	.9733	1.1212	1.2662	1.4098	1.5533	1.6982	1.8459
45	1.4647	.5467	.7241	.8972	1.0677	1.2372	1.4076	1.5807	1.7589	1.9447	2.1410
50	1.7897	.6515	.8426	1.0348	1.2305	1.4326	1.6449	1.8719	2.1191	2.3934	2.7326
55	2.2912	.7636	.9777	1.2048	1.4506	1.7218	2.0266	2.3751	2.7793	3.2547	3.1116

$l_{(2)}$ = 900 Alpha = -0.3834 Growth Rate = 3.15% Mean Age at Birth of all Children = 26.91

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.3636	.3225	.3870	.4427	.4903	.5309	.5661	.5980	.6286	.6597	.6923
15	.4007	.3271	.4056	.4764	.5403	.5985	.6524	.7039	.7546	.8060	.8538
20	.4610	.3265	.4240	.5146	.5991	.6783	.7536	.8264	.8979	.9691	1.0434
25	.5273	.3272	.4467	.5592	.6653	.7657	.8615	.9538	1.0437	1.1318	1.2135
30	.5994	.3297	.4709	.6041	.7300	.8494	.9631	1.0723	1.1778	1.2802	1.3811
35	.6813	.3307	.4907	.6419	.7849	.9207	1.0502	1.1742	1.2937	1.4096	1.5226
40	.7877	.3594	.5335	.6984	.8549	1.0041	1.1473	1.2856	1.4206	1.5536	1.6857
45	.9291	.3753	.5607	.7379	.9081	1.0730	1.2342	1.3934	1.5524	1.7135	1.8739
50	1.1374	.4338	.6267	.8153	1.0010	1.1864	1.3744	1.5684	1.7726	1.9921	2.2328
55	1.4696	.4726	.6748	.8802	1.0930	1.3104	1.5625	1.8323	2.1362	2.4842	2.8849

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.3

$l_{(2)}$ = 650 Alpha = 0.6202 Growth Rate = 0.69% Mean Age at Birth of all Children = 27.25

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN									
		17	18	19	20	21	22	23	24	25	26
10	1.8668	.4495	.4884	.5209	.5483	.5721	.5945	.6171	.6412	.6677	.6963
15	2.1253	.5235	.5735	.6189	.6610	.7013	.7417	.7834	.8275	.8744	.8859
20	2.4634	.6246	.6913	.7550	.8169	.8783	.9406	1.0047	1.0714	1.1400	1.0469
25	2.8136	.7551	.8418	.9266	1.0107	1.0953	1.1815	1.2702	1.3619	1.4297	1.1250
30	3.1809	.9091	1.0183	1.1270	1.2366	1.3482	1.4629	1.5818	1.7057	1.5390	1.2349
35	3.5874	1.0927	1.2179	1.3554	1.4968	1.6436	1.7973	1.9597	2.1327	1.4377	1.3252
40	4.0526	1.3136	1.4835	1.6617	1.8505	2.0530	2.2722	2.5117	2.2868	1.3683	1.3327
45	4.5874	1.5794	1.8040	2.0487	2.3182	2.6186	2.9573	3.3439	1.7075	1.4166	.6751
50	5.1790	1.9707	2.2933	2.6641	3.0969	3.6093	4.2241	3.2313	1.4146	1.2530	.2641
55	5.7824	2.4051	2.9053	3.5163	4.2718	5.2170	6.2055	1.3590	1.4276	.6301	.3547

$l_{(2)}$ = 800 Alpha = 0.2366 Growth Rate = 1.75% Mean Age at Birth of all Children = 27.09

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN									
		17	18	19	20	21	22	23	24	25	26
10	.9103	.3764	.4341	.4838	.5264	.5630	.5955	.6258	.6558	.6868	.7195
15	1.0410	.4109	.4817	.5459	.6043	.6580	.7089	.7585	.8086	.8600	.9133
20	1.2397	.4576	.5456	.6281	.7058	.7801	.8520	.9232	.9947	1.0671	1.1413
25	1.4604	.5209	.6282	.7306	.8289	.9241	1.0175	1.1101	1.2029	1.2967	1.3913
30	1.7063	.5985	.7250	.8472	.9661	1.0827	1.1982	1.3139	1.4306	1.5493	1.6705
35	1.9998	.6876	.8326	.9750	1.1158	1.2562	1.3977	1.5418	1.6898	1.8433	1.9457
40	2.3732	.8225	.9874	1.1532	1.3214	1.4942	1.6738	1.8629	2.0643	2.2807	2.0482
45	2.8711	.9806	1.1733	1.3744	1.5869	1.8144	2.0611	2.3321	2.6337	2.9741	1.7615
50	3.5359	1.2489	1.4933	1.7626	2.0641	2.4076	2.8056	3.2744	3.8349	2.6395	1.9171
55	4.3661	1.5802	1.9319	2.3498	2.8543	3.4722	4.2390	5.2027	3.9641	1.9079	1.3431

TABLE A.1.1. 1 (Continued)

FUNCTION ESTIMATED : $l_{(20+x)}/l_{(20)}$ BETA = 1.3

$l_{(2)}$ = 900 Alpha = -0.1689 Growth Rate = 3.00% Mean Age at Birth of all Children = 26.85

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.4056	.3149	.3866	.4496	.5047	.5528	.5954	.6345	.6719	.7092	.7475
15	.4607	.3188	.4067	.4869	.5601	.6274	.6902	.7500	.8085	.8667	.9256
20	.5526	.3251	.4326	.5330	.6270	.7154	.7995	.8805	.9595	1.0376	1.1151
25	.6585	.3394	.4678	.5890	.7036	.8123	.9161	1.0163	1.1138	1.2094	1.3036
30	.7777	.3603	.5080	.6481	.7812	.9081	1.0300	1.1480	1.2631	1.3761	1.4878
35	.9224	.3830	.5469	.7032	.8529	.9970	1.1368	1.2733	1.4079	1.5418	1.6763
40	1.1119	.4362	.6122	.7821	.9472	1.1089	1.2690	1.4296	1.5926	1.7603	1.9349
45	1.3835	.4843	.6714	.8565	1.0418	1.2295	1.4225	1.6238	1.8366	2.0654	2.3151
50	1.8057	.5988	.8001	1.0081	1.2264	1.4598	1.7140	1.9967	2.3177	2.6894	3.1277
55	2.4865	.7413	.9734	1.2313	1.5245	1.8656	2.2702	2.7589	3.3584	4.1046	3.9573

BETA = 0.8

$l_{(2)}$ = 650 Alpha = 0.2626 Growth Rate = 1.42% Mean Age at Birth of all Children = 27.38

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	1.5649	.4317	.4675	.4963	.5194	.5384	.5554	.5725	.5912	.6125	.6359
15	1.6960	.4844	.5317	.5715	.6074	.6410	.6741	.7085	.7454	.7855	.8240
20	1.8692	.5514	.6125	.6696	.7240	.7770	.8303	.8851	.9423	1.0021	1.0250
25	2.0472	.6287	.7094	.7867	.8617	.9356	1.0095	1.0845	1.1611	1.2396	1.2039
30	2.2338	.7128	.8139	.9119	1.0076	1.1019	1.1962	1.2910	1.3871	1.4845	1.3457
35	2.4441	.7992	.9201	1.0381	1.1542	1.2693	1.3845	1.5005	1.6182	1.7382	1.4118
40	2.6961	.9182	1.0579	1.1960	1.3334	1.4716	1.6118	1.7553	1.9033	1.9979	1.4341
45	3.0146	1.0433	1.2052	1.3683	1.5344	1.7051	1.8822	2.0679	2.2646	2.0350	1.5230
50	3.4300	1.2411	1.4332	1.6334	1.8445	2.0704	2.3153	2.5845	2.8840	1.8331	1.6513
55	3.9729	1.4682	1.7138	1.9828	2.2816	2.6173	2.9989	3.4374	2.9973	1.6600	1.7626

TABLE A.3.3. 1 (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 0.8

$l_{(2)}$ = 800 Alpha = -0.1210 Growth Rate = 2.17% Mean Age at Birth of all Children = 27.26

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.7601	.3401	.4101	.4718	.5062	.5345	.5585	.5804	.6020	.6250	.6515
15	.8237	.4073	.4677	.5211	.5688	.6119	.6521	.6914	.7314	.7735	.8131
20	.9180	.4319	.5088	.5799	.6463	.7091	.7694	.8295	.8899	.9517	1.0154
25	1.0177	.4590	.5563	.6482	.7355	.8192	.9003	.9802	1.0597	1.1394	1.2147
30	1.1233	.4869	.6052	.7178	.8253	.9288	1.0291	1.1271	1.2238	1.3197	1.4150
35	1.2435	.5125	.6501	.7816	.9077	1.0292	1.1471	1.2622	1.3754	1.4872	1.5934
40	1.3901	.5663	.7198	.8672	1.0094	1.1472	1.2818	1.4144	1.5462	1.6780	1.8138
45	1.5824	.6138	.7821	.9455	1.1052	1.2626	1.4188	1.5756	1.7345	1.8972	2.0659
50	1.8521	.7156	.8980	1.0788	1.2600	1.4436	1.6323	1.8292	2.0381	2.2631	2.4231
55	2.2516	.8142	1.0168	1.2260	1.4455	1.6799	1.9341	2.2143	2.5269	2.8804	2.5415

$l_{(2)}$ = 900 Alpha = -0.5265 Growth Rate = 3.25% Mean Age at Birth of all Children = 26.93

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH IF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.3382	.3290	.3880	.4380	.4798	.5145	.5437	.5697	.5946	.6205	.6464
15	.3552	.3357	.4066	.4698	.5261	.5767	.6232	.6676	.7119	.7574	.8051
20	.4083	.3122	.4212	.5034	.5796	.6510	.7168	.7846	.8498	.9154	.9820
25	.4547	.3257	.4370	.5415	.6399	.7330	.8220	.9080	.9922	1.0752	1.1575
30	.5039	.3179	.4521	.5785	.6979	.8110	.9188	1.0221	1.1220	1.2189	1.3132
35	.5594	.3063	.4612	.6072	.7450	.8752	.9987	1.1163	1.2288	1.3369	1.4438
40	.6264	.3217	.4928	.6539	.8054	.9484	1.0837	1.2125	1.3357	1.4543	1.5649
45	.7138	.3232	.5079	.6817	.8458	1.0014	1.1495	1.2916	1.4289	1.5627	1.6946
50	.8362	.3566	.5592	.7420	.9163	1.0840	1.2470	1.4076	1.5686	1.7328	1.9036
55	1.0192	.3771	.5763	.7693	.9589	1.1486	1.3418	1.5425	1.7548	1.9832	2.2328

TABLE A.1.3.1 (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0 **Low Fertility Model**

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 1.85% Mean Age at Birth of all Children = 26.44

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.5727	[illegible]	.4093	.4599	.5028	.5393	.5709	.5997	.6277	.6565	.6871
15	.6317	.3672	.4390	.5037	.5620	.6151	.6646	.7122	.7598	.8085	.8590
20	.7242	.3430	.4720	.5562	.6342	.7077	.7781	.8467	.9149	.9835	1.0530
25	[illegible]	.4071	.5137	.6180	.7170	.8113	.9020	.9905	1.0775	1.1640	1.2501
30	.9337	.4263	.5574	.6819	.8006	.9141	1.0215	1.1299	1.2342	1.3378	1.4388
35	1.0595	.4442	.5976	.7400	.8764	1.0076	1.1345	1.2583	1.3798	1.4999	1.6195
40	1.2160	.4949	.6618	.8192	.9712	1.1188	1.2633	1.4064	1.5493	1.6935	1.8404
45	1.4256	.5388	.7156	.8842	1.0580	1.2265	1.3957	1.5675	1.7439	1.9274	2.1209
50	1.7270	.6239	.8196	1.0100	1.2033	1.4024	1.6107	1.8324	2.0728	2.3382	2.6361
55	2.1890	.7103	.9188	1.1385	1.3747	1.6333	1.9221	2.2500	2.6280	3.0694	3.5913

$l_{(2)}$ = 875 Alpha = -0.2578 Growth Rate = 2.07% Mean Age at Birth of all Children = 26.41

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	17	18	19	20	21	22	23	24	25	26
10	.4652	.3374	.3996	.4529	.4982	.5368	.5703	.6007	.6301	.6601	.6917
15	.5129	.3449	.4241	.4918	.5530	.6087	.6604	.7101	.7592	.8093	.8609
20	.5887	.3569	.4505	.5374	.6186	.6951	.7679	.8386	.9084	.9782	1.0486
25	.6719	.3676	.4826	.5909	.6933	.7906	.8838	.9741	1.0625	1.1497	1.2360
30	.7613	.3804	.5167	.6453	.7674	.8837	.9952	1.1029	1.2076	1.3101	1.4110
35	.8660	.3923	.5466	.6930	.8324	.9657	1.0937	1.2175	1.3379	1.4559	1.5723
40	.9957	.4317	.6009	.7606	.9144	1.0624	1.2060	1.3465	1.4854	1.6239	1.7534
45	1.1694	[illegible]	.6384	.8125	.9820	1.1493	1.3132	1.4785	1.6462	1.8184	1.9978
50	1.4223	.5297	.7199	.9083	1.0969	1.2883	1.4856	1.6925	1.9137	2.1548	2.4221
55	1.8113	.5432	.7662	.9962	1.2178	1.4566	1.7191	2.0132	2.3481	2.7351	3.1384

TABLE A.3.1. 1 (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0 Low Fertility Model

$l_{(2)}$ = 900 Alpha = -0.3834 Growth Rate = 2.29% Mean Age at Birth of all Children = 26.37

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	[illegible]	[illegible]	.3898	.4456	.4934	.5343	.5699	.6020	.6329	.6641	.6969
15	[illegible]	[illegible]	.4090	.4799	.5440	.6024	.6566	.7083	.7592	.8107	.8635
20	[illegible]	[illegible]	.4281	.5149	.6034	.6829	.7583	.8312	.9028	.9746	[illegible]
25	[illegible]	[illegible]	.4517	.5642	.6703	.7708	.8666	.9589	1.0487	1.1367	1.2233
30	[illegible]	[illegible]	.4765	.6096	.7354	.8547	.9684	1.0774	1.1827	1.2856	1.3946
35	.6793	.3368	.4966	.6475	.7903	.9260	1.0552	1.1791	1.2984	1.4146	1.5267
40	.7917	[illegible]	.5391	.7036	.8598	1.0087	1.1516	1.2897	1.4244	1.5571	1.6388
45	.9135	.3795	.5645	.7412	.9111	1.0755	1.2363	1.3950	1.5536	1.7142	1.6789
50	1.1201	.4333	.6258	.8135	.9984	1.1828	1.3697	1.5623	1.7647	1.9817	2.2190
55	1.4337	.4585	.6547	.8617	1.0713	1.2927	1.5314	1.7943	2.0894	2.4258	2.8155

$l_{(2)}$ = 925 Alpha = -0.5410 Growth Rate = 2.52% Mean Age at Birth of all Children = 26.34

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	26
10	.2657	.3125	.3798	.4383	.4887	.5318	.5695	.6035	.6358	.6683	.7322
15	.2921	.3117	.3937	.4679	.5351	.5964	.6530	.7069	.7597	.8127	.8568
20	.3362	.3039	.4057	.5003	.5984	.6711	.7493	.8246	.8980	.9707	1.0430
25	.3849	.2965	.4209	.5373	.6479	.7517	.8504	.9449	1.0362	1.1250	1.2119
30	.4377	.2905	.4371	.5750	.7049	.8274	.9434	1.0539	1.1597	1.2614	1.3597
35	.4989	.2921	.4481	.6040	.7507	.8889	1.0195	1.1433	1.2613	1.3742	1.4827
40	.5746	.3011	.4812	.6504	.8095	.9596	1.1016	1.2370	1.3671	1.4938	1.6158
45	.6761	.3033	.4947	.6752	.8462	1.0092	1.1659	1.3178	1.4668	1.6147	1.7436
50	.8235	.3420	.5341	.7278	.9102	1.0885	1.2652	1.4434	1.6268	1.8194	2.0241
55	1.0545	.3407	.5417	.7404	.9404	1.1462	1.3628	1.5959	1.8523	2.1395	2.4458

TABLE A.3.3. : (Continued)

FUNCTION ESTIMATED : $l_{(20+N)}/l_{(20)}$ BETA = 1.0 Low Fertility Model

$l_{(2)}$ = 950 Alpha = -0.7570 Growth Rate = 2.74% Mean Age at Birth of all Children = 26.30

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 17	18	19	20	21	22	23	24	25	2[illegible]
10	.1730	.2995	.3697	.4309	.4839	.5295	.5692	.6051	.6391	.6730	.[illegible]082
15	.1900	.2928	.3784	.4560	.5264	.5905	.6499	.7061	.7608	.8155	.[illegible]711
20	.2147	.2771	.3833	.4820	.5738	.6599	.7411	.8188	.8943	.968[illegible]	1.[illegible]419
25	.2502	.2594	.3906	.5123	.6265	.7339	.8356	.9323	1.0252	1.115[illegible]	1.[illegible]020
30	.2856	.2459	.3987	.5419	.6762	.8022	.9208	1.0327	1.1389	1.2400	1.336[illegible]
35	.[illegible]	.2449	.4020	.5636	.7146	.8556	.9876	1.1112	1.2273	1.3366	1.[illegible]402
40	.3752	.2402	.4231	.6028	.7653	.9165	1.0576	1.1896	1.3138	1.4318	1.5435
45	.4414	.2336	.4334	.6189	.7917	.9532	1.1050	1.2488	1.3862	1.519[illegible]	1.[illegible]493
50	.5357	.2614	.4660	.6577	.8384	1.0105	1.1765	1.3391	1.5015	1.6674	1.[illegible]410
55	.[illegible]	.2168	.4436	.6419	.8354	1.0278	1.2238	1.4283	1.6466	1.8849	2.[illegible]503

Appendix 3.4

Full Weights for Paternal Orphanhood Reports of Eldest Surviving Children

Sets of weights for a variety of mortality and fertility conditions are reproduced in Table A.3.4. Three measures of mortality are given, the first and second parameters of the Brass model life table system, alpha and beta, and the life table survivors to age two of a radix of 1,000 births, $l_{(2)}$. Both the level and the age pattern of mortality are varied, from very high mortality, with an $l_{(2)}$ of 650 and beta of 1.3, to moderate mortality, with an $l_{(2)}$ of 900 and beta of 0.8, or from relatively heavy child mortality, with an $l_{(2)}$ of 650 and beta of 0.8, to relatively light child mortality, with an $l_{(2)}$ of 900 and beta of 1.3. The rate of population growth is varied to remain consistent with the mortality assumptions and a fixed fertility schedule with a total fertility rate of 6.5. Different estimating equations are used, both on a base of 30 years. Different fertility levels, birth intervals, and parity distributions are also introduced as specified on the tables.

The two means that are given require some explanation. The mean age at birth of all children is the mean age at childbearing in the stable population, when firstbirths all occur at exact age 25, and secondbirths exactly one mean birth interval later, and so on. The mean age at birth of eldest surviving children is the difference between the mean age at bearing what is an eldest surviving child at a given central age (in the stable population), and the mean age at bearing first children in the stable population, which is 25 throughout. Thus the mean age of mother at the birth of eldest surviving children aged 35 is the value shown in the relevant column plus 25 years.

TABLE A.3.4. : PATERNAL ORPHANHOOD WEIGHTS FOR ELDEST SURVIVING CHILDREN

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 650 Alpha = 0.4057 Growth Rate = 1.15% Mean Age at Birth of all Children = 32.65

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.7172	.6522	.6795	.7075	.7371	.7690	.8031	.8395	.8777	.9176	.9271
15	1.9030	.6306	.6816	.7340	.7884	.8451	.9041	.9650	1.0275	1.0913	1.0545
20	2.1475	.6074	.6867	.7671	.8489	.9324	1.0175	1.1039	1.1916	1.2804	1.1293
25	2.4014	.5847	.6921	.8000	.9087	1.0185	1.1297	1.2421	1.3561	1.4490	1.1492
30	2.6708	.5920	.7239	.8564	.9901	1.1253	1.2627	1.4026	1.5457	1.5003	1.2161
35	2.9766	.5771	.7307	.8860	1.0440	1.2058	1.3726	1.5457	1.7266	1.4300	1.2580
40	3.3424	.5896	.7609	.9374	1.1208	1.3130	1.5162	1.7329	1.9664	1.2307	1.3063
45	3.7967	.5392	.7248	.9211	1.1311	1.3587	1.6085	1.8868	1.6629	1.2248	1.3199
50	4.3618	.4789	.6732	.8872	1.1271	1.4004	1.7165	2.0696	1.1301	1.2178	.8329
55	5.0367	.4212	.6218	.8549	1.1307	1.4630	1.8712	1.3500	1.0986	1.1432	.1800

$l_{(2)}$ = 700 Alpha = 0.2916 Growth Rate = 1.35% Mean Age at Birth of all Children = 32.63

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.3933	.6186	.6485	.6783	.7094	.7425	.7778	.8153	.8547	.8957	.9362
15	1.5468	.5735	.6277	.6827	.7393	.7980	.8587	.9211	.9851	1.0503	1.0888
20	1.7569	.5242	.6075	.6913	.7760	.8619	.9490	1.0372	1.1261	1.2159	1.2076
25	1.9793	.4763	.5882	.6999	.8116	.9239	1.0367	1.1503	1.2645	1.3797	1.2714
30	2.2180	.4614	.5976	.7333	.8691	1.0054	1.1429	1.2817	1.4226	1.5661	1.2834
35	2.4923	.4272	.5839	.7409	.8990	1.0593	1.2229	1.3909	1.5648	1.6643	1.2618
40	2.8283	.4275	.5987	.7731	.9522	1.1379	1.3320	1.5367	1.7548	1.5957	1.3116
45	3.2593	.3716	.5523	.7409	.9400	1.1528	1.3833	1.6365	1.9189	1.3048	1.3275
50	3.8211	.3221	.5056	.7046	.9243	1.1711	1.4531	1.7800	1.6050	1.2108	1.3358
55	4.5314	.2854	.4681	.6776	.9221	1.2128	1.5652	1.7783	1.0920	1.1965	.6291

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 750 Alpha = 0.1659 Growth Rate = 1.62% Mean Age at Birth of all Children = 32.59

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.0970	.5834	.6159	.6481	.6812	.7161	.7530	.7922	.8331	.8755	.9193
15	1.2179	.5142	.5722	.6307	.6903	.7516	.8147	.8794	.9454	1.0123	1.0800
20	1.3909	.4386	.5270	.6152	.7038	.7931	.8830	.9735	1.0644	1.1556	1.2469
25	1.5761	.3645	.4826	.5994	.7155	.8312	.9467	1.0620	1.1772	1.2926	1.3585
30	1.7768	.3265	.4690	.6097	.7491	.8880	1.0267	1.1655	1.3051	1.4460	1.4372
35	2.0102	.2726	.4346	.5951	.7552	.9155	1.0774	1.2418	1.4099	1.5834	1.4374
40	2.3005	.2571	.4308	.6053	.7821	.9631	1.1498	1.3442	1.5486	1.7659	1.3674
45	2.6850	.1938	.3724	.5560	.7469	.9478	1.1619	1.3934	1.6477	1.6890	1.3128
50	3.2108	.1496	.3242	.5099	.7109	.9327	1.1817	1.4659	1.7957	1.3355	1.3221
55	3.9218	.1348	.3005	.4870	.7009	.9510	1.2490	1.6115	1.4456	1.1704	1.3254

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 32.51

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.8272	.5454	.5814	.6166	.6525	.6897	.7289	.7701	.8129	.8572	.9027
15	.9171	.4521	.5150	.5777	.6412	.7060	.7723	.8398	.9084	.9775	1.0471
20	1.0513	.3501	.4449	.5387	.6323	.7259	.8196	.9134	1.0069	1.1000	1.1926
25	1.1970	.2496	.3756	.4993	.6211	.7415	.8607	.9788	1.0959	1.2121	1.3275
30	1.3555	.1883	.3393	.4870	.6319	.7748	.9161	1.0561	1.1954	1.3344	1.4739
35	1.5405	.1128	.2831	.4499	.6142	.7769	.9390	1.1014	1.2654	1.4323	1.5817
40	1.7734	.0813	.2611	.4390	.6166	.7955	.9774	1.1640	1.3572	1.5595	1.6145
45	2.0887	.0065	.1868	.3690	.5551	.7473	.9484	1.1617	1.3916	1.6435	1.5017
50	2.5399	-.0367	.1332	.3097	.4963	.6973	.9181	1.1652	1.4465	1.7283	1.2775
55	3.1964	-.0323	.1189	.2847	.4704	.6826	.9300	1.2243	1.5820	1.3107	1.2796

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 2.55% Mean Age at Birth of all Children = 32.37

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	22	23	24	25	26	27	28	29	30	31
10	.5830	.5044	.5444	.5834	.6225	.6628	.7047	.7485	.7939	.8405	.8880
15	.6448	.3866	.4554	.5236	.5919	.6611	.7313	.8025	.8743	.9462	1.0180
20	.7410	.2581	.3608	.4618	.5618	.6610	.7595	.8573	.9541	1.0497	1.1440
25	.8465	.1316	.2677	.4002	.5295	.6562	.7805	.9024	1.0220	1.1395	1.2550
30	.9612	.0481	.2106	.3679	.5206	.6694	.8148	.9572	1.0970	1.2346	1.3708
35	1.0956	-.0482	.1343	.3108	.4824	.6498	.8141	.9763	1.1373	1.2986	1.4615
40	1.2648	-.0972	.0936	.2794	.4617	.6420	.8221	1.0035	1.1880	1.3776	1.5748
45	1.4957	-.1879	.0004	.1868	.3733	.5619	.7549	.9552	1.1662	1.3922	1.6393
50	1.8362	-.2350	-.0634	.1104	.2890	.4761	.6758	.8936	1.1356	1.4097	1.5904
55	2.3665	-.2154	-.0728	.0781	.2418	.4232	.6285	.8660	1.1463	1.4874	1.3247

$l_{(2)}$ = 900 Alpha = -0.3834 Growth Rate = 3.15% Mean Age at Birth of all Children = 32.23

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	22	23	24	25	26	27	28	29	30	31
10	.3659	.4611	.5056	.5488	.5920	.6360	.6814	.7284	.7768	.8262	.8762
15	.4033	.3184	.3944	.4691	.5434	.6181	.6932	.7689	.8445	.9198	.9943
20	.4644	.1640	.2766	.3866	.4945	.6087	.7053	.8082	.9090	1.0076	1.1038
25	.5317	.0125	.1616	.3055	.4447	.5796	.7104	.8372	.9601	1.0792	1.1945
30	.6049	-.0913	.0869	.2573	.4209	.5780	.7294	.8754	1.0164	1.1529	1.2855
35	.6905	-.2058	-.0052	.1861	.3690	.5444	.7133	.8769	1.0361	1.1923	1.3467
40	.7975	-.2693	-.0598	.1404	.3327	.5189	.7006	.8795	1.0574	1.2359	1.4173
45	.9428	-.3797	-.1737	.0255	.2199	.4115	.6025	.7953	.9930	1.1990	1.4179
50	1.1579	-.4426	-.2576	-.0760	.1050	.2883	.4776	.6773	.8924	1.1291	1.3946
55	1.5049	-.4149	-.2698	-.1224	.0308	.1940	.3719	.5702	.7967	1.0617	1.3798

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.3

$l_{(2)}$ = 650 Alpha = 0.6202 Growth Rate = 0.69% Mean Age at Birth of all Children = 32.54

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.9102	.6475	.6777	.7085	.7408	.7752	.8118	.8503	.8906	.9324	.9329
15	2.1803	.6413	.6958	.7518	.8097	.8699	.9322	.9965	1.0624	1.1302	1.0450
20	2.5329	.6453	.7279	.8119	.8979	.9859	1.0759	1.1680	1.2621	1.3336	1.0831
25	2.8992	.6544	.7645	.8763	.9902	1.1068	1.2262	1.3489	1.4755	1.3667	1.1481
30	3.2848	.6911	.8264	.9649	1.1072	1.2542	1.4069	1.5661	1.7338	1.2747	1.2074
35	3.7127	.6974	.8564	1.0216	1.1946	1.3772	1.5716	1.7805	1.7548	1.1819	1.2380
40	4.2034	.7217	.9037	1.0984	1.3087	1.5381	1.7906	2.0742	1.4196	1.2032	1.0029
45	4.7674	.6636	.8652	1.0887	1.3402	1.6272	1.9618	1.8871	1.1246	1.1840	.3894
50	5.3899	.5744	.7899	1.0421	1.3433	1.7082	2.1683	1.1376	1.0878	.7901	.2606
55	6.0220	.4659	.6869	.9623	1.3118	1.7749	1.4407	.9959	1.0024	.4075	.3465

$l_{(2)}$ = 700 Alpha = 0.5061 Growth Rate = 1.00% Mean Age at Birth of all Children = 32.48

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	[illegible]	[illegible]	.6414	.6747	.7090	.7452	.7834	.8235	.8652	.9084	.9501
15	[illegible]	[illegible]	.6331	.6922	.7527	.8153	.8796	.9458	1.0134	1.0824	1.1049
20	[illegible]	[illegible]	[illegible]	.7245	.8133	.9036	.9955	1.0890	1.1840	1.2808	1.1996
25	[illegible]	.5323	.6464	.7612	.8772	.9951	1.1150	1.2373	1.3625	1.4912	1.1968
30	2.7711	[illegible]	[illegible]	.8236	.9657	1.1113	1.2611	1.4161	1.5777	1.5751	1.2219
35	3.1777	[illegible]	[illegible]	[illegible]	1.0255	1.2015	1.3868	1.5844	1.7969	1.4323	1.2586
40	[illegible]	[illegible]	[illegible]	.9140	1.1124	1.3265	1.5599	1.8192	1.9365	1.2152	1.2978
45	[illegible]	[illegible]	.6904	.8977	1.1279	1.3871	1.6870	2.0390	1.4136	1.2031	.9712
50	[illegible]	[illegible]	[illegible]	[illegible]	1.1325	1.4580	1.8613	1.7026	1.0981	1.1728	.2621
55	[illegible]	[illegible]	[illegible]	[illegible]	1.1145	1.5216	1.8505	1.0085	1.0458	.5977	.3055

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.3

$l_{(2)}$ = 750 Alpha = 0.3805 Growth Rate = 1.35% Mean Age at Birth of all Children = 32.43

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.2136	.5662	.6031	.6396	.6768	.7154	.7559	.7982	.8420	.8871	.9333
15	1.3991	.5052	.5683	.6317	.6960	.7618	.8291	.8979	.9679	1.0388	1.1107
20	1.5591	.4309	.5434	.6358	.7287	.8225	.9173	1.0132	1.1099	1.2077	1.2837
25	1.9411	.4046	.5245	.6440	.7638	.8843	1.0059	1.1290	1.2539	1.3812	1.3649
30	2.2529	.3940	.5362	.6785	.8222	.9679	1.1163	1.2685	1.4255	1.5883	1.3736
35	2.6197	.3641	.5237	.6858	.8517	1.0228	1.2009	1.3886	1.5878	1.7640	1.2634
40	3.0706	.3696	.5415	.7204	.9089	1.1095	1.3261	1.5626	1.8237	1.6065	1.3066
45	3.6437	.3219	.5003	.6925	.9025	1.1357	1.4011	1.7069	1.9721	1.1991	1.3149
50	4.3539	.2927	.4616	.6648	.9001	1.1819	1.5244	1.9472	1.3096	1.1861	.8384
55	5.1633	.2460	.4224	.6365	.9060	1.2528	1.7078	1.3814	1.0549	.9774	.2372

$l_{(2)}$ = 800 Alpha = 0.2366 Growth Rate = 1.75% Mean Age at Birth of all Children = 32.37

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.9212	.5208	.5623	.6029	.6438	.6858	.7294	.7746	.8212	.8687	.9171
15	1.0557	.4317	.5010	.5699	.6392	.7095	.7808	.8533	.9265	1.0001	1.0743
20	1.2597	.3470	.4471	.5462	.6449	.7437	.8428	.9420	1.0415	1.1413	1.2414
25	1.4873	.2709	.3991	.5256	.6511	.7761	.9010	1.0262	1.1521	1.2789	1.4074
30	1.7421	.2343	.3837	.5317	.6792	.8269	.9761	1.1270	1.2807	1.4383	1.5507
35	2.0478	.1825	.3468	.5114	.6774	.8463	1.0200	1.1998	1.3879	1.5868	1.5429
40	2.4399	.1730	.3442	.5194	.7005	.8908	1.0928	1.3095	1.5448	1.8039	1.4205
45	2.9630	.1259	.2961	.4759	.6688	.8799	1.1140	1.3783	1.6824	1.6859	1.2950
50	3.6653	.1074	.2694	.4479	.6524	.8904	1.1732	1.5161	1.8937	1.1605	1.3066
55	4.5417	.1092	.2598	.4419	.6652	.9455	1.3057	1.7808	1.1145	1.1447	.6152

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 1.3

$l_{(2)}$ = 850 Alpha = 0.0625 Growth Rate = 2.35% Mean Age at Birth of all Children = 32.25

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	[illegible]	.4701	.5173	.5632	.6089	.6553	.7029	.7518	.8018	.8525	.9037
15	.7417	.3516	.4240	.5052	.5811	.6573	.7339	.8111	.8884	.9655	1.0425
20	.3691	.2360	.3461	.4541	.5607	.6663	.7711	.8751	.9783	1.0807	1.1825
25	1.0562	.1244	.2690	.4054	.5391	.6709	.8009	.9298	1.0577	1.1850	1.3123
30	[illegible]	.0650	.2259	.3831	.5377	.6905	.8423	.9939	1.1460	1.2996	1.4560
35	1.4779	-.0124	.1615	.3331	.5034	.6737	.8455	1.0204	1.2002	1.3868	1.5828
40	1.7742	-.0404	.1354	.3118	.4907	.6744	.8651	1.0657	1.2791	1.5093	1.7474
45	2.1946	-.0938	.0735	.2463	.4273	.6197	.8275	1.0562	1.3126	1.6060	1.5831
50	2.4134	-.0946	.0549	.2153	.3914	.5895	.8180	1.0878	1.4131	1.7490	1.2433
55	3.6831	-.0320	.0765	.2250	.4013	.6159	.8839	1.2271	1.6782	1.1391	1.2574

$l_{(2)}$ = 900 Alpha = -0.1689 Growth Rate = 3.00% Mean Age at Birth of all Children = 32.13

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.4078	.4146	.4687	.5211	.5728	.6248	.6776	.7312	.7856	.8403	.8950
15	.4637	.2663	.3539	.4395	.5240	.6078	.6913	.7744	.8569	.9384	1.0188
20	.5571	.1197	.2432	.3632	.4804	.5951	.7076	.8179	.9259	1.0318	1.1355
25	.6646	-.0167	.1392	.2897	.4353	.5767	.7143	.8484	.9796	1.1081	1.2345
30	.7863	-.1065	.0721	.2439	.4100	.5714	.7289	.8832	1.0352	1.1857	1.3358
35	.9343	-.2096	-.0180	.1674	.3477	.5241	.6982	.8714	1.0454	1.2228	1.4034
40	1.1296	-.2601	-.0699	.1163	.3003	.4843	.6705	.8611	1.0589	1.2669	1.4887
45	1.4108	-.3298	-.1550	.0201	.1979	.3809	.5723	.7760	.9970	1.2420	1.5194
50	1.8525	-.3209	-.1745	-.0239	.1342	.3043	.4921	.7050	.9526	1.2473	1.6052
55	2.5718	-.2374	-.1261	-.0045	.1327	.2922	.4830	.7172	1.0129	1.3963	1.2755

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 0.8

$l_{(2)}$ = 650 Alpha = 0.2626 Growth Rate = 1.42% Mean Age at Birth of all Children = 32.72

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.5987	.6588	.6833	.7084	.7352	.7643	.7960	.8301	.8663	.9042	.9185
15	1.7354	.6292	.6765	.7252	.7760	.8292	.8849	.9427	1.0021	1.0636	1.0507
20	1.9156	.5892	.6647	.7412	.8192	.8988	.9799	1.0621	1.1453	1.2292	1.1487
25	2.1013	.5456	.6500	.7543	.8590	.9643	1.0701	1.1764	1.2831	1.3902	1.1972
30	2.2971	.5326	.6621	.7910	.9196	1.0483	1.1772	1.3068	1.4370	1.5594	1.2109
35	2.5180	.5014	.6532	.8042	.9552	1.1069	1.2601	1.4155	1.5741	1.5871	1.2564
40	2.7842	.5047	.6730	.8424	1.0139	1.1890	1.3690	1.5553	1.7497	1.5528	1.3090
45	3.1221	.4514	.6323	.8176	1.0094	1.2098	1.4214	1.6477	1.8929	1.3505	1.3302
50	3.5649	.3969	.5840	.7815	.9934	1.2236	1.4775	1.7612	1.7570	1.2305	1.3461
55	4.1450	.3524	.5412	.7499	.9839	1.2502	1.5582	1.9207	1.2412	1.2226	1.1352

$l_{(2)}$ = 700 Alpha = .1485 Growth Rate = 1.70% Mean Age at Birth of all Children = 32.65

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	[illegible]	[illegible]	[illegible]	.6812	.7049	.7389	.7713	.8061	.8431	.8819	.9222
15	[illegible]	[illegible]	.6269	.6775	.7300	.7847	.8418	.9009	.9615	1.0234	1.0788
20	1.5541	[illegible]	.5915	.6710	.7515	.8332	.9162	1.0001	1.0846	1.1695	1.2098
25	[illegible]	[illegible]	[illegible]	.6612	.7691	.8770	.9848	1.0926	1.2002	1.3077	1.3033
30	[illegible]	[illegible]	[illegible]	.6767	.8083	.9393	1.0696	1.1996	1.3293	1.4592	1.3713
35	[illegible]	[illegible]	[illegible]	.6699	.8231	.9756	1.1282	1.2815	1.4365	1.5942	1.3750
40	[illegible]	[illegible]	[illegible]	.6390	.8601	1.0329	1.2084	1.3881	1.5736	1.7666	1.3287
45	[illegible]	[illegible]	[illegible]	[illegible]	.8356	1.0287	1.2301	1.4424	1.6694	1.7032	1.3224
50	[illegible]	[illegible]	[illegible]	[illegible]	.7939	1.0138	1.2462	1.5023	1.7883	1.4597	1.3334
55	[illegible]	[illegible]	[illegible]	.5543	.7770	1.0155	1.2873	1.6024	1.7224	1.2005	1.3456

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 0.8

$l_{(2)}$ = 750 Alpha = 0.0229 Growth Rate = 1.95% Mean Age at Birth of all Children = 32.61

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.0226	.5947	.6261	.6562	.6853	.7165	.7501	.7861	.8241	.8640	.9053
15	1.1198	.5274	.5605	.6339	.6886	.7454	.8044	.8652	.9276	.9909	1.0552
20	1.2363	.4404	.5216	.6069	.6906	.7752	.8607	.9469	1.0332	1.1196	1.2058
25	1.3641	.3490	.4535	.5766	.6886	.7999	.9105	1.0205	1.1296	1.2379	1.3304
30	1.5083	.2934	.4350	.5732	.7092	.8434	.9760	1.1073	1.2373	1.3663	1.4286
35	1.6690	.2295	.3849	.5487	.7058	.8608	1.0142	1.1669	1.3197	1.4735	1.4761
40	1.8637	.2007	.3779	.5524	.7253	.8978	1.0711	1.2465	1.4254	1.6093	1.4978
45	2.1236	.1257	.3112	.4955	.6813	.8702	1.0642	1.2660	1.4784	1.7052	1.4060
50	2.4774	.0566	.2485	.4342	.6266	.8290	1.0453	1.2799	1.5383	1.6890	1.3098
55	2.9906	.0398	.2092	.3897	.5854	.8011	1.0427	1.3180	1.6375	1.3683	1.3097

$l_{(2)}$ = 800 Alpha = -0.1210 Growth Rate = 2.17% Mean Age at Birth of all Children = 32.58

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.7690	.5670	.5979	.6283	.6593	.6921	.7272	.7646	.8041	.8453	.8880
15	.8342	.4737	.5302	.5868	.6445	.7039	.7652	.8282	.8926	.9578	1.0237
20	.9308	.3624	.4508	.5386	.6265	.7147	.8034	.8923	.9810	1.0692	1.1568
25	1.0331	.2472	.3685	.4875	.6047	.7204	.8347	.9475	1.0587	1.1682	1.2760
30	1.1420	.1708	.3200	.4652	.6068	.7455	.8813	1.0146	1.1454	1.2740	1.4008
35	1.2659	.0829	.2554	.4227	.5853	.7441	.8996	1.0525	1.2038	1.3541	1.5044
40	1.4179	.0430	.2290	.4098	.5867	.7608	.9334	1.1056	1.2788	1.4543	1.6340
45	1.6182	-.0444	.1473	.3359	.5230	.7103	.8995	1.0928	1.2929	1.5030	1.6246
50	1.9013	-.1113	.0738	.2592	.4474	.6413	.8443	1.0603	1.2938	1.5500	1.5280
55	2.3239	-.1347	.0306	.2025	.3846	.5809	.7961	1.0361	1.3089	1.6250	1.3065

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(30+N)}/l_{(30)}$ BETA = 0.8

$l_{(2)}$ = 850 Alpha = -0.2951 Growth Rate = 2.70% Mean Age at Birth of all Children = 32.42

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN									
		22	23	24	25	26	27	28	29	30	31
10	.5418	.5328	.5668	.5995	.6329	.6678	.7048	.7441	.7853	.8282	.8723
15	.5806	.4183	.4792	.5398	.6011	.6637	.7280	.7937	.8606	.9280	.9957
20	.6555	.2836	.3782	.4716	.5645	.6573	.7499	.8421	.9336	1.0241	1.1134
25	.7294	.1446	.2745	.4010	.5247	.6458	.7646	.8810	.9949	1.1060	1.2145
30	.8075	.0446	.2081	.3620	.5110	.6555	.7958	.9319	1.0642	1.1927	1.3178
35	.8955	-.0555	.1290	.3052	.4755	.6399	.7990	.9533	1.1038	1.2511	1.3963
40	1.0040	-.1068	.0647	.2802	.4639	.6419	.8156	.9862	1.1549	1.3230	1.4921
45	1.1479	-.2106	-.0067	.1906	.3830	.5719	.7593	.9472	1.1377	1.3336	1.5383
50	1.3531	-.2402	-.0452	.0960	.2858	.4770	.6724	.8755	1.0903	1.3210	1.5728
55	1.6580	-.3145	-.1462	.0241	.1996	.3837	.5803	.7941	1.0310	1.2990	1.5630

$l_{(2)}$ = 900 Alpha = -0.5265 Growth Rate = 3.25% Mean Age at Birth of all Children = 32.27

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN									
		22	23	24	25	26	27	28	29	30	31
10	.3402	.4974	.5345	.5704	.6065	.6439	.6833	.7248	.7682	.8131	.8591
15	.3675	.3619	.4279	.4931	.5587	.6253	.6932	.7623	.8322	.9022	.9722
20	.4111	.2044	.3064	.4066	.5055	.6037	.7011	.7975	.8924	.9856	1.0767
25	.4582	.0433	.1833	.3188	.4504	.5784	.7028	.8235	.9405	1.0535	1.1626
30	.5081	-.0708	.1017	.2668	.4252	.5771	.7229	.8628	.9969	1.1253	1.2483
35	.5645	-.1910	.0096	.2001	.3811	.5533	.7174	.8740	1.0240	1.1682	1.3075
40	.6329	-.2522	-.0353	.1696	.3638	.5487	.7256	.8958	1.0605	1.2212	1.3794
45	.7221	-.3663	-.1424	.0702	.2731	.4681	.6571	.8419	1.0249	1.2083	1.3954
50	.8476	-.4636	-.2488	-.0430	.1560	.3510	.5449	.7408	.9421	1.1527	1.3767
55	1.0369	-.5004	-.3173	-.1379	.0412	.2230	.4110	.6090	.8216	1.0549	1.3170

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(32\frac{1}{2}+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 650 Alpha = 0.4057 Growth Rate = 1.15% Mean Age at Birth of all Children = 32.65

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	22	23	24	25	26	27	28	29	30	31
10	1.7172	.1309	.1692	.2089	.2507	.2952	.3425	.3921	.4439	.4975	.5459
15	1.9030	.0876	.1540	.2219	.2919	.3641	.4385	.5146	.5921	.6706	.6932
20	2.1475	.0454	.1425	.2403	.3391	.4389	.5398	.6414	.7435	.8461	.7915
25	2.4014	.0293	.1534	.2770	.4007	.5245	.6487	.7731	.8981	1.0081	.8455
30	2.6708	.0123	.1575	.3020	.4464	.5912	.7368	.8836	1.0322	1.0525	.9015
35	2.9766	.0026	.1622	.3219	.4825	.6450	.8104	.9798	1.1547	1.0171	.9394
40	3.3424	-.0019	.1635	.3314	.5033	.6809	.8660	1.0606	1.2673	.8958	.9621
45	3.7967	-.0694	.0928	.2610	.4373	.6245	.8258	1.0457	1.0240	.8670	.9318
50	4.3618	-.0750	.0748	.2351	.4100	.6044	.8244	1.0708	.8153	.8615	.5865
55	5.0367	-.0977	.0312	.1762	.3427	.5377	.7714	.8075	.8000	.7982	.1800

$l_{(2)}$ = 700 Alpha = 0.2916 Growth Rate = 1.35% Mean Age at Birth of all Children = 32.63

		FIRST BIRTH MEAN									
CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	22	23	24	25	26	27	28	29	30	31
10	1.3913	.0855	.1266	.1687	.2128	.2593	.3085	.3602	.4140	.4694	.5259
15	1.5468	.0153	.0860	.1577	.2311	.3065	.3840	.4630	.5432	.6242	.6896
20	1.7569	-.0552	.0477	.1507	.2542	.3584	.4631	.5682	.6733	.7785	.8170
25	1.9793	-.0958	.0353	.1651	.2942	.4227	.5507	.6784	.8058	.9332	.9019
30	2.2180	-.1323	.0202	.1708	.3202	.4690	.6175	.7661	.9153	1.0657	.9199
35	2.4923	-.1549	.0111	.1758	.3400	.5044	.6702	.8383	1.0100	1.1320	.9158
40	2.8283	-.1611	.0082	.1781	.3501	.5257	.7066	.8947	1.0921	1.0614	.9370
45	3.2593	-.2192	-.0568	.1094	.2813	.4612	.6519	.8569	1.0809	.8619	.9061
50	3.8211	-.1991	-.0532	.1004	.2650	.4450	.6456	.8733	.9104	.8237	.8963
55	4.5314	-.1871	-.0658	.0682	.2196	.3942	.6000	.7937	.7653	.8037	.4288

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(32\frac{1}{2}+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 750 Alpha = 0.1659 Growth Rate = 1.62% Mean Age at Birth of all children = 32.59

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.0970	.0370	.0817	.1271	.1740	.2233	.2751	.3294	.3858	.4437	.5030
15	1.2179	-.0606	.0154	.0919	.1698	.2494	.3307	.4134	.4971	.5813	.6660
20	1.3909	-.1604	-.0503	.0593	.1689	.2785	.3882	.4977	.6068	.7153	.8232
25	1.5761	-.2280	-.0878	.0501	.1862	.3209	.4543	.5864	.7174	.8474	.9405
30	1.7768	-.2862	-.1238	.0354	.1920	.3466	.4998	.6517	.8029	.9539	.9976
35	2.0102	-.3232	-.1477	.0246	.1947	.3634	.5316	.7001	.8704	1.0435	.9985
40	2.3005	-.3353	-.1588	.0160	.1907	.3668	.5458	.7293	.9193	1.1182	.9355
45	2.6850	-.3856	-.2199	-.0526	.1178	.2933	.4763	.6697	.8772	.9800	.8592
50	3.2108	-.3415	-.1972	-.0483	.1079	.2751	.4577	.6610	.8919	.8100	.8516
55	3.9218	-.2905	-.1758	-.0517	.0855	.2405	.4196	.6313	.7332	.7534	.8216

$l_{(2)}$ = 800 Alpha = 0.0221 Growth Rate = 2.00% Mean Age at Birth of all Children = 32.51

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.8272	-.0154	.0339	.0833	.1341	.1869	.2422	.2998	.3593	.4203	.4825
15	.9171	-.1412	-.0586	.0240	.1076	.1924	.2786	.3660	.4541	.5423	.6305
20	1.0513	-.2717	-.1525	-.0346	.0826	.1992	.3153	.4305	.5446	.6575	.7689
25	1.1970	-.3676	-.2159	-.0676	.0778	.2205	.3609	.4990	.6348	.7685	.9002
30	1.3555	-.4501	-.2745	-.1038	.0628	.2257	.3855	.5427	.6974	.8504	1.0023
35	1.5405	-.5055	-.3165	-.1327	.0469	.2228	.3961	.5677	.7388	.9104	1.0689
40	1.7734	-.5252	-.3368	-.1526	.0288	.2088	.3891	.5712	.7569	.9481	1.0456
45	2.0897	-.5721	-.3982	-.2257	-.0528	.1220	.3009	.4863	.6813	.8898	.8951
50	2.5399	-.5050	-.3581	-.2098	-.0580	.1005	.2691	.4525	.6559	.8678	.7785
55	3.1964	-.4124	-.3016	-.1852	-.0601	.0777	.2326	.4109	.6211	.6901	.7542

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(32\frac{1}{2}+N)}/l_{(30)}$ BETA = 1.0

$l_{(2)}$ = 850 Alpha = -0.1521 Growth Rate = 2,55% Mean Age at Birth of all Children = 32.37

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.5830	-.0726	-.0179	.0366	.0921	.1494	.2089	.2706	.3341	.3988	.4646
15	.6448	-.2277	-.1371	-.0468	.0439	.1353	.2277	.3208	.4142	.5073	.5999
20	.7410	-.3907	-.2601	-.1316	-.0047	.1207	.2448	.3672	.4876	.6059	.7217
25	.8465	-.5168	-.3503	-.1885	-.0311	.1223	.2719	.4177	.5599	.6986	.8339
30	.9612	-.6254	-.4319	-.2455	-.0654	.1090	.2785	.4431	.6034	.7599	.9132
35	1.0956	-.7019	-.4932	-.2925	-.0989	.0885	.2705	.4481	.6224	.7946	.9662
40	1.2648	-.7347	-.5270	-.3270	-.1332	.0560	.2422	.4269	.6118	.7987	.9898
45	1.4957	-.7852	-.5952	-.4101	-.2282	-.0479	.1327	.3157	.5037	.6999	.9091
50	1.8362	-.6959	-.5391	-.3848	-.2309	-.0749	.0863	.2563	.4396	.6417	.8102
55	2.3665	-.5587	-.4466	-.3328	-.2146	-.0891	.0473	.1992	.3720	.5754	.6601

$l_{(2)}$ = 900 Alpha = -0.3834 Growth Rate = 3.15% Mean Age at Birth of all Children = 32.23

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.3659	-.1346	-.0736	-.0130	.0484	.1113	.1761	.2429	.3113	.3807	.4509
15	.4033	-.3205	-.2199	-.1201	-.0206	.0792	.1793	.2796	.3796	.4787	.5765
20	.4644	-.5175	-.3724	-.2304	-.0911	.0456	.1798	.3112	.4395	.5644	.6856
25	.5317	-.6760	-.4898	-.3103	-.1369	.0304	.1921	.3482	.4986	.6436	.7833
30	.5049	-.8144	-.5959	-.3874	-.1882	.0026	.1854	.3607	.5290	.6906	.8463
35	.6905	-.9157	-.6775	-.4512	-.2360	-.0310	.1649	.3526	.5334	.7086	.8795
40	.7975	-.9670	-.7276	-.5009	-.2853	-.0790	.1197	.3126	.5014	.6879	.8740
45	.9428	-1.0341	-.8137	-.6034	-.4014	-.2057	-.0147	.1739	.3624	.5537	.7514
50	1.1579	-.9305	-.7505	-.5778	-.4103	-.2458	-.0815	.0858	.2602	.4459	.6483
55	1.5049	-.7446	-.6203	-.4990	-.3781	-.2550	-.1266	.0105	.1603	.3287	.5234

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(32|+N)}/l_{(30)}$ BETA = 1.3

$l_{(2)}$ = 650 Alpha = 0.6202 Growth Rate = 0.69% Mean Age at Birth of all Children = 32.54

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.9102	.1293	.1700	.2120	.2560	.3024	.3511	.4020	.4547	.5091	.5595
15	2.1803	.1044	.1726	.2422	.3138	.3874	.4629	.5400	.6186	.6984	.7017
20	2.5329	.0921	.1887	.2863	.3852	.4854	.5871	.6900	.7941	.8847	.7801
25	2.8992	.1074	.2280	.3493	.4717	.5956	.7211	.8488	.9791	.9604	.8580
30	3.2848	.1161	.2550	.3955	.5383	.6842	.8340	.9883	1.1488	.9240	.9066
35	3.7127	.1217	.2732	.4285	.5889	.7559	.9310	1.1166	1.1679	.8883	.9336
40	4.2034	.1198	.2771	.4422	.6176	.8058	1.0098	1.2355	.9824	.8992	.7465
45	4.7674	.0444	.1969	.3620	.5433	.7456	.9761	1.05[illegible]0	.8412	.8641	.3130
50	5.3899	.0144	.1539	.3117	.4947	.7111	.9780	.8442	.8301	.6155	.2606
55	6.0220	-.0407	.0740	.2111	.3792	.5948	.7771	.8194	.7818	.4075	.3465

$l_{(2)}$ = 800 Alpha = 0.2366 Growth Rate = 1.75% Mean Age at Birth of all Children = 32.37

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.9212	-.0411	.0142	.0693	.1254	.1830	.2425	.3037	.3663	.4301	.4946
15	1.0557	-.1570	-.0690	.0187	.1067	.1956	.2854	.3758	.4665	.5573	.6480
20	1.2597	-.2623	-.1411	-.0213	.0975	.2156	.3331	.4500	.5662	.6816	.7964
25	1.4873	-.3253	-.1778	-.0330	.1096	.2504	.3900	.5284	.6662	.8038	.9416
30	1.7421	-.3728	-.2092	-.0486	.1099	.2671	.4239	.5809	.7389	.8987	1.0281
35	2.0478	-.3932	-.2246	-.0576	.1087	.2755	.4444	.6165	.7937	.9781	1.0123
40	2.4389	-.3799	-.2187	-.0566	.1079	.2774	.4538	.6395	.8376	1.0518	.9184
45	2.9630	-.3863	-.2438	-.0970	.0563	.2193	.3949	.5878	.8040	.9030	.8189
50	3.6653	-.3056	-.1879	-.0635	.0729	.2254	.4007	.6074	.8426	.7536	.8207
55	4.5417	-.2348	-.1471	-.0472	.0695	.2095	.3829	.6042	.7234	.7505	.4138

TABLE A.3.4. : (Continued)

FUNCTION ESTIMATED : $l_{(32\frac{1}{2}+N)}/l_{(30)}$ BETA = 1.3

$l_{(2)}$ = 900 Alpha = -0.1689 Growth Rate = 3.00% Mean Age at Birth of all Children = 32.13

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.4078	-.1912	-.1184	-.0467	.0251	.0975	.1709	.2454	.3204	.3957	.4709
15	.4637	-.3775	-.2641	-.1527	-.0425	.0668	.1753	.2829	.3892	.4930	.5967
20	.5571	-.5584	-.4035	-.2527	-.1057	.0377	.1778	.3145	.4477	.5772	.7033
25	.6646	-.6899	-.5013	-.3198	-.1448	.0243	.1878	.3461	.4996	.6488	.7941
30	.7863	-.7955	-.5864	-.3863	-.1941	-.0088	.1704	.3443	.5138	.6798	.8432
35	.9343	-.8569	-.6438	-.4394	-.2425	-.0519	.1338	.3157	.4956	.6750	.8562
40	1.1296	-.8545	-.6567	-.4660	-.2806	-.0987	.0819	.2631	.4473	.6369	.8349
45	1.4108	-.8291	-.6642	-.5028	-.3429	-.1827	-.0201	.1476	.3237	.5125	.7197
50	1.8525	-.6578	-.5341	-.4116	-.2886	-.1623	-.0293	.1147	.2757	.4606	.6790
55	2.5718	-.4613	-.3823	-.3014	-.2159	-.1225	-.0171	.1057	.2535	.4375	.5771

BETA = 0.8

$l_{(2)}$ = 650 Alpha = 0.2626 Growth Rate = 1.42% Mean Age at Birth of all Children = 32.72

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	1.5987	.1369	.1720	.2087	.2477	.2897	.3347	.3824	.4325	.4846	.5323
15	1.7354	.0831	.1463	.2113	.2786	.3484	.4206	.4947	.5703	.6471	.6812
20	1.9156	.0214	.1166	.2126	.3097	.4079	.5071	.6069	.7068	.8069	.7939
25	2.1013	-.0169	.1078	.2316	.3550	.4780	.6007	.7230	.8447	.9660	.8687
30	2.2971	-.0541	.0947	.2416	.3871	.5316	.6753	.8183	.9610	1.0971	.8916
35	2.5180	-.0790	.0874	.2517	.4145	.5764	.7382	.9006	1.0644	1.1246	.9355
40	2.7842	-.0904	.0844	.2582	.4321	.6074	.7853	.9671	1.1544	1.0831	.9642
45	3.1221	-.1640	.0103	.1861	.3650	.5486	.7392	.9391	1.1517	.9172	.9398
50	3.5649	-.1651	-.0032	.1647	.3406	.5275	.7293	.9506	1.0375	.8539	.9349
55	4.1450	-.1776	-.0357	.1168	.2833	.4681	.6769	.9172	.8045	.8323	.7583

TABLE A.3.4.1 (Continued)

FUNCTION ESTIMATED : $l_{(32\frac{1}{2}+N)}/l_{(30)}$ BETA = 0.8

$l_{(2)}$ = 800 Alpha = −0.1210 Growth Rate = 2.17% Mean Age at Birth of all Children = 32.58

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.7690	.0096	.0528	.0966	.1418	.1896	.2403	.2937	.3496	.4074	.4668
15	.8342	-.1192	-.0434	.0330	.1108	.1903	.2719	.3552	.4395	.5245	.6098
20	.9308	-.2636	-.1499	-.0368	.0759	.1885	.3010	.4129	.5240	.6337	.7419
25	1.0331	-.3796	-.2298	-.0832	.0605	.2016	.3403	.4762	.6094	.7399	.8675
30	1.1420	-.4840	-.3046	-.1307	.0382	.2026	.3628	.5190	.6712	.8198	.9652
35	1.2659	-.5609	-.3607	-.1674	.0195	.2006	.3766	.5481	.7158	.8808	1.0439
40	1.4179	-.6024	-.3944	-.1941	-.0001	.1888	.3740	.5565	.7375	.9186	1.1013
45	1.6182	-.6857	-.4837	-.2873	-.0953	.0938	.2817	.4701	.6610	.8573	.9994
50	1.9013	-.6525	-.4737	-.2982	-.1242	.0507	.2292	.4144	.6099	.8197	.8883
55	2.3239	-.5816	-.4410	-.2993	-.1537	-.0016	.1601	.3353	.5287	.7469	.7367

$l_{(2)}$ = 900 Alpha = −0.5265 Growth Rate = 3.25% Mean Age at Birth of all Children = 32.27

CENTRAL AGE OF RESPONDENTS	MEAN AGE AT BIRTH OF ELDEST SURVIVING CHILDREN	FIRST BIRTH MEAN 22	23	24	25	26	27	28	29	30	31
10	.3402	-.0884	-.0370	.0143	.0668	.1215	.1788	.2387	.3009	.3649	.4302
15	.3675	-.2693	-.1805	-.0918	-.0025	.0881	.1800	.2730	.3665	.4600	.5529
20	.4111	-.4729	-.3395	-.2081	-.0784	.0499	.1768	.3018	.4244	.5444	.6612
25	.4592	-.6461	-.4687	-.2968	-.1302	.0313	.1879	.3394	.4856	.6264	.7618
30	.5091	-.8027	-.5868	-.3804	-.1828	.0064	.1875	.3607	.5261	.6838	.8342
35	.5645	-.9234	-.6776	-.4446	-.2237	-.0144	.1841	.3724	.5515	.7223	.8856
40	.6329	-.9973	-.7366	-.4915	-.2607	-.0426	.1643	.3613	.5500	.7317	.9081
45	.7221	-1.1202	-.8609	-.6170	-.3864	-.1676	.0414	.2426	.4379	.6297	.8207
50	.8476	-1.0926	-.8623	-.6450	-.4386	-.2406	-.0484	.1409	.3303	.5233	.7237
55	1.0369	-.9781	-.8019	-.6333	-.4700	-.3090	-.1477	.0165	.1870	.3676	.5636

Appendix 4.1

A Computer Programme for Calculating Adjustment Weights for Use with Reports of Widowhood

Programme WIDOW estimates weights for interpolating between proportions widowed in adjacent age groups to give a life table survivorship probability. The programme will be described for widowhood, that is for female respondents. Numerous minor changes are needed to calculate weights for widowerhood. The pgoramme has two main parts, one calculating proportions not widowed for a range of exposures to risk, and the other using the exposure to risk to estimate the proportion not widowed in an age group. Details of the calculations have been described in Chapter 4, so only an outline will be given here.

The basic mortality model, the male marriage distribution, and the mortality parameters, are read in (lines 5 to 8). The required model life table is constructed, and a set of age distribution factors is derived from it and the growth rate (lines 9 to 16). Two life table factors, for use in calculating the weights, are then calculated (lines 17 to 22). Lines 23 to 37 then work out and sum elements of the integrals in equation 4.1, and calculate the population mean of the male marriage distribution. The calculations are just the same as those in the programme for developing weights for firstborn children. The section from line 38 to line 100 is repeated for 10 point values of age at female marriage, and within it the section from line 39 to line 67 is repeated for 17 different locations of the male marriage distribution. Lines 40 to 43 evaluate equation 4.1 for different exposures to risk. From line 44 to 66, the proportions not widowed are weighted into five year age groups of respondents for different point ages of female marriage; the calculations are described in section 4.7. The proportions not widowed are for round ages of the start of the male marriage distribution, whereas it is convenient to work with round values of the male mean. Thus the lines from 68 to 75 convert the proportions to round values of the population mean of male marriage. The weights themselves are then calculated, the estimating equation used being suitable for the female mean age at marriage (lines 76 to 81). Lines 82 to 86 ensure that each unit value of the male mean occurs at least once. The programme concludes, from line 88 onwards, with a rather complicated printing routine, and once that is complete, it returns to line 7 to read in a new set of stable population parameters.

For the programme to run for widowhood, a lot of minor changes are needed. Because males marry later, the age groups of respondents covered run from 25 to 70 instead of 20 to 65. The point ages at which respondents marry are older, and the range of the marriage distribution of their spouses is younger. This makes for a large number of changes of dimensions and the ranges of loops, but no fundamental changes are needed.

List of Main Variables

YS(I)	:	the standard logit values of the Brass model life table system.
XMAR(I)	:	the male marriage distribution.
BETA	:	the second parameter of the Brass model life table system.
XL2	:	the life table survivors to age 2.
RATE	:	the rate of population growth.

ALPHA	: the first parameter of the Brass model life table system.
XL(I)	: life table survivors to age I.
W(I)	: an age distribution factor.
CONST1(I)	: $l_{(N+5)}/l_{(22\frac{1}{2})}$
CONST2(I)	: $l_{(N+5)}/l_{(27\frac{1}{2})}$
PRO	: elements of the numerator of equation 4.1.
SUMI(I)	: the sum of these elements, approximating the value of the integral.
XMEAN(I)	: the mean age at male marriage in the stable population.
PI(J) :	: the proprotion not widowed after exactly J years of marriage when male marrying starts at age IM.
PROD(I,IM)	: The proportion not widowed in the five year age group ending at exact age I, when male marrying starts at IM.
MEAN	: an integer value of the mean age at male marriage in the stable population.
QUOT(I)	: the proportion not widowed by age group for integer values of the mean age at male marriage in the stable population.
WEIGHTI(I,MEAN)	: weights for estimating equation 4.2.
WEIGHT2(I,MEAN)	: weights for estimating equation 4.3.

```
      PROGRAM WIDOW(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      DIMENSION YS(100),CONST1(100),XMAR(40),PI(100),WEIGHT1(65,34),CONST
     1T2(100),SUM1(100),W(100),WEIGHT2(65,34),XL(100),PROD(70,26),XMEAN(26
     226),QUOT(70)
      READ(5,100) (YS(I),I=1,96)
      READ(5,100) (XMAR(I),I=1,40)
    1 READ(5,100) BETA,XL2,RATE
      IF(EOF(5).NE.0) STOP
      A = (1.0-XL2)/XL2
      ALPHA = ALOG(A)/2.0 - BETA*YS(2)
      DO 2 I = 1,96
      FI = I
      Y = ALPHA + BETA*YS(I)
      XL(I) = 1.0/(1.0+EXP(2.0*Y))
      W(I) = XL(I)/EXP(FI*RATE)
    2 CONTINUE
      A = (XL(22)+XL(23))/2.0
      B = (XL(27)+XL(28))/2.0
      DO 3 I=20,65,5
      CONST1(I) = XL(I+5)/A
      CONST2(I) = XL(I+5)/B
    3 CONTINUE
      DO 4 I=7,85
      SUM = 0.0
      SUM1(I) = 0.0
      DO 5 J = 1,40
      K = I+J
      IF(K-96) 6,5,5
    6 FK = K
      FJ = J
      FAC = (XL(K) + XL(K-1))/2.0
      PRO = XMAR(J)*FAC/EXP(FJ*RATE)
      SUM1(I) = SUM1(I) + PRO
      SUM = SUM + PRO*(FK-0.5)
    5 CONTINUE
      IF(I.LE.26) XMEAN(I) = SUM/SUM1(I)
    4 CONTINUE
      DO 7 IS = 15,24
      DO 16 IM = 10,26
      DO 8 J = 1,60
      K = IM + J
      PI(J) = SUM1(K)/SUM1(IM)
    8 CONTINUE
      M = IS
      DO 9 I = 29,70,5
      IF(IS.LT.20) GO TO 17
      PROD(2,IM) = 1.0
      IF(I.EQ.29) GO TO 9
   17 SUM1 = 0.0
      SUM2 = 0.0
   18 IF(M.GE.I5) GO TO 11
      MM = M+1-IS
      A = W(M) + W(M+1)*PI(MM)
      B = W(M) + W(M+1)
      SUM1 = SUM1 + A/2.0
      SUM2 = SUM2 + B/2.0
      GO TO 18
```

```
11 MM = M+1-IS
   A = W(M)*PI(MM-1) + W(M+1)*PI(MM)
   B = W(M) + W(M+1)
   SUM = SUM + A/2.0
   SUM2 = SUM2 + B/2.0
12 M=M+1
   IF(M.NE.I) GO TO 10
13 PROD(I,IM) = SUM/SUM2
 9 CONTINUE
16 CONTINUE
   DO 30 IM = 19,25
   MEAN = XMEAN(IM) + 1.0
   FMEAN = MEAN
   DIFF = XMEAN(IM) - FMEAN
39 FAC = DIFF/(XMEAN(IM)-XMEAN(IM+1))
   DO 31 I = 20,70,5
   QUOT(I) = PROD(I,IM)*(1.0-FAC) + FAC*PROD(I,IM+1)
31 CONTINUE
   DO 14 I = 20,65,5
   IF(IS-20) 20,20,22
20 WEIGHT1(I,MEAN) = (CONST1(I) - QUOT(I+5))/(QUOT(I) - QUOT(I+5))
   IF(IS.NE.20) GO TO 14
22 WEIGHT2(I,MEAN) = (CONST2(I)-QUOT(I+5))/(QUOT(I)-QUOT(I+5))
14 CONTINUE
   MEAN1 = XMEAN(IM+1) + 1.0
   IF((MEAN1-MEAN).LE.1) GO TO 30
   DIFF = DIFF-1.0
   MEAN = MEAN + 1
   GO TO 39
30 CONTINUE
   WRITE(6,201)
   IF(IS-20) 32,32,34
32 WRITE(6,203)
   DO 35 MEAN = 19,30
   WRITE(6,202) IS,MEAN,(WEIGHT1(I,MEAN),I=20,65,5)
35 CONTINUE
   IF(IS.EQ.20) GO TO 34
   GO TO 7
34 WRITE(6,204)
   DO 36 MEAN = 19,30
   WRITE(6,202)IS,MEAN,(WEIGHT2(I,MEAN),I=20,65,5)
36 CONTINUE
 7 CONTINUE
100 FORMAT(10F8.4)
200 FORMAT(1H1,8HALPHA = ,F8.4,10H   BETA = ,F8.4,9H   XL2 = ,F8.4,10H
  1   RATE = ,F8.4,/1X,14HMARRIAGE RATES,10F8.4,/15X,10F8.4,/15X,10F8
  2.4,/15X,10F8.4/)
201 FORMAT(/41X,20HCENTRAL AGE OF WOMEN,/10X,6HFEMALE,10H   MALE   ,77H
  1   20       25       30       35       40       45       50       55
  2   ...    ...,/10X,5H YEAR ,10H   MEAN   /)
202 FORMAT(/I14,I9,2X,10F8.4)
203 FORMAT(/1 X,14H1(I+5)/1(22.5))
204 FORMAT(/1 X,14H1(N+5)/1(27.5))
   STOP
   END
```

Appendix 4.2

Full Weights for Converting Proportions Widowed into Life Table Functions

The full set of weights for converting proportions widowed into life table functions, for a range of respondents' and spouses' mean ages at marriage, is reproduced in Table A.4.2. The mortality model used throughout has an $l_{(2)}$ of 800 and beta of 1.00; the implied value of alpha is 0.0221. The population growth rate is taken as two per cent per annum, consistent with a total fertility rate of 6.0. The marriage distributions used are described in Chapter 4. The means referred to in the tables are also described in Chapter 4.

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TABLE A.4.2. : FULL WEIGHTS FOR CONVERTING PROPORTIONS WIDOWED INTO LIFE TABLE FUNCTIONS

WIDOWHOOD

FUNCTION ESTIMATED : $l_{(N+5)}/l_{(22\frac{1}{2})}$

Female Mean = 15

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	.9140	.9544	.9492	.8219	.7785	.7211	.6471	.5829	.4781	.3813
20	.9383	.9031	.9083	.8963	.8728	.8370	.7841	.7377	.6481	.5613
21	.9594	.9443	.9606	.9650	.9619	.9476	.9155	.8873	.8144	.7405
22	.9772	.9786	1.0068	1.0287	1.0462	1.0533	1.0422	1.0325	.9782	.9207
23	.9916	1.0068	1.0482	1.0885	1.1268	1.1551	1.1648	1.1743	1.1409	1.1036
24	1.0026	1.0300	1.0859	1.1454	1.2043	1.2536	1.2843	1.3138	1.3043	1.2912
25	1.0107	1.0500	1.1215	1.2005	1.2799	1.3499	1.4015	1.4525	1.4698	1.4864
26	1.0168	1.0684	1.1566	1.2552	1.3546	1.4449	1.5174	1.5917	1.6392	1.6924
27	1.0220	1.0869	1.1925	1.3103	1.4292	1.5394	1.6329	1.7330	1.8146	1.9134
28	1.0273	1.1064	1.2299	1.3665	1.5043	1.6342	1.7491	1.8780	1.9981	2.1548
29	1.0333	1.1277	1.2691	1.4241	1.5802	1.7294	1.8668	2.0280	2.1922	2.4228
30	1.0402	1.1506	1.3101	1.4828	1.6568	1.8254	1.9869	2.1842	2.4001	2.7251

Female Mean = 16

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	.7589	.6558	.6510	.6256	.5826	.5242	.4479	.3818	.2751	.1805
20	.8258	.7042	.7113	.7022	.6802	.6444	.5897	.5412	.4489	.3614
21	.8487	.7436	.7650	.7730	.7724	.7540	.7256	.6948	.6177	.5401
22	.8640	.7805	.8128	.8391	.8600	.8686	.8562	.8435	.7828	.7180
23	.8937	.8095	.8558	.9012	.9437	.9740	.9823	.9879	.9455	.8968
24	.8959	.8337	.8952	.9605	1.0244	1.0758	1.1048	1.1292	1.1073	1.0783
25	.9050	.8548	.9326	1.0181	1.1030	1.1752	1.2245	1.2685	1.2698	1.2647
26	.9121	.8744	.9695	1.0753	1.1806	1.2724	1.3425	1.4073	1.4347	1.4586
27	.9182	.8942	1.0072	1.1329	1.2580	1.3694	1.4546	1.5468	1.6037	1.6635
28	.9244	.9152	1.0465	1.1917	1.3357	1.4657	1.5765	1.6886	1.7797	1.8834
29	.9315	.9379	1.0880	1.2518	1.4140	1.5637	1.6940	1.8340	1.9618	2.1234
30	.9396	.9625	1.1311	1.3131	1.4928	1.6610	1.8128	1.9841	2.1552	2.3898

TABLE A.4.2. : (Continued)

WIDOWHOOD

FUNCTION ESTIMATED : $l_{(M+5)}/l_{(22\frac{1}{2})}$

Female Mean = 17

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	.6515	.4571	.4506	.4250	.3810	.3206	.2416	.1743	.0668	-.0229
20	.6821	.5049	.5116	.5033	.4815	.4449	.3885	.3389	.2453	.1605
21	.7080	.5460	.5661	.5760	.5767	.5636	.5292	.4971	.4179	.3402
22	.7294	.5809	.6150	.6440	.6673	.6772	.6642	.6498	.5857	.5176
23	.7467	.6102	.6592	.7082	.7541	.7864	.7943	.7977	.7498	.6943
24	.7602	.6349	.6999	.7696	.8378	.8919	.9203	.9418	.9116	.8719
25	.7704	.6566	.7387	.8294	.9195	.9947	1.0432	1.0829	1.0727	1.0522
26	.7785	.6770	.7771	.8890	1.0002	1.0956	1.1639	1.2225	1.2347	1.2376
27	.7856	.6976	.8164	.9491	1.0805	1.1954	1.2831	1.3617	1.3993	1.4306
28	.7929	.7196	.8575	1.0104	1.1611	1.2948	1.4016	1.5018	1.5681	1.6345
29	.8011	.7435	.9007	1.0731	1.2422	1.3940	1.5201	1.6442	1.7429	1.8534
30	.8105	.7692	.9459	1.1370	1.3236	1.4932	1.6389	1.7899	1.9255	2.0921

Female Mean = 18

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	.4564	.2573	.2486	.2209	.1741	.1102	.0279	-.0404	-.1478	-.2305
20	.4928	.2952	.3100	.3003	.2771	.2386	.1802	.1299	.0363	-.0430
21	.5232	.3459	.3648	.3744	.3749	.3614	.3259	.2934	.2137	.1393
22	.5491	.3805	.4142	.4440	.4683	.4790	.4657	.4508	.3853	.3178
23	.5678	.4097	.4590	.5094	.5580	.5921	.6002	.6028	.5521	.4940
24	.5830	.4344	.5006	.5731	.6447	.7015	.7303	.7504	.7154	.6696
25	.5965	.4563	.5404	.6349	.7294	.8079	.8568	.8944	.8767	.8462
26	.6030	.4770	.5799	.6965	.9131	.9123	.9807	1.0359	1.0375	1.0257
27	.6129	.4979	.6205	.7589	.8966	1.0154	1.1027	1.1761	1.1994	1.2103
28	.6204	.5204	.6630	.8226	.9802	1.1178	1.2236	1.3160	1.3639	1.4026
29	.6300	.5449	.7078	.8878	1.0643	1.2197	1.3438	1.4569	1.5326	1.6057
30	.6409	.5715	.7567	.9543	1.1485	1.3212	1.4636	1.5998	1.7071	1.8235

TABLE A.4.2. : (Continued)

WIDOWHOOD

FUNCTION ESTIMATED : $1_{(N+5)}/1_{(22\frac{1}{2})}$

Female Mean = 19

MALE MEAN	20	25	30	35	40	45	50	55	60	65
	CENTRAL AGE OF WOMEN									
19	.1884	.0546	.0463	.0142	-.0375	-.1066	-.1934	-.2629	-.3694	-.4436
20	.2336	.1040	.1073	.0941	.0674	.0255	-.0357	-.0862	-.1791	-.2508
21	.2711	.1452	.1620	.1690	.1675	.1522	.1153	.0831	.0039	-.0644
22	.3016	.1797	.2113	.2396	.2633	.2738	.2602	.2457	.1803	.1167
23	.3255	.2085	.2563	.3067	.3556	.3909	.3995	.4025	.3511	.2942
24	.3434	.2329	.2981	.3714	.4451	.5042	.5341	.5542	.5173	.4695
25	.3568	.2546	.3383	.4348	.5327	.6145	.6647	.7018	.6802	.6442
26	.3674	.2751	.3785	.4982	.6194	.7227	.7923	.8462	.8412	.8200
27	.3769	.2960	.4199	.5625	.7059	.8293	.9177	.9885	1.0020	.9989
28	.3867	.3164	.4635	.6285	.7928	.9351	1.0415	1.1296	1.1640	1.1830
29	.3978	.3431	.5095	.6961	.8799	1.0401	1.1641	1.2704	1.3285	1.3746
30	.4104	.3700	.5578	.7652	.9673	1.1445	1.2859	1.4120	1.4971	1.5769

Female Mean = 20

MALE MEAN	20	25	30	35	40	45	50	55	60	65
	CENTRAL AGE OF WOMEN									
19	-.1982	-.1539	-.1565	-.1943	-.2534	-.3296	-.4224	-.4936	-.5988	-.6636
20	-.1396	-.1009	-.0960	-.1145	-.1469	-.1940	-.2593	-.3102	-.4016	-.4642
21	-.0937	-.0575	-.0418	-.0395	-.0451	-.0638	-.1029	-.1346	-.2123	-.2724
22	-.0510	-.0221	.0071	.0316	.0528	.0616	.0472	.0338	-.0302	-.0871
23	-.0199	.0069	.0517	.0995	.1473	.1827	.1917	.1959	.1454	.0931
24	.0031	.0310	.0933	.1651	.2393	.2999	.3311	.3524	.3156	.2696
25	.0199	.0521	.1334	.2296	.3295	.4141	.4663	.5042	.4814	.4441
26	.0325	.0721	.1737	.2945	.4191	.5262	.5981	.6524	.6443	.6182
27	.0436	.0925	.2155	.3605	.5086	.6367	.7273	.7977	.8055	.7936
28	.0581	.1145	.2596	.4283	.5985	.7462	.8546	.9410	.9664	.9721
29	.0682	.1389	.3065	.4981	.6890	.8548	.9803	1.0831	1.1286	1.1557
30	.0932	.1656	.3558	.5695	.7796	.9625	1.1046	1.2249	1.2932	1.3468

TABLE A.4.2. : (Continued)

WIDOWHOOD

FUNCTION ESTIMATED : $1_{(N+5)}/1_{(27\frac{1}{2})}$

Female Mean = 20

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	2.2912	.8987	.7837	.6646	.4865	.2690	.0343	-.1619	-.3702	-.5144
20	2.2231	.9137	.8332	.7274	.5709	.3823	.1786	.0080	-.1811	-.3188
21	2.1754	.9352	.8754	.7837	.6499	.4903	.3167	.1708	.0005	-.1303
22	2.1325	.9534	.9107	.8344	.7243	.5936	.4492	.3271	.1755	.0522
23	2.0991	.9681	.9400	.8804	.7949	.6927	.5766	.4777	.3447	.2301
24	2.0743	.9794	.9645	.9230	.8627	.7885	.6997	.6234	.5090	.4050
25	2.0562	.9877	.9859	.9638	.9288	.8819	.8193	.7652	.6696	.5783
26	2.0425	.9941	1.0059	1.0042	.9944	.9738	.9365	.9040	.8279	.7518
27	2.0306	.9997	1.0266	1.0454	1.0603	1.0650	1.0519	1.0407	.9853	.9272
28	2.0183	1.0054	1.0472	1.0881	1.1270	1.1559	1.1662	1.1761	1.1433	1.1063
29	2.0041	1.0119	1.0703	1.1328	1.1948	1.2468	1.2798	1.3112	1.3031	1.2913
30	1.9883	1.0191	1.0951	1.1792	1.2635	1.3377	1.3928	1.4466	1.4662	1.4846

Female Mean = 21

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	2.6292	.7709	.5848	.4643	.2853	.0580	-.1865	-.3896	-.6010	-.7392
20	2.5466	.7986	.6340	.5280	.3691	.1744	-.0373	-.2133	-.4050	-.5365
21	2.4751	.8222	.6763	.5854	.4503	.2856	.1056	-.0445	-.2170	-.3419
22	2.4187	.8420	.7121	.6373	.5265	.3922	.2429	.1174	-.0362	-.1544
23	2.3734	.8581	.7422	.6847	.5993	.4948	.3748	.2732	.1381	.0272
24	2.3397	.8705	.7675	.7289	.6694	.5941	.5024	.4236	.3067	.2043
25	2.3156	.8800	.7899	.7712	.7379	.6909	.6262	.5696	.4708	.3784
26	2.2981	.8874	.8110	.8132	.8060	.7862	.7472	.7121	.6315	.5512
27	2.2837	.8938	.8323	.8562	.8745	.8806	.8662	.8519	.7900	.7244
28	2.2691	.9005	.8549	.9008	.9440	.9748	.9837	.9898	.9478	.8995
29	2.2522	.9080	.8793	.9476	1.0145	1.0688	1.1031	1.1265	1.1061	1.0783
30	2.2127	.8165	.9056	.9961	1.0860	1.1626	1.2156	1.2625	1.2661	1.2628

WIDOWHOOD

FUNCTION ESTIMATED : $l_{(N+5)}/l_{(22\frac{1}{2})}$

Female Mean = 22

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	3.1951	.6196	.3856	.2623	.0757	-.1594	-.4145	-.6257	-.8404	-.9722
20	3.0786	.6513	.4344	.3263	.1631	-.0394	-.2606	-.4428	-.6368	-.7617
21	2.9801	.6780	.4763	.3841	.2454	.0747	-.1129	-.2677	-.4419	-.5600
22	2.8983	.7092	.5121	.4367	.3235	.1844	.0291	-.0997	-.2547	-.3663
23	2.8329	.7180	.5424	.4851	.3982	.2902	.1658	.0617	-.0746	-.1797
24	2.7839	.7318	.5682	.5303	.4703	.3928	.2980	.2174	.0992	.0011
25	2.7491	.7424	.5910	.5738	.5409	.4930	.4263	.3681	.2677	.1776
26	2.7243	.7509	.6127	.6171	.6113	.5918	.5516	.5149	.4319	.3514
27	2.7054	.7584	.6347	.6615	.6823	.6897	.6745	.6585	.5930	.5240
28	2.6871	.7660	.6582	.7078	.7544	.7873	.7957	.7996	.7521	.6970
29	2.6659	.7747	.6837	.7563	.8277	.8847	.9155	.9389	.9104	.8719
30	2.6407	.7846	.7112	.8068	.9019	.9817	1.0340	1.0768	1.0690	1.0504

Female Mean = 23

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	4.3308	.4191	.1851	.0591	-.1344	-.3797	-.6493	-.8704	-1.0890	-1.2143
20	4.1479	.4570	.2342	.1230	-.0465	-.2585	-.4911	-.6808	-.8773	-.9952
21	3.9927	.4886	.2760	.1809	.0368	-.1420	-.3388	-.4991	-.6748	-.7856
22	3.8625	.5144	.3114	.2336	.1160	-.0296	-.1921	-.3247	-.4807	-.5848
23	3.7588	.5364	.3415	.2823	.1921	.0791	-.0506	-.1572	-.2942	-.3920
24	3.6766	.5536	.3672	.3260	.2657	.1848	.0863	.0041	-.1145	-.2060
25	3.6192	.5655	.3931	.3722	.3382	.2883	.2192	.1601	.0592	-.0257
26	3.5793	.5721	.4119	.4164	.4106	.3905	.3491	.3117	.2280	.1505
27	[illegible]	[illegible]	.4342	.4619	.4837	.4919	.4764	.4597	.3927	.3241
28	3.5243	.5807	.4531	.5095	.5563	.5930	.6017	.6046	.5545	.4967
29	3.4366	.5967	.4841	.5594	.6342	.6940	.7253	.7475	.7142	.6696
30	[illegible]	.6111	.5123	.6116	.7112	.7945	.8473	.8881	.8729	.8443

TABLE A.4.2. : (Continued)

WIDOWHOOD

FUNCTION ESTIMATED : $l_{(N+5)}/l_{(27\frac{1}{2})}$

Female Mean = 24

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
19	7.7461	.1435	-.0186	-.1444	-.3465	-.6053	-.8907	-1.1237	-1.3474	-1.4660
20	7.3655	.1907	.0323	-.0811	-.2587	-.4825	-.7285	-.9275	-1.1271	-1.2379
21	7.0421	.2299	.0748	-.0237	-.1752	-.3640	-.5719	-.7391	-.9165	-1.0197
22	6.7694	.2617	.1102	.0287	-.0954	-.2494	-.4207	-.5581	-.7149	-.8110
23	6.5448	.2866	.1400	.0772	-.0185	-.1382	-.2746	-.3843	-.5214	-.6109
24	6.3721	.3053	.1653	.1228	.0563	-.0297	-.1330	-.2168	-.3352	-.4187
25	6.2477	.3193	.1879	.1672	.1301	.0769	.0047	-.0551	-.1555	-.2332
26	6.1615	.3303	.2095	.2118	.2041	.1823	.1393	.1019	.0186	-.0530
27	6.1009	.3402	.2315	.2579	.2792	.2872	.2712	.2549	.1880	.1232
28	6.0504	.3505	.2553	.3063	.3559	.3919	.4011	.4045	.3535	.2968
29	5.9943	.3621	.2814	.3574	.4343	.4964	.5289	.5512	.5160	.4694
30	5.9243	.3754	.3098	.4109	.5139	.6006	.6549	.6953	.6763	.6423

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED : $^{1}(N-5)/^{1}(17\frac{1}{2})$

Male Mean = 20

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	.8693	.7126	.7013	.7160	.7193	.7155	.7006	.6674	.6382	.5648
16	.9040	.7879	.7883	.8109	.8262	.8370	.8374	.8195	.8033	.7428
17	.9368	.8576	.8676	.8986	.9264	.9520	.9678	.9654	.9630	.9177
18	.9666	.9200	.9379	.9780	1.0193	1.0599	1.0915	1.1053	1.1176	1.0907
19	.9931	.9735	.9988	1.0494	1.1049	1.1611	1.2089	1.2396	1.2692	1.2630
20	1.0163	1.0179	1.0510	1.1132	1.1838	1.2561	1.3208	1.3688	1.4162	1.4359
21	1.0359	1.0533	1.0952	1.1706	1.2570	1.3459	1.4280	1.4939	1.5628	1.6109
22	1.0509	1.0805	1.1324	1.2225	1.3252	1.4312	1.5313	1.6157	1.7097	1.7899
23	1.0615	1.1098	1.1644	1.2792	1.3898	1.5132	1.6316	1.7356	1.8581	1.9750
24	1.0683	1.1168	1.1935	1.3157	1.4523	1.5932	1.7299	1.8553	2.0097	2.1695

Male Mean = 21

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	.7501	.5172	.5009	.5162	.5208	.5177	.5029	.4684	.4379	.3623
16	.7899	.5916	.5884	.6128	.6305	.6433	.6447	.6257	.6080	.5436
17	.9268	.6630	.6684	.7025	.7339	.7624	.7799	.7764	.7719	.7204
18	.8597	.7211	.7397	.7841	.8298	.8744	.9081	.9206	.9301	.8939
19	.8865	.7741	.8019	.8577	.9186	.9796	1.0296	1.0588	1.0831	1.0653
20	.9132	.8185	.8555	.9239	1.0008	1.0794	1.1452	1.1914	1.2322	1.2359
21	.9345	.8566	.9014	.9836	1.0771	1.1717	1.2557	1.3193	1.3787	1.4071
22	.9533	.8826	.9405	1.0379	1.1484	1.2603	1.3619	1.4432	1.5239	1.5804
23	.9629	.9040	.9742	1.0880	1.2159	1.3452	1.4647	1.5643	1.6695	1.7577
24	.9697	.9211	1.0050	1.1358	1.2812	1.4279	1.5652	1.6840	1.8171	1.9413

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED : $^{1}(N-5)/^{1}(17\frac{1}{2})$

Male Mean = 22

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	.5944	.3186	.3004	.3143	.3179	.3138	.2980	.2621	.2310	.1546
16	.6414	.3944	.3877	.4118	.4300	.4432	.4449	.4252	.4066	.3406
17	.6845	.4626	.4679	.5028	.5359	.5662	.5850	.5811	.5756	.5209
18	.7224	.5228	.5397	.5861	.6346	.6823	.7180	.7301	.7381	.6964
19	.7548	.5748	.6026	.6616	.7263	.7913	.8440	.8725	.8946	.8683
20	.7821	.6187	.6571	.7296	.8114	.8940	.9637	1.0090	1.0462	1.0380
21	.8047	.6547	.7041	.7913	.8907	.9909	1.0779	1.1403	1.1939	1.2070
22	.8224	.6831	.7444	.8476	.9649	1.0830	1.1873	1.2671	1.3391	1.3766
23	.8351	.7051	.7795	.8998	1.0354	1.1711	1.2930	1.3904	1.4832	1.5484
24	.8439	.7228	.8117	.9498	1.1036	1.2568	1.3961	1.5114	1.6281	1.7244

Male Mean = 23

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	.3853	.1129	.0994	.1110	.1113	.1043	.0861	.0483	.0172	-.0593
16	.4423	.1930	.1869	.2087	.2252	.2371	.2380	.2174	.1988	.1325
17	.4944	.2635	.2669	.3004	.3332	.3638	.3831	.3790	.3733	.3175
18	.5399	.3242	.3386	.3847	.4343	.4835	.5209	.5332	.5408	.4964
19	.5783	.3758	.4017	.4614	.5284	.5964	.6516	.6804	.7017	.6704
20	.6100	.4191	.4566	.5310	.6161	.7028	.7757	.8211	.8568	.8408
21	.6357	.4546	.5041	.5943	.6980	.8034	.8939	.9563	1.0070	1.0090
22	.6553	.4826	.5451	.6522	.7751	.8990	1.0070	1.0865	1.1535	1.1765
23	.6693	.5049	.5811	.7061	.8483	.9906	1.1160	1.2127	1.2977	1.3447
24	.6739	.5228	.6143	.7579	.9193	1.0795	1.2221	1.3360	1.4413	1.5154

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED : $l_{(N-5)}/l_{(17\frac{1}{2})}$

Male Mean = 24

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	.0946	-.1041	-.1014	-.0929	-.0983	-.1102	-.1326	-.1734	-.2042	-.2804
16	.1658	-.0167	-.0139	.0046	.0168	.0255	.0241	.0019	-.0161	-.0820
17	.2310	.0590	.0658	.0962	.1263	.1553	.1741	.1696	.1644	.1088
18	.2877	.1229	.1372	.1808	.2292	.2785	.3167	.3294	.3374	.2925
19	.3354	.1759	.2001	.2562	.3254	.3949	.4522	.4818	.5033	.4699
20	.3746	.2193	.2549	.3287	.4152	.5049	.5808	.6273	.6628	.6425
21	.4057	.2545	.3023	.3930	.4995	.6091	.7034	.7667	.8166	.8115
22	.4290	.2822	.3434	.4522	.5790	.7043	.8205	.9008	.9656	.9783
23	.4452	.3040	.3797	.5074	.6548	.8034	.9332	1.0305	1.1113	1.1445
24	.4560	.3218	.4134	.5607	.7284	.8957	1.0427	1.1567	1.2551	1.3118

Male Mean = 25

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	-.3274	-.3363	-.3057	-.2968	-.3099	-.3291	-.3579	-.4032	-.4338	-.5094
16	-.2362	-.2369	-.2158	-.2000	-.1944	-.1911	-.1967	-.2215	-.2386	-.3038
17	-.1518	-.1548	-.1353	-.1089	-.0840	-.0546	-.0421	-.0476	-.0516	-.1063
18	-.0781	-.0447	-.0642	-.0246	.0202	.0675	.1053	.1182	.1273	.0832
19	-.0159	-.0276	-.0018	.0527	.1179	.1871	.2455	.2762	.2987	.2655
20	.0355	.0181	.0526	.1235	.2094	.3004	.3768	.4268	.4632	.4416
21	.0763	.0540	.0497	.1884	.2956	.4081	.5059	.5710	.6214	.6128
22	.1065	.1417	.1404	.2482	.3772	.5197	.6274	.7094	.7741	.7805
23	.1271	.1030	.1764	.3043	.4552	.6043	.7441	.8429	.9225	.9462
24	.1494	.1233	.2044	.3587	.5312	.7051	.8573	.9727	1.0678	1.1115

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED : $l_{(N-5)}/l_{(22\frac{1}{2})}$

Male Mean = 25

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	2.6154	.7882	.6125	.5596	.4689	.3359	.1765	.0028	-.1392	-.3056
16	2.5044	.8271	.6892	.6481	.5688	.4542	.3179	.1681	.0444	-.1069
17	2.4017	.8633	.7600	.7290	.6619	.5663	.4528	.3261	.2205	.0840
18	2.3120	.8958	.8233	.8013	.7474	.6714	.5806	.4765	.3890	.2674
19	2.2362	.9244	.8777	.8646	.8251	.7694	.7014	.6196	.5506	.4443
20	2.1738	.9491	.9231	.9194	.8956	.8610	.8157	.7561	.7057	.6155
21	2.1242	.9697	.9596	.9665	.9600	.9458	.9242	.8868	.8550	.7824
22	2.0874	.9857	.9881	1.0070	1.0190	1.0276	1.0277	1.0124	.9995	.9465
23	2.0623	.9970	1.0100	1.0424	1.0740	1.1046	1.1272	1.1337	1.1403	1.1093
24	2.0461	1.0045	1.0277	1.0751	1.1269	1.1793	1.2239	1.2520	1.2788	1.2723

Male Mean = 26

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	3.0552	.6564	.4155	.3588	.2659	.1234	-.0383	-.2204	-.3671	-.5366
16	[illegible]	.7015	.4929	.4474	.3670	.2492	.1072	-.0493	-.1765	-.3308
17	2.7788	.7429	.5519	.5289	.4617	.3640	.2464	.1144	.0060	-.1331
18	2.6610	.7745	.6241	.6019	.5489	.4719	.3785	.2704	.1804	.0565
19	2.5697	.8110	.6780	.6662	.6286	.5730	.5035	.4188	.3473	.2386
20	2.4771	[illegible]	.7234	.7222	.7012	.6677	.6220	.5602	.5074	.4140
21	[illegible]	[illegible]	.7604	.7708	.7676	.7566	.7346	.6953	.6612	.5839
22	[illegible]	.8775	.7997	.8129	.8288	.8406	.8420	.8249	.8095	.7496
23	[illegible]	[illegible]	[illegible]	.8438	.8861	.9207	.9451	.9500	.9533	.9126
24	2.3617	[illegible]	[illegible]	.8840	.9413	.9345	1.0451	1.0716	1.0938	1.0746

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED : $l_{(N-5)}/l_{(22\frac{1}{2})}$

Male Mean = 25

FEMALE MEAN	25	30	35	40	45	50	55	60	65	70
	CENTRAL AGE OF MEN									
15	2.6154	.7482	.6125	.5596	.4689	.3359	.1765	.0028	-.1392	-.3056
16	2.5044	.8271	.6892	.6481	.5688	.4542	.3179	.1681	.0444	-.1069
17	2.4017	.8633	.7600	.7290	.6619	.5663	.4528	.3261	.2205	.0840
18	2.3120	.8958	.8233	.8013	.7474	.6714	.5806	.4765	.3890	.2674
19	2.2362	.9244	.8777	.8646	.8251	.7694	.7014	.6196	.5506	.4443
20	2.1738	.9491	.9231	.9194	.8956	.8610	.8157	.7561	.7057	.6155
21	2.1242	.9697	.9596	.9665	.9600	.9468	.9242	.8868	.8550	.7824
22	2.0874	.9857	.9881	1.0070	1.0190	1.0276	1.0277	1.0124	.9995	.9465
23	2.0623	.9970	1.0100	1.0424	1.0740	1.1046	1.1272	1.1337	1.1403	1.1093
24	2.0461	1.0045	1.0277	1.0751	1.1269	1.1793	1.2239	1.2520	1.2788	1.2723

Male Mean = 26

FEMALE MEAN	25	30	35	40	45	50	55	60	65	70
	CENTRAL AGE OF MEN									
15	3.0552	.6564	.4155	.3588	.2659	.1284	-.0393	-.2204	-.3671	-.5366
16	[illegible]	[illegible]	.4920	.4474	.3670	.2492	.1072	-.0493	-.1765	-.3308
17	2.7788	.7429	.5619	.5289	.4617	.3640	.2464	.1144	.0060	-.1331
18	2.6610	.7745	.6241	.6019	.5489	.4719	.3785	.2704	.1804	.0565
19	[illegible]	.8110	.6780	.6652	.6286	.5730	.5035	.4188	.3473	.2386
20	2.4771	[illegible]	.7234	.7222	.7012	.6677	.6220	.5602	.5074	.4140
21	[illegible]	[illegible]	.7604	.7708	.7676	.7566	.7346	.6953	.6612	.5839
22	[illegible]	.8775	.7497	.8124	.8288	.8406	.8420	.8249	.8095	.7496
23	[illegible]	[illegible]	[illegible]	[illegible]	.8861	.9297	.9451	.9500	.9533	.9126
24	2.3017	[illegible]	[illegible]	.8840	.9413	.9345	1.0451	1.0716	1.0938	1.0746

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED : $l_{(N-5)}/l_{(22\frac{1}{2})}$

Male Mean = 27

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45
15	3.7890	.4844	.2145	.1576	.0613
16	3.5958	.5381	.2932	.2462	.1628
17	3.4103	.5870	.3636	.3277	.2584
18	3.2457	.6297	.4253	.4010	.3468
19	3.1049	.6659	.4784	.4657	.4279
20	2.9865	.6961	.5233	.5223	.5021
21	2.8889	.7208	.5602	.5717	.5703
22	2.8142	.7398	.5897	.6148	.6333
23	2.7622	.7536	.6129	.6529	.6924
24	2.7289	.7631	.6320	.6883	.7496

Male Mean = 28

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45
15	5.2551	.2535	.0054	-.0431	-.1442
16	4.9644	.3142	.0894	.0450	-.0429
17	4.6773	.3788	.1623	.1262	.0528
18	4.4192	.4305	.2257	.1993	.1417
19	4.1977	.4741	.2789	.2639	.2237
20	4.0108	.5049	.3233	.3207	.2990
21	3.9539	.5385	.3598	.3703	.3684
22	3.7309	.5602	.3890	.4137	.4328
23	3.6440	.5756	.4122	.4525	.4935
24	3.5472	.5862	.4313	.4887	.5523

50	55	60	65	70
-.0829	-.2588	-.4511	-.6037	-.7760
.0397	-.1097	-.2744	-.4057	-.5625
.1567	.0333	-.1049	-.2163	-.3577
.2671	.1695	.0567	-.0355	-.1613
.3708	.2987	.2106	.1373	.0269
.4682	.4214	.3572	.3027	.2076
.5600	.5381	.4972	.4615	.3818
.6470	.6494	.6313	.6143	.5505
.7301	.7563	.7604	.7619	.7153
.8109	.8601	.8857	.9056	.8777

50	55	60	65	70
-.2973	-.4845	-.6893	-.8492	-1.0244
-.1735	-.3323	-.5070	-.6437	-.8028
-.0549	-.1859	-.3320	-.4469	-.5903
.0575	-.0460	-.1647	-.2592	-.3867
.1633	.0871	-.0052	-.0800	-.1918
.2631	.2137	.1468	.0913	-.0049
.3574	.3344	.2920	.2554	.1746
.4470	.4498	.4309	.4132	.3477
.5329	.5607	.5646	.5653	.5156
.6166	.6683	.6940	.7130	.6798

TABLE A.4.2. : (Continued)

WIDOWERHOOD

FUNCTION ESTIMATED ; $1_{(N-5)}/1_{(22\frac{1}{2})}$

Male Mean = 29

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
15	9.6465	-.0667	-.2160	-.2452	-.3497	-.5140	-.7147	-.9344	-1.1038	-1.2824
16	9.0686	.0154	-.1236	-.1562	-.2492	-.3896	-.5601	-.7471	-.8906	-1.0521
17	9.4809	.0904	-.0440	-.0753	-.1540	-.2700	-.4107	-.5667	-.6863	-.8314
18	7.9454	.1555	.0229	-.0027	-.0653	-.1564	-.2677	-.3939	-.4913	-.6202
19	7.4931	.2102	.0781	.0616	.0168	-.0489	-.1311	-.2289	-.3052	-.4181
20	7.0941	.2550	.1231	.1180	.0926	.0527	-.0007	-.0713	-.1276	-.2244
21	6.7632	.2904	.1594	.1674	.1627	.1492	.1238	.0792	.0424	-.0387
22	6.4980	.3168	.1882	.2107	.2280	.2411	.2431	.2234	.2055	.1398
23	6.3078	.3350	.2109	.2494	.2898	.3294	.3579	.3619	.3627	.3121
24	6.1812	.3472	.2298	.2858	.3499	.4157	.4694	.4959	.5149	.4796

Appendix 4.3

The Effect on Widowhood Weights of Different Mortality Assumptions

Widowhood and widowerhood weights for different levels and patterns of mortality are shown in Table A.4.3. The mortality assumptions are shown in the tables. The weights are all for one mean age of respondent, 20 for female respondents and 25 for male respondents. Both estimating equations for each sex are used.

TABLE A.4.3. : WIDOWHOOD WEIGHTS FOR DIFFERENT MORTALITY PATTERNS

WIDOWHOOD

MORTALITY PARAMETERS : Alpha = 0.4057 Beta = 1.0 $l_{(2)}$ = 650 Growth Rate = 1.15%

Female Mean = 20

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
Function Estimated : $l_{(N+5)}/l_{(22\frac{1}{2})}$										
19	-.1865	-.1340	-.1252	-.1537	-.2080	-.2841	-.3797	-.4551	-.5596	-.6203
20	-.1331	-.0879	-.0753	-.0886	-.1198	-.1695	-.2396	-.2958	-.3875	-.4456
21	-.0890	-.0511	-.0318	-.0281	-.0357	-.0592	-.1045	-.1420	-.2206	-.2756
22	-.0538	-.0224	.0063	.0284	.0450	.0475	.0262	.0068	-.0582	-.1094
23	-.0271	-.0001	.0400	.0820	.1231	.1510	.1529	.1515	.1004	.0543
24	-.0063	.0173	.0707	.1336	.1993	.2521	.2764	.2929	.2559	.2165
25	.0041	.0315	.1000	.1847	.2749	.3516	.3976	.4318	.4094	.3790
26	.0122	.0445	.1297	.2367	.3508	.4505	.5173	.5692	.5621	.5432
27	.0185	.0580	.1612	.2907	.4280	.5496	.6364	.7061	.7156	.7108
28	.0251	.0732	.1956	.3474	.5070	.6494	.7558	.8433	.8710	.8835
29	.0335	.0909	.2333	.4071	.5881	.7502	.8756	.9815	1.0299	1.0633
30	.0439	.1113	.2742	.4697	.6708	.8520	.9963	1.1215	1.1934	1.2524
Function Estimated : $l_{(N+5)}/l_{(27\frac{1}{2})}$										
19	2.2773	.9047	.8334	.7459	.5881	.3791	.1405	-.0652	-.2820	-.4327
20	2.2198	.9277	.8779	.7990	.6582	.4735	.2642	.0826	-.1163	-.2602
21	2.1723	.9474	.9148	.8452	.7230	.5643	.3831	.2254	.0446	-.0920
22	2.1344	.9637	.9443	.8855	.7834	.6512	.4980	.3638	.2015	.0730
23	2.1056	.9765	.9675	.9211	.8404	.7350	.6094	.4987	.3551	.2360
24	2.0854	.9858	.9856	.9532	.8951	.8165	.7182	.6308	.5063	.3983
25	2.0721	.9920	1.0003	.9837	.9488	.8969	.8253	.7612	.6562	.5615
26	2.0634	.9962	1.0136	1.0141	1.0029	.9773	.9318	.8907	.8061	.7272
27	2.0566	.9994	1.0271	1.0460	1.0584	1.0545	1.0386	1.0205	.9576	.8970
28	2.0495	1.0027	1.0422	1.0803	1.1161	1.1412	1.1464	1.1513	1.1120	1.0729
29	2.0435	1.0059	1.0594	1.1173	1.1762	1.2258	1.2556	1.2841	1.2707	1.2569
30	2.0293	1.0120	1.0789	1.1571	1.2387	1.3121	1.3664	1.4195	1.4350	1.4513

TABLE A.4.3. : (Continued)

WIDOWHOOD

MORTALITY PARAMETERS : Alpha = -0.3834 Beta = 1.0 $l_{(2)}$ = 900 Growth Rate = 3.15%

Female Mean = 20

MALE MEAN	CENTRAL AGE OF WOMEN 20	25	30	35	40	45	50	55	60	65
Function Estimated : $l_{(N+5)}/l_{(22\frac{1}{2})}$										
19	-.2105	-.1692	-.1810	-.2259	-.2874	-.3608	-.4462	-.5066	-.6067	-.6757
20	-.1472	-.1107	-.1117	-.1336	-.1649	-.2058	-.2606	-.2980	-.3806	-.4447
21	-.0942	-.0621	-.0487	-.0462	-.0476	-.0576	-.0841	-.1006	-.1669	-.2266
22	-.0507	-.0215	.0089	.0370	.0649	.0843	.0838	.0863	.0351	-.0197
23	-.0164	.0126	.0623	.1166	.1733	.2202	.2436	.2636	.2266	.1775
24	.0097	.0420	.1126	.1936	.2782	.3508	.3959	.4321	.4086	.3668
25	.0296	.0686	.1615	.2692	.3804	.4766	.5416	.5927	.5824	.5500
26	.0458	.0941	.2104	.3444	.4807	.5985	.6813	.7464	.7496	.7288
27	.0605	.1202	.2606	.4202	.5797	.7169	.8159	.8940	.9115	.9051
28	.0759	.1478	.3128	.4969	.6777	.8321	.9457	1.0363	1.0695	1.0806
29	.0931	.1777	.3671	.5745	.7745	.9442	1.0713	1.1743	1.2252	1.2575
30	.1119	.2047	.4234	.6526	.8699	1.0532	1.1927	1.3088	1.3797	1.4381
Function Estimated : $l_{(N+5)}/l_{(27\frac{1}{2})}$										
19	2.3056	.8751	.7449	.6014	.4081	.1959	-.0409	-.2227	-.4184	-.5579
20	2.2373	.9017	.7985	.6722	.5047	.3164	.1232	-.0298	-.2025	-.3324
21	2.1801	.9248	.8449	.7366	.5956	.4394	.2789	.1526	.0016	-.1192
22	2.1332	.9444	.8846	.7955	.6815	.5565	.4268	.3253	.1948	.0832
23	2.0962	.9604	.9184	.8497	.7630	.6681	.5675	.4893	.3781	.2765
24	2.0681	.9731	.9477	.9004	.8410	.7750	.7016	.6453	.5526	.4624
25	2.0466	.9829	.9741	.9490	.9165	.8780	.8299	.7942	.7196	.6427
26	2.0292	.9909	.9991	.9969	.9905	.9778	.9534	.9369	.8806	.8190
27	2.0133	.9943	1.0242	1.0450	1.0636	1.0750	1.0725	1.0744	1.0370	.9932
28	1.9966	1.0058	1.0502	1.0941	1.1364	1.1700	1.1879	1.2074	1.1903	1.1672
29	1.9762	1.0141	1.0777	1.1441	1.2087	1.2630	1.2999	1.3368	1.3417	1.3431
30	1.9573	1.0231	1.1065	1.1950	1.2804	1.3538	1.4097	1.4636	1.4926	1.5232

TABLE A.4.3. : (Continued)

WIDOWHOOD

MORTALITY PARAMETERS : Alpha = -0.1210 Beta = 0.8 $l_{(2)}$ = 800 Growth Rate = 2.17%

Female Mean = 20

CENTRAL AGE OF WOMEN

MALE MEAN	20	25	30	35	40	45	50	55	60	65
Function Estimated : $l_{(N+5)}/l_{(22\frac{1}{2})}$										
19	-.1884	-.1404	-.1364	-.1691	-.2250	-.2989	-.3886	-.4544	-.5531	-.6143
20	-.1328	-.0913	-.0913	-.0960	-.1255	-.1692	-.2289	-.2707	-.3499	-.4020
21	-.0868	-.0516	-.0326	-.0275	-.0303	-.0445	-.0759	-.0952	-.1560	-.1998
22	-.0499	-.0198	.0108	.0371	.0613	.0757	.0710	.0727	.0293	-.0063
23	-.0214	.0055	.0501	.0988	.1499	.1918	.2122	.2335	.2066	.1796
24	-.0009	.0259	.0864	.1586	.2363	.3045	.3483	.3881	.3768	.3593
25	.0132	.0435	.1216	.2178	.3216	.4145	.4801	.5372	.5409	.5340
26	.0233	.0600	.1572	.2777	.4066	.5226	.6083	.6816	.6999	.7052
27	.0318	.0771	.1947	.3394	.4922	.6294	.7335	.8219	.8552	.8743
28	.0407	.0960	.2350	.4035	.5786	.7352	.8563	.9589	1.0077	1.0426
29	.0515	.1176	.2786	.4700	.6658	.8401	.9767	1.0930	1.1584	1.2116
30	.0644	.1418	.3251	.5386	.7535	.9439	1.0949	1.2248	1.3083	1.3830
Function Estimated : $l_{(N+5)}/l_{(27\frac{1}{2})}$										
19	2.2629	.9010	.8171	.7149	.5471	.3342	.1012	-.0936	-.2999	-.4452
20	2.2038	.9245	.8629	.7716	.6237	.4396	.2392	.0733	-.1083	-.2398
21	2.1544	.9446	.9012	.8217	.6951	.5399	.3710	.2326	.0746	-.0437
22	2.1156	.9616	.9326	.8662	.7621	.6337	.4972	.3850	.2495	.1441
23	2.0854	.9748	.9580	.9061	.8255	.7277	.6184	.5312	.4171	.3248
24	2.0636	.9847	.9795	.9428	.8265	.8166	.7352	.6718	.5783	.4999
25	2.0436	.9916	.9959	.9778	.9461	.9033	.8495	.8076	.7341	.6706
26	2.0379	.9967	1.0121	1.0128	1.0055	.9848	.9591	.9395	.8855	.8384
27	[illegible]	1.0008	1.0265	1.0490	1.0656	1.0736	1.0675	1.0681	1.0339	1.0044
28	[illegible]	1.0052	1.0464	1.0871	1.1269	1.1543	1.1743	1.1940	1.1802	1.1703
29	[illegible]	[illegible]	1.0663	1.1275	1.1855	1.2429	1.2797	1.3180	1.3255	1.3375
30	[illegible]	[illegible]	1.0883	1.1699	1.2532	1.3273	1.3836	1.4404	1.4706	1.5077

TABLE A.4.3. : (Continued)

WIDOWHOOD

MORTALITY PARAMETERS : Alpha = 0.2366 Beta = 1.3 $l_{(2)}$ = 800 Growth Rate = 1.75%

Female Mean = 20

CENTRAL AGE OF WOMEN

MALE MEAN	20	25	30	35	40	45	50	55	60	65
Function Estimated : $l_{(N+5)}/l_{(22\frac{1}{2})}$										
19	-.2126	-.1717	-.1821	-.2259	-.2890	-.3688	-.4656	-.5409	-.6438	-.6940
20	-.1498	-.1140	-.1154	-.1392	-.1765	-.2298	-.3036	-.3647	-.4623	-.5194
21	-.0972	-.0660	-.0551	-.0574	-.0688	-.0962	-.1478	-.1950	-.2861	-.3491
22	-.0539	-.0262	-.0001	.0201	.0345	.0325	.0023	-.0310	-.1147	-.1820
23	-.0196	.0070	.0503	.0941	.1342	.1568	.1473	.1281	.0531	-.0166
24	.0065	.0353	.0974	.1654	.2309	.2772	.2879	.2834	.2181	.1487
25	.0263	.0604	.1427	.2351	.3254	.3946	.4251	.4359	.3816	.3159
26	.0421	.0841	.1878	.3044	.4188	.5100	.5598	.5867	.5453	.4870
27	.0561	.1081	.2337	.3744	.5119	.6240	.6930	.7369	.7110	.6642
28	.0703	.1332	.2815	.4456	.6051	.7374	.8257	.8878	.8805	.8501
29	.0860	.1603	.3313	.5183	.6987	.8505	.9584	1.0404	1.0558	1.0475
30	.1033	.1893	.3832	.5921	.7926	.9636	1.0918	1.1959	1.2389	1.2600
Function Estimated : $l_{(N+5)}/l_{(27\frac{1}{2})}$										
19	2.3342	.9717	.7404	.6018	.4128	.1907	-.0452	-.2407	-.4422	-.5671
20	2.2651	.9967	.7948	.6720	.5057	.3114	.1028	-.0731	-.2642	-.3927
21	2.2072	.9223	.8419	.7358	.5931	.4267	.2450	.0887	-.0913	-.2221
22	2.1596	.9423	.8822	.7938	.6757	.5373	.3821	.2453	.0776	-.0542
23	2.1219	.9588	.9165	.8471	.7542	.6437	.5147	.3978	.2432	.1126
24	2.0931	.9718	.9459	.8966	.8297	.7467	.6436	.5470	.4067	.2800
25	2.0713	.9819	.9720	.9440	.9031	.8473	.7698	.6941	.5694	.4500
26	2.0540	.9903	.9960	.9906	.9757	.9465	.8943	.8402	.7332	.6246
27	2.0386	.9972	1.0209	1.0377	1.0483	1.0453	1.0183	.9865	.8997	.8064
28	2.0323	1.0045	1.0462	1.0859	1.1217	1.1442	1.1426	1.1343	1.0710	.9978
29	2.0056	1.0124	1.0729	1.1358	1.1961	1.2438	1.2678	1.2846	1.2491	1.2020
30	1.9457	1.0219	1.1011	1.1871	1.2715	1.3443	1.3945	1.4389	1.4362	1.4226

TABLE A.4.3. : (Continued)

WIDOWERHOOD

MORTALITY PARAMETERS : Alpha = 0.2366 Beta = 1.3 $l_{(2)}$ = 800 Growth Rate = 1.75%

Male Mean = 25

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
Function Estimated : $l_{(N-5)}/l_{(17\frac{1}{2})}$										
15	-.3325	-.3439	-.3171	-.3116	-.3282	-.3516	-.3857	-.4385	-.4764	-.5546
16	-.2371	-.2417	-.2215	-.2084	-.2066	-.2049	-.2227	-.2590	-.2890	-.3643
17	-.1493	-.1534	-.1353	-.1109	-.0900	-.0716	-.0658	-.0863	-.1079	-.1790
18	-.0725	-.0742	-.0584	-.0201	.0204	.0594	.0845	.0796	.0674	.0016
19	-.0073	-.0182	.0098	.0637	.1242	.1839	.2279	.2388	.2373	.1782
20	.0465	.0314	.0700	.1409	.2218	.3023	.3650	.3919	.4026	.3520
21	.0897	.0712	.1229	.2121	.3138	.4149	.4963	.5397	.5641	.5246
22	.1224	.1029	.1693	.2779	.4008	.5225	.6225	.6831	.7226	.6975
23	.1455	.1262	.2107	.3396	.4839	.6258	.7444	.8232	.8794	.8728
24	.1615	.1493	.2493	.3990	.5646	.7263	.8635	.9612	1.0362	1.0528
Function Estimated : $l_{(N-5)}/l_{(22\frac{1}{2})}$										
15	2.6565	.7725	.5752	.5045	.4018	.2630	.1015	-.0733	-.2155	-.3779
16	2.5360	.8140	.6564	.5993	.5096	.3893	.2492	.0948	-.0347	-.1902
17	2.4288	.8524	.7317	.6868	.6108	.5096	.3909	.2565	.1404	-.0072
18	2.3333	.8869	.7994	.7659	.7045	.6230	.5260	.4118	.3100	.1717
19	2.2527	.9173	.8585	.8362	.7905	.7296	.6545	.5609	.4748	.3471
20	2.1854	.9437	.9035	.8981	.8694	.8238	.7769	.7045	.6354	.5204
21	2.1316	.9659	.9493	.9523	.9420	.9242	.8940	.8435	.7927	.6931
22	2.0910	.9837	.9832	.9946	1.0090	1.0136	1.0065	.9787	.9476	.8670
23	2.0623	.9967	1.0098	1.0417	1.0718	1.0991	1.1154	1.1112	1.1014	1.0441
24	2.0425	1.0058	1.0321	1.0807	1.1320	1.1821	1.2222	1.2423	1.2561	1.2267

TABLE A.4.3. : (Continued)

WIDOWERHOOD

MORTALITY PARAMETERS : Alpha = 0.4057 Beta = 1.0 $l_{(2)}$ = 650 Growth Rate = 1.15%

Male Mean = 25

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
Function Estimated : $l_{(N-5)}/l_{(17\frac{1}{2})}$										
15	-.3242	-.3266	-.2909	-.2788	-.2905	-.3107	-.3422	-.3905	-.4233	-.4955
16	-.2366	-.2364	-.2107	-.1947	-.1905	-.1903	-.2002	-.2292	-.2493	-.3120
17	-.1589	-.1588	-.1398	-.1161	-.0950	-.0744	-.0632	-.0735	-.0809	-.1337
18	-.0892	-.0946	-.0781	-.0443	-.0055	.0358	.0679	.0758	.0819	.0395
19	-.0305	-.0433	-.0253	.0205	.0778	.1401	.1929	.2191	.2392	.2080
20	.0174	-.0035	.0193	.0787	.1553	.2389	.3122	.3567	.3917	.3725
21	.0550	.0265	.0566	.1312	.2278	.3330	.4266	.4894	.5399	.5343
22	.0821	.0482	.0874	.1788	.2961	.4229	.5366	.6179	.6846	.6947
23	.0992	.0632	.1134	.2229	.3615	.5096	.6432	.7432	.8267	.8549
24	.1088	.0741	.1370	.2656	.4258	.5948	.7477	.8666	.9678	1.0169
FUNCTION ESTIMATED : $l_{(N-5)}/l_{(22\frac{1}{2})}$										
15	2.6101	.7993	.6451	.6168	.5461	.4231	.2641	.0839	-.0680	-.2412
16	2.5060	.8360	.7176	.6984	.6354	.5276	.3892	.2311	.0966	-.0630
17	2.4091	.8703	.7845	.7724	.7180	.6264	.5090	.3729	.2559	.1105
18	2.3243	.9011	.8437	.8373	.7927	.7185	.6226	.5087	.4100	.2793
19	2.2529	.9282	.8940	.8927	.8595	.8038	.7301	.6387	.5591	.4439
20	2.1947	.9513	.9347	.9392	.9190	.8830	.8320	.7636	.7037	.6053
21	2.1490	.9704	.9661	.9776	.9723	.9570	.9292	.8842	.8445	.7646
22	2.1161	.9847	.9890	1.0091	1.0204	1.0266	1.0224	1.0011	.9823	.9231
23	2.0952	.9942	1.0049	1.0354	1.0648	1.0931	1.1128	1.1155	1.1182	1.0824
24	2.0836	.9996	1.0163	1.0589	1.1075	1.1583	1.2017	1.2284	1.2538	1.2441

TABLE A.4.3. : (Continued)

WIDOWERHOOD

MORTALITY PARAMETERS : Alpha = -0.1210 Beta = 0.8 $l_{(2)}$ = 800 Growth Rate = 2.17%

Male Mean = 25

FEMALE MEAN	CENTRAL AGE OF MEN 25	30	35	40	45	50	55	60	65	70
FUNCTION ESTIMATED : $l_{(N-5)}/l_{(17\frac{1}{2})}$										
15	-.3248	-.3310	-.2972	-.2857	-.2966	-.3135	-.3390	-.3789	-.4016	-.4671
16	-.2366	-.2372	-.2121	-.1947	-.1873	-.1813	-.1824	-.1994	-.2053	-.2557
17	-.1548	-.1565	-.1365	-.1095	-.0831	-.0545	-.0322	-.0280	-.0181	-.0541
18	-.0834	-.0896	-.0702	-.0311	.0149	.0660	.1108	.1350	.1602	.1376
19	-.0232	-.0357	-.0128	.0402	.1064	.1799	.2464	.2897	.3299	.3202
20	.0261	.0067	.0364	.1049	.1920	.2879	.3752	.4368	.4916	.4946
21	.0650	.0393	.0784	.1639	.2724	.3904	.4978	.5769	.6457	.6619
22	.0932	.0636	.1140	.2181	.3485	.4881	.6148	.7107	.7931	.8233
23	.1117	.0814	.1450	.2689	.4214	.5821	.7271	.8390	.9346	.9800
24	.1226	.0952	.1737	.3182	.4928	.6736	.8357	.9630	1.0715	1.1334
Function Estimated : $l_{(N-5)}/l_{(22\frac{1}{2})}$										
15	2.5894	.7499	.6398	.6016	.5216	.3943	.2368	.0642	-.0759	-.2382
16	2.4936	.8361	.7131	.6851	.6149	.5052	.3712	.2241	.1054	-.0371
17	2.3855	.8708	.7807	.7610	.7014	.6098	.4990	.3764	.2784	.1546
18	2.2998	.9019	.8406	.8279	.7799	.7074	.6196	.5208	.4429	.3371
19	2.2275	.9292	.8916	.8857	.8507	.7980	.7332	.6576	.5994	.5110
20	2.1684	.9526	.9334	.9349	.9144	.8822	.8403	.7874	.7484	.6774
21	2.1218	.9719	.9663	.9764	.9719	.9607	.9416	.9109	.8905	.8374
22	2.0879	.9867	.9910	1.0112	1.0243	1.0346	1.0379	1.0288	1.0265	.9921
23	2.0657	.9966	1.0091	1.0411	1.0730	1.1048	1.1301	1.1420	1.1574	1.1428
24	2.0524	1.0027	1.0229	1.0685	1.1198	1.1729	1.2195	1.2514	1.2844	1.2907

TABLE A.4.3. : (Continued)

WIDOWERHOOD

MORTALITY PARAMETERS : Alpha = -0.3834   Beta = 1.0 $l_{(2)}$ = 900   Growth Rate = 3.15%

Male Mean = 25

CENTRAL AGE OF MEN

FEMALE MEAN	25	30	35	40	45	50	55	60	65	70
Function Estimated : $l_{(N-5)}/l_{(17\frac{1}{2})}$										
15	-.3356	-.3440	-.3167	-.3103	-.3238	-.3405	-.3638	-.4013	-.4236	-.4971
16	-.2387	-.2404	-.2188	-.2028	-.1951	-.1871	-.1852	-.2001	-.2067	-.2663
17	-.1499	-.1511	-.1307	-.1015	-.0722	-.0404	-.0150	-.0095	-.0017	-.0485
18	-.0724	-.0763	-.0520	-.0072	.0439	.0989	.1462	.1705	.1918	.1568
19	-.0069	-.0148	.0179	.0800	.1531	.2337	.2985	.3402	.3744	.3506
20	.0473	.0352	.0797	.1605	.2556	.3553	.4424	.5002	.5468	.5344
21	.0905	.0756	.1343	.2350	.3523	.4731	.5784	.6515	.7098	.7095
22	.1230	.1078	.1825	.3041	.4437	.5849	.7071	.7946	.8644	.8775
23	.1461	.1338	.2261	.3694	.5310	.6914	.8294	.9305	1.0115	1.0408
24	.1620	.1559	.2672	.4325	.6155	.7939	.9463	1.0602	1.1528	1.1986
Function Estimated : $l_{(N-5)}/l_{(22\frac{1}{2})}$										
15	2.6265	.7782	.5872	.5162	.4109	.2717	.1148	-.0489	-.1771	-.3332
16	2.5085	.8192	.6677	.6105	.5198	.4020	.2709	.1335	.0261	-.1113
17	2.4903	.8570	.7418	.6972	.6216	.5251	.4188	.3060	.2183	.0982
18	2.3960	.8909	.8081	.7752	.7154	.6406	.5581	.4687	.3995	.2958
19	2.2262	.9207	.8658	.8444	.8014	.7483	.6891	.6218	.5706	.4826
20	2.1602	.9465	.9145	.9053	.8802	.8489	.8121	.7661	.7321	.6599
21	2.1076	.9682	.9546	.9587	.9524	.9429	.9280	.9023	.8848	.8292
22	2.0680	.9852	.9870	1.0056	1.0191	1.0312	1.0373	1.0313	1.0298	.9920
23	2.0399	.9877	1.0131	1.0475	1.0814	1.1147	1.1411	1.1538	1.1681	1.1499
24	2.0235	1.0065	1.0352	1.0865	1.1409	1.1947	1.2404	1.2708	1.3013	1.3043

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