RECENT FERTILITY TRENDS IN CHINA: RESULTS FROM THE 1990 CENSUS

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RECENT FERTILITY TRENDS IN CHINA: RESULTS FROM THE 1990 CENSUS

The primary contribution of the 1990 census to the study of fertility in China at the national and provincial level is to provide fertility statistics for the late 1980s. The level and trend of fertility in China for earlier years are well known from earlier work, including the 1982 census (State Statistical Bureau 1985) and one per thousand survey (China Population Information Centre 1984; Coale and Chen 1987; Feeney and Yu 1987), the 1987 one percent survey (State Statistical Bureau 1988; Feeney, Wang, Zhou and Xiao 1989; Luther, Feeney and Zhang 1990), and the 1988 two per thousand survey (State Family Planning commission of China 1991; Lavely 1992; Feeney and Wang 1991).

While the period on which the census provides new information is short, great interest attaches to the result, for the level of fertility was rising during the mid-1980s (Luther, Feeney and Zhang 1990; Feeney and Wang 1991). Will the census show the level of fertility continuing to rise in the last years of the 1980s, or will fertility level off or decline? How may the observed changes be explained?

Results of the 1990 census are available in several sources, most importantly in the 1991 publication of 10 percent sample tabulations (State Statistical Bureau 1991). This paper is based both on these 10 percent tabulations and on a one per thousand sample tape of census records.

The ten percent sample tabulations show a total fertility rate of 2.25 children per woman for calendar year 1989 (calculated from the single year age-specific birth rates given in State Statistical Bureau 1991:469, Table 10-16). This represents a significant decline from the peaks reached in the late 1990s. Birth histories collected in the 1988 two per thousand survey showed a total fertility rate of 2.57 children per woman for calendar year 1987 (Song and Li 1991:1). Reconstructed birth histories from the 1987 one percent survey show a rate of 2.46 for the year ending on 30 June 1987 (Luther, Feeney and Zhang 1990:350). The plot shown in Fenq (1991:10) and the time series given in Luther, Feeney and Zhang (1990) show that these values represent an increase over lows reached following the 'high tide, of birth planning work in 1983 (Hardee-Cleaveland and Banister 1988: Table 2 and passim; see also Zeng 1989).

This indication of resumed fertility decline in China during the late 1980s is based on a direct question on births in households during the three six month periods prior to the census date (30 June/July 1990). Questions of this type have been used in censuses and surveys throughout the world, and the general tendency has been to more or less severe under reporting of births. They have been used in China before with very good results, to be sure, but it would nonetheless be unwise to let conclusions on so important an issue be decided by reference to a single statistic whose accuracy is even slightly in doubt.

In any case, the census data are capable of yielding far more information on fertility change. The original own children method yields annual age-specific fertility rates for 15 years prior to the census (Cho, Retherford and Choe 1986). Birth history reconstruction, an extension of the own children method developed by Norman Y. Luther (Luther and Cho 1988), allows us to apply the whole panoply of techniques for analyzing birth histories, including the calculation of period parity progression ratios and mean birth intervals (Feeney 1983; Feeney and Wang 1991).

THE EFFECT OF AGE DISTRIBUTION ON FUTURE BIRTHS

Fertility is generally understood to refer to the incidence rather than the absolute number of births. Absolute numbers are of considerable interest for China, however, and we begin our investigation of the 1990 census results by studying the effect of changing age distribution on numbers of births.

Figure I shows the age distribution of China's population as of the 1990 census, based on the 10 percent sample tabulation of the census results (SSB 1991: Table 4-1, pp. 93-95). Age is shown on the lower scale, birth cohort on the upper scale. The solid dots and lines plot the 1990 age distribution. The remaining points will be discussed later in this section.

Chinese discussion of population trends refers to three peak periods for numbers of births. The first peak period was in the post-revolutionary decade of the 1950s and includes the years 1950-58. Persons born during this nine year period were between age 31.5 and age 40.5 at mid-1990. While there can be no exact correspondence between birth years and the completed years of age given by the mid-1990 age distribution, inspection of Figure I shows that there were relatively large numbers of persons at ages 32-40. There were 17.4 million persons, on the average, at each single year of age in these ages, nearly double the average of the 1940s, and well above the subsequent crisis years.

The second peak period, 1963-1971, followed the crisis years circa 1960 and preceded the rapid fertility decline of the 1970s. Persons born during this period were aged between 18h and 27k at mid-1990. Figure 1 indicates that the relevant range of completed years of age is 19-27, for which the average number of persons per single year of age was 25.4 million. This is nearly half again as many as during the first peak period, suggesting that the peak periods are superimposed on a rising long term trend.

The third peak period is generally considered to have begun in 1986 and is projected to end in 1994. Persons born between the beginning of 1986 and mid-1990 were aged between zero and 4k at the latter time. The numbers at the youngest ages shown in Figure 1 suggest 1987, however, rather than 1986, as the first year of this peak period. There were an average of 23.8 million persons at each single year of age for these four ages, below, but not much below, the corresponding figure for the second peak period.

These concentrations of unusually large numbers of persons in certain age ranges influence annual numbers of births and crude birth rates. To visualize this influence, imagine replacing the plot in Figure 1 by a moving picture, showing the age distribution first in mid-1990, then in mid-1991, then in mid-1992, and so on. Because every person in the population gets one year older every year, moving from one year to the next in time corresponds to moving the entire age distribution to the right by one year of age.

It is of course necessary to make allowance for mortality as well as aging, with the result that the points representing the number of persons at any given year of age move down as well as to the right with each passing year. For ages below 40, however, where nearly all reproduction is concentrated, the effect of mortality is very small.

A period in which relatively large numbers of births occur generates relatively large numbers of persons at corresponding ages in the age distribution. As time passes, these relatively large cohorts move into, through, and finally out of the reproductive ages. As they move into the reproductive ages, they tend to push numbers of births and crude birth rates up. As they move out of the reproductive ages, they tend to pull births and birth rates down.

The effect of age distribution on births depends on the distribution of childbearing by age. The reproductive ages are usually taken to be 15-49, but the chances of birth vary widely over this interval, and varying degrees of concentration within this range are observed in different populations and within the same population at different periods.

Figure 2 shows age-specific birth rates for China in 1989 from the 10 percent tabulations (State Statistical Bureau 1991: Table 10-16, pages 469-70). The scale in Figure 2 has been drawn to conform to that in Figure 1 to facilitate comparison.

As represented by this schedule, childbearing in China is overwhelmingly concentrated in ages 20-29, with a maximum of 243 births per thousand women at age 23. Looking at the contributions of each age to the total fertility rate, ages 20-29 account for 1.73 children per woman, or 77 percent of the total fertility rate of 2.25 children per woman. Ages 30-34 and 15-19 add another 0.28 and 0.11 (13 and 5 percent) children per woman, respectively, whence ages 15-34 account for 95 percent of total fertility.

Comparison of Figure 2 with Figure 1 shows that, in mid-1990, the birth cohort of the second peak period coincided nearly exactly with the ages of highest birth rates. We might expect on this basis that numbers of births would tend to decline during the 1990s as persons born during the second peak period move out of the ages of highest childbearing, but this is not the case.

The second peak period, unlike the first peak period, did not end abruptly, but was followed by a decline that extended over more than five years and saw large numbers of persons born. Although there were large numbers of persons aged 19-27 at the time of the 1990 census, the birth cohort of the second peak period, there were also large numbers aged 15-18. The effect of these persons moving into the reproductive ages during the early 1990s more than counteracts the effect of the aging of the peak period birth cohorts and exerts a small but positive effect on births and birth rates.

To show the detailed effect of these age distribution effects we ask how many births would occur in the 15 years following the 1990 census if the birth rates during these years were constant at the level observed in 1989. The results are shown on the left side of Table 1, which shows both the projected number of births in millions and an index showing the number in each year relative to the number in 1990.

The index numbers show that changing age distribution will tend to push numbers of births up by six percent during the first half of the 1990s. During the second half of the 1990s this effect reverses. By 1999, the age distribution effect is nil, and in following years it is negative, tending to pull numbers of births down by nearly ten percent from the 1990 level.

While these effects are certainly not negligible, they are modest indeed compared to the influence of age distribution on births during the 15 years prior to the 1990 census. Reverse projected numbers of births for 1975-1990 are shown on the right in Table 1 together with an index relating the number each year to the number in 1975.[1] During this 15 year period, the effect of changing age distribution was to increase numbers of births by half, from just over 16.4 million in 1975 to nearly 24.6 million in 1990.

The explanation for this radically reduced effect of age distribution on births and birth rates is the aging of population that occurred between 1975 and 1990, where 'aging' is understood in the formal demographic sense of changing age structure, not as an increase in numbers of what are conventionally regarded as 'old' persons. While this aging could be studied using the census age distributions of 1953 and 1964, it is more convenient to resort to the estimated age distributions at five year intervals since 1950 produced by the United Nations Population Division (United Nations Department of International Economic and Social Affairs 1991).

The upper panel of Table 2 summarizes the estimates for China and the 1990 census data by showing numbers of persons in millions, for ten year age groups, at ten year intervals from 1950 to 1990. The rapid growth of population tends to obscure the changing age structure, which is best displayed by computing a series of index numbers. These are shown in the lower panel of Table 2. The left hand side shows index numbers for the age distributions in 1950, 1970 and 1990, with the 0-9 age group set equal to 100.

We see at once from these numbers that the population became younger between 1950 and 1970. Relative to the number of persons in the 0-9 age group, the number of persons in each subsequent age group declined for all but the oldest age group. Between 1970 and 1990, however, the population became older, for the same index numbers increase. Considering the period 1950 to 1990 as a whole, the aging effect predominated, with the index numbers in 1990 exceeding those for 1950 in every age group.

The age distribution below age 30 ages sharply between 1970 and 1990. In 1970, the numbers of persons aged 10-19 and 20-29 are, respectively, 74 percent and 50 percent of the number aged 0-9. In 1990, the distribution of population under age 30 is close to uniform, with index numbers of 101 and 106, respectively, for the 10-19 and 20-29 age groups.

A useful perspective on these changing age distributions is provided by the stationary population numbers that would result from current mortality conditions combined with current numbers of births. The use of a stationary population as a reference point is reasonable in view of the relatively constant numbers projected for the next 15 years in Table 1.

The best available estimates of current mortality levels are probably those given in Zhang and Lu (1991), which compare direct calculations for 1987 from the 1988 two-per-thousand fertility survey with intercensal estimates for 1982-1990 using the method of Preston and Bennett (1983). The male, female and combined L, values for these life tables are shown in Table 3.

The center column in the lower panel of Table 2 shows index numbers for the stationary age distribution corresponding to the combined male and female L, values given in Table 3. Dividing the index numbers in each row at lower left t in Table 2 by the corresponding stationary index number gives a percentage that shows how close the observed (relative) number in this age group is to the corresponding stationary number. These numbers are shown at lower right in Table 2.

In a young population, numbers in older age groups will be far below the corresponding stationary numbers. Population aging corresponds to a movement upwards towards the stationary numbers. Because a movement towards stationarity typically begins with an approximate leveling of annual numbers of births, the younger age groups reach the stationary values first, with older age groups moving up to stationary levels, one after the other, in successive time periods.

Taking the median number of persons aged 0-27 at the 1990 census as a rough estimate of numbers of future births and applying the Zhang-Lu life table survival proportions gives the stationary age distribution plotted with circles and dotted lines in Figure 1. We see that the stationary population is a reasonable approximation to the overall level of numbers of persons observed until just under age 30. Beyond this age, and especially over age 45, observed numbers of persons fall short of the stationary numbers.

This shows graphically what is shown numerically in the last column of the lower panel of Table 2. The 1990 age structure is approximately stationary for ages under 30, but falls increasingly short of stationarity for older age groups.

The prospect for the near future, at least, is for continued aging, with numbers of persons over 30 rising toward the stationary pattern. It is this pattern of population aging, together with the relatively large numbers of births during the second peak period, that explains the very large impact of age distribution on numbers of births before 1990 and the relatively minor influence on numbers after 1990.

AGE-SPECIFIC BIRTH RATES: 1976-1990

The 1990 census contained direct questions on births to women during the three six month periods preceding the census, the first and second halves of 1989, and the first half of 1990. Direct questions of this type have been used in many surveys and numerous censuses throughout the world, but have usually suffered more or less severe under reporting.

The results for the 1990 census of China appear to be quite good, however. The ten percent sample tabulations show a total of 23.84million births during the year prior to the census (Table 10.1-10.3 for city, town and rural, respectively, pages 427-429). The number of persons aged zero in completed years at the time of the census was 23.27 million. Reverse surviving this number using the life table Lo value from the Zhang-Lu life tables given in Table 3 gives 24.07 million births during the preceding year, less than one percent above the number directly reported.

Table 4 shows annual age-specific birth rates for five year age groups and the corresponding total fertility rates for China as a whole for the 15 years prior to the 1990 census. Table 5 shows annual single year rates for 1979-1990 and corresponding total fertility rates. The total fertility rates in these two tables are not identical. Total fertility rates based on five year age groups are less accurate than rates based on single year age groups because of the variation of numbers of women and birth rates by single years within quinquennial age groups. Under most circumstances, the differences would be negligible, but here they range from -3 to +3 percent. These relatively large differences are due to the sharp disturbances of China's age structure.

Because year of birth in the reconstructed birth histories is derived from age in completed years at the time of the census, the birth rates in Tables 4 and 5 are for years ending 30 June. Unless otherwise stated, the same will apply to all annual fertility statistics given in this paper.

The age-specific birth rates in Table 4 show two features of particular interest. First, rates for the 15-19 group decline by nearly half between 1976 and 1980 and more than double between 1980 and 1985. The most obvious explanation for these shifts is changing age at marriage. The rise after 1980 is consistent with the decline in age at marriage that began in 1979 (Feeney and Wang 1991: Table 2), and the single year rates in Table 5 show that these increases extended from the early 20s down to age 19, suggesting an effectively imposed limit at this age. What is puzzling is the rapid decline during the late 1970s, for age at marriage increased rapidly during the early 1970s and relatively slowly during the late 1970s.

The second feature of particular interest is the shift in the age group of maximum fertility. In 1982 and before, the highest rates are in the 25-29 age group, but beginning in 1983 they are in the 20-24 age group. Rates for the 20-24 age group are approximately level over the fifteen year period. Rates for the 25-29 age decline substantially over the period, from about 230 in 1976 to about 150 in 1990.

The overall decline in the birth rate for the 25-29 age group, and the corresponding shift of the highest rate down to the 20-24 age group, reflects the overall decline in fertility level from nearly three and one half to just over two children per woman. It is reasonable to suppose, and we shall see evidence below, that this decline is in higher order births, which occur at older ages.

QUALITY OF THE ASBR-TFR ESTIMATES

The method of birth history reconstruction was applied to the 1987 one percent survey of China with considerable success (Luther, Feeney and Zhang 1990), but every application requires independent consideration both of data quality and of the performance of the procedures used. The essential tool for this assessment is the comparison of estimates from different data sources.

Figure 3 shows three 15 year series of annual total fertility rates calculated from single year age-specific birth rates. The first series consists of the total fertility rates shown in Table 5. The second series consists of total fertility rates for 19731987 calculated from birth histories reconstructed from the 1987 one percent survey (Luther, Feeney and Zhang 1990:350). The third series consists of total fertility rates for 1970-1981 calculated from the birth histories collected in the 1982 one per thousand fertility survey (Coale and Chen 1987:24-25).

The consistency of the three series suggests that the total fertility rates estimated from the 1990 census provide a reasonably accurate picture of fertility trends in China. Consistency does not imply correctness in general, since statistics may be consistently biased, but the nature of the errors here makes consistent bias improbable.

RENEWED FERTILITY DECLINE IN THE LATE 1980s

Fertility in China declined extremely rapidly during the 1970s, far more rapidly than in any other country in the world (Feeney 1992). Figure 3 shows this decline ending shortly before the introduction of the one-child family program in 1979 ' Subsequent years show fluctuations superimposed on a very slight overall decline.

This indication that fertility decline nearly ceased shortly before the one-child family program was introduced turns out to be incorrect, as previous analyses have shown (Luther, Feeney and Zhang 1990; Feeney 1992). For the present, however, we focus on the trends indicated by conventional total fertility rates computed from age-specific birth rates.

The important substantive finding in Figure 3 and Tables 4 and 5 is that the increase in fertility observed between 1985 and 1987 was reversed in the latter year. Total fertility rates in Table 5 rise from 2.30 in 1985 to 2.55 in 1987, an increase of over ten percent. In every subsequent year, however, they decline, reaching 2.18 children per woman in 1990. This represents a decline of 15 percent from the 1987 high and a decline of five percent over the lowest value to date, the 2.30 children per woman reached in 1984. The 1990 level is also only slightly above replacement.

A CLOSER LOOK AT FERTILITY TRENDS IN THE LATE 1980S

The advantage of the method of birth history reconstruction over the original own children method is that it provides a far richer source of data for fertility analysis. In particular, it may be used to calculate various kinds of parity progression measures. These measures provide a useful complement to the more familiar age-specific birth rates in many respects (Feeney and Lutz 1990:*passim*).

Parity progression measures have, moreover, a particular relevance for China. Since 1979, the one-child family program has been the center piece of Chinese population policy. To measure the demographic impact of this program we want to know what proportion of women, having had a first child, go on to have a second. The parity progression ratio for progression from first to second birth answers precisely this question.

Second births may be deferred for a number of years, whence the period parity progression ratio for any single year provides limited information about eventual progression to second birth. Chances of a second birth tend to decline as the time since first birth increases, however, (see the discussion in Feeney 1986:34-35) and a reasonably long time series of parity progression ratios provides a good indication of eventual progression to second birth.

It is possible to obtain a better indication of eventual progression by computing cohort parity progression ratios, but the length of time that must be allowed to obtain a satisfactory approximation to ultimate progression is so great that we lose the ability to analyze recent trends. Annual period statistics have the advantage, moreover, of allowing us to gauge year to year fluctuations in birth probabilities and to relate these fluctuations to the campaigns and vicissitudes of birth planning efforts.

For a general discussion of period versus cohort fertility statistics, see Ni Bhrolchain (forthcoming).

Period parity progression ratios and associated fertility statistics for China have been discussed in a series of previous studies (Feeney 1983; Feeney and Yu 1987; Feeney, Wang, Zhou and Xiao 1989; Luther, Feeney and Zhang 1990; Feeney and Wang 1991; Feeney 1992), whence generalities need not be discussed in any detail here. For comparative purposes, however, it may be useful to note similar studies for other countries (Henry 1953/1980; Penhale 1984; Feeney 1986; Ni Bhrolchain 1987; Luther and Cho 1988; Feeney 1990:10-15; Feeney 1991b; Luther and Pejaranonda 1991).

Table 6 shows annual period progression ratios for China as a whole during 1976-1990. Looking first at progression from first to second birth, we see that progression declined steadily from 1979 through 1985, reaching a low of 0.659 in that year, but that it rose sharply in the next two years, reaching 0.763 in 1987. These values are reasonably, though not perfectly consistent, with those obtained by the same method from the 1987 one percent survey, which indicates a low of 0.630 reached in 1984 and a rise to 0.768 in 1987.

The subsequent trend of progression from first to second birth is of exceptional interest, for an extrapolation of the increase before 1987 for more than a few years would have raised progression from first to second birth back to the level observed before the introduction of the one child family program in 1979. Table 6 shows that the levels reached in 1987 were peaks, with progression to second birth declining for the rest of the decade.

Progression from second to third birth declines modestly as well, but minor changes are observed in the higher order progressions. That the decline in fertility during the last years of the 1980s was due primarily to decline in progression from first to second birth is quite strong evidence that the decline was due to reinvigorated birth planning efforts, and not to extraneous demographic shifts or general socioeconomic trends. This is the most important way in which the period parity progression ratios advance our knowledge beyond what can be learned from the age age-specific birth rates.

Table 6 shows extremely high proportions of women having a first birth. Since the level of childlessness in natural fertility populations is expected to be a minimum of about three percent,[2] we expect no more than about 97 percent of all women to progress to second birth. The likely explanation of these low levels of childlessness is that adopted children are reported as natural births. Married women who remain childless beyond certain ages and durations of marriage are likely to attempt to adopt a child, both to have an heir, and to increase the likelihood of a natural child.[3] If adoptive children are predominantly second and higher order births of their natural mothers, as ifs very likely, the number of first births will be inflated. Adoptive children who are first births of their natural mother will not bias the incidence of first birth unless the child is reported as a birth both to the adopted and to the natural mother.

The 1982 one per thousand survey obtained similarly low levels of childlessness, whereas the 1988 two per thousand survey obtained the expected low levels of about three percent. The 1988 survey contained explicit questions on adoption and explicit instructions to interviewers to probe for the presence of adopted children (State Family Planning Commission of China 1991:16). Neither the 1982 survey nor the 1990 census included questions on adoption or explicit protection against reported adopted as natural children. Thus the reasonable levels indicated by the two per thousand survey and the unreasonably high levels indicated by the 1982 survey and 1990 census are consistent with a bias in the latter sources resulting from reporting adopted as natural children.

MEASURING THE SUCCESS OF THE ONE-CHILD FAMILY POLICY

The proportion of all births that are first births has often been used as an indicator of success of the one-child family program. The rationale for this statistic is presumably that universal one-child families would mean that all births would be first births.

While the proportion of first births has the advantage of ease of calculation, it has two undesirable properties. First, it depends not only on the proportion of women who go on to have a second birth, but also on the number of women who go on to higher parities. Table 6 shows that there are still considerable numbers of such women in China. Second, it will reflect changes in numbers of women marrying over time. The period parity progression ratio for progression from first to second birth is clearly a superior statistics, but it is also more difficult to computer. It is therefore of interest to see how well or poorly proportions of first births correspond to period progression from first to second birth.

Table 7 shows annual births by birth order tabulation from the reconstructed birth histori9es, from which we may calculation proportions of first births (taking the sum of first through eighth births as an estimate of total births). A comparison of these proportions with the period parity progression ratios for progression from first to second birth is shown in Figure 4. The period parity progression ratios for progression from first to second birth (Table 6) are plotted with solid dots, with the scale to the left. Proportions of births are plotted with small circles, with the scale to the right. The scale for proportions of first births is inverted and chosen so as to bring out the correlation between the two statistics.

As expected, there is a clear correlation between the two measures, with high levels of progression to second birth corresponding to low proportions of first birth, and *visa versa*. On looking more closely, however, we see that the proportion of first births is a very poor indicator of anything but the long term historical trend. Between 1975 and 1980, for example, progression from first to second birth declined by only a few percent, but the proportion of first births increased sharply, from 25 to 38 percent. During the late 1980s, progression from first to second birth varied sharply and apparently in direct response to changes in birth planning efforts, while the proportions of first births changed very little.

The reason the proportion of first births moved up so rapidly during the late 1970s, for example, was that numbers of marriages were increasing very rapidly during this time. Rapidly increasing numbers of marriages resulted in increasing numbers of births of all orders, but a disproportionate increase in first births. These changes are important, but they are unrelated to the one-child family program, which was initiated only in 1979.

While the period parity progression ratios for progression from first to second birth shown in Table 6 are the preferred measures of the demographic impact of the one-child family program, the complexities of their calculation discourage use at lower levels of government, e.g., at the county (xian) level and below. Is it possible to devise a simple index superior to the proportion of first births that could be used at this level?

Since the only women who can have a second birth in any given year are those who had a first birth in some prior year, and since the distribution of intervals between first and second births is reasonably compact, it is natural to ask whether we cannot estimate the parity progression ratio as the ratio of second births in one year to some number or average of first births in preceding years. Inspection and some trial calculation in Table 8 suggest that this approach will not be satisfactory, however. It is possible that a modification of the indirect estimation procedure proposed by Henry (1953/1980) will server the purpose, a possibility worth exploring in future research.

‘URBAN’ AND ‘RURAL’ FERTILITY

The power and importance of the urban-rural distinction in social research has tended to obscure the conceptual inadequacy of dichotomizing what is in many respects a continuum of related characteristics. On the one hand, the variation of many social characteristics on the urban-rural continuum is so strong that any but the most foolish dividing line is likely to yield important differences between people living in places classified as ‘urban’ and ‘rural.’ On the other hand, the conceptual and practical complexities that arise in deciding how places shall be classified has discouraged attempts at refinement.

The problem of definitional differences is nowhere more apparent than in China during the 1980s. Between 1983 and 1987 persons living in nominally ‘urban’ areas rose from 23 to 47 percent (Lee 1989:772). So rapid a change would be impossible if the statistics represented underlying social reality as opposed to definitional changes. Goldstein (1990:678) notes that in 1987 China’s city population could have ranged from as little as 12 percent to as much as 58 percent of total population, depending on the definition adopted.

A natural and obvious approach to a strained dichotomy is a refinement recognizing more categories. In the case of the urban-rural continuum, however, casual attempts at such refinement tend more to show the difficulty of the problem than to provide a satisfactory solution. Cities may be classified by size, for example, but size *per se* is clearly not the operative factor. The masses of data available for many countries admit far more complicated schemes, but in the absence of a unifying conceptual scheme the arguments against pursing the issue may be as strong as the arguments in favor. The temptation to stick with what is familiar and readily available and get on with one’s research is likely to be overwhelming.

The ubiquity of the simplistic urban-rural dichotomy is therefore evidence not only of its adequacy in capturing significant variation, but of the conceptual and practical difficulties of a conceptually more satisfactory refinement. In the case of China, the work of G. William Skinner on regional systems and urban hierarchies (1977a; 1977b) has provided a full conceptual and operational basis for refinement, but these results have yet to see widespread use in research on Chinese population.

The issues involved are too complicated and extensive for even brief summary here, whence the reader is referred directly to Skinner’s work, published and forthcoming. The complexities involved far exceed those involved in, for example, defining Standard Metropolitan Statistical Areas (SMSAs) in the United

States. A necessary condition for widespread use is therefore incorporation into official statistical practice, similar in spirit, though not in detail, to the use of SMSAs by the United States Census Bureau. It is to be hoped that the 1990s will see progress in this direction.

For the present, however, we are obliged to work with the two trichotomies provided in the ten percent sample tabulations of the 1990 census, which divide places in China into cities (*shi*), towns (*zhen*) and counties (*xian*). One of these trichotomies provides broader, the other more stringent criteria for classification as a city or town. We use the more stringent classification, according to which approximately 20 percent of China's population lives in cities and towns. Thus the 10 percent sample tabulations show 213 million persons (19 percent) living in cities, 84 million (7 percent) living in towns, and 834 million (74 percent) living in counties (Tables 4-2, 4-3, and 4-4, respectively).

Table 8 shows age-specific birth rates and total fertility rates for cities, in the upper panel, and for towns and countries combined in the lower panel. While it may be that the standard urban-rural dichotomy is better recognized b y grouping cities and towns, analysis of the 1988 two per thousand survey showed that the important distinction with respect to fertility is between cities, on the one hand, and towns and counties on the other (Feeney and Wang 1991). Looking for example at period parity progression ratios for progression from first to second birth in 1987, 85 percent of women in counties and 76 percent of women in towns go on to have a second birth, but the corresponding figure for cities is only 15 percent.

Fertility is sharply lower in cities, with a total fertility rate of 1.46 children per woman in 1990 and a median level of 1.6 children per woman during the 11 year period 1980-1990. The total fertility rate in towns and counties in 1990 was 2.38 children per woman, with a median level of 2.65 children per woman during 1980-1990. Despite the difference in level, the fluctuations in the two series are very similar, suggesting similar influences on the level of fertility.

FERTILITY LEVELS AMONG PROVINCIAL UNITS

Beginning with the premise that great differences between different areas in China necessitate the study of fertility below the national level, but wanting to limit the volume of statistics presented, we intended initially to provide fertility statistics for the familiar regional groupings of provinces.

On mapping an unpublished set of total fertility ate estimates by province, however, we found the regional division unsuited to the purpose. Map 1 shows estimated total fertility rates as of the late 1980s for all provincial level unites. It will be seen at once that the variation in fertility levels corresponds very poorly to the usual provincial groupings, *Dongbei* being the single obvious exception.

Table 9 presents times series of total fertility rates for a grouping of provinces that recognizes both geographic position and level of fertility. While the grouping may be objected to on various grounds, as putting Inner Mongolia together with Hebei and Shanxi, and the grouping of the non-contiguous provinces of Henan, Guizho and Hainan with Xianjiang and Tibet, it does provide a summary of provincial level variation superior to that resulting from the more familiar statistical regions and more efficient than a complete listing of provincial units.

Alternative provincial groupings might be explored, but there would be little point in pursuing this very far, for it is clear from the work of G. William Skinner mentioned earlier that satisfactory regional divisions require going down at least to the prefectural (*diqu*) level.

CHILDREN EVER BORN DATA IN THE 1990 CENSUS

One primary focus in this paper is the study of recent trends. Because the children ever born data give information on the cumulative fertility of birth cohorts, they are not directly useful for this purpose. The children ever born information is of the utmost importance, however, because it is a necessary ingredient for the birth history reconstruction upon which all our results are based, as indicated in Appendix 1.

The Chinese censuses are peculiar in restricting the children ever born question to women aged 15-64. The normal practice is to ask the question of all women over some lower age limit, perhaps restricting it to ever married women. Practice in the various countries of Asia may be seen in Cho and Hearn (1984), which provides English translations of census schedules for many Asian countries. The restriction to women under age 65 is a minor nuisance in the birth history reconstruction procedure. More importantly, it looses some potentially useful historical information.

The published volume of 10 percent sample tabulations is unsatisfactory in omitting to classify women by age as well as children ever born (see, e.g., State Statistical Bureau 1991:430-33, Table 10-4). This is curious, since both the 1982 census and the 1987 one percent survey provided the appropriate tabulations of women by age and number of children ever born, though some supplementary tables omitted the age classification. It is important because the information is of little use without the age classification.

Table 10 shows a tabulation of women by age and number of children ever born data for China as a whole. See Feeney 1976 for a general discussion of the issues involved in tabulating children ever born data. Figure 5 compares the mean numbers of children ever born to women aged 45-64 shown in Table 10 with the corresponding figures from the 1987 one percent survey (State Statistical Bureau 1988:582-83. Table 9-1) and the 1982 census (State Statistical Bureau 1985:498-99, Table 76) using the time plotting technique described in Feeney (1991a:80-82). The disparity between the plots for the three sources indicates that mean children ever born is under reported for older women in all three sources. Over the periods shown, the magnitude of the bias is about 0.2 children ever born for younger women within the age range 45-64, increasing to 0.3-0.4 children per woman for the older women.

Information on children surviving shows the net 4effect of fertility and mortality and is a valuable complement to the children ever born information. When mortality levels are low, there is little numerical difference between completed fertility and family size. When mortality is high, however, these concepts are very different indeed.

Completed fertility refers to he number of children women have over their reproductive lives. It is indeterminate until women reach the end of the reproductive age span, after which it is a single determinate value.

Family size is defined at all times and changes continuously, with each birth of a child increasing family size and death of a child decreasing it. During the younger ages (earlier marital durations, lower parities) childbearing tends to predominate, so that family size increases. Under low mortality conditions, family size approaches and remains close to completed fertility. Under high mortality conditions, however, family size begins to decline after some point, as childbearing slows and as children already born accumulate increased exposure to the risk of death.

Information on surviving children can be and most often is tabulated in the same was as information on children ever born. For many purposes, however, a more useful tabulation is that shown in Table 11, in which we tabulate total numbers of surviving children to women in each age and parity group. The entry for women aged 30-34 with three children ever born, for example, shows that these women had a total of 27,715 surviving children.

Dividing the numbers of surviving children in Table 11 by the corresponding numbers of women in Table 10 gives mean numbers of surviving children to women of each age and parity. These are shown in the upper panel of Table 12. We see that although significant numbers of women have as many as 12 children, mean family size even for the largest families does not much exceed seven children. Women with a small number of children ever born have a mean number of surviving children close to the number of children ever born, but women with large numbers of children ever born had mean numbers of surviving children far below the number ever born.

This pattern is explained by the mortality experienced by the children of women in different parity and age groups. Using the numbers of surviving children in Table 11 and the corresponding numbers of children ever born that may be readily calculated from the numbers of women in Table 10,[4] we may calculate the proportion of deceased children for each age and parity group.

These proportions of deceased children are shown in the lower panel of Table 12. We see that, for women in any given age group, proportions of deceased children increase sharply with increasing number of children ever born. The differences are very large indeed, with the proportion deceased among children of the largest families on the order of ten times that of single children.

It is not immediately apparent whether these differences reflect different mortality risks or different average periods of exposure to risk, but Fernandez Castilla (1989) has shown that by far the greatest part is due to different mortality risks. To a very reasonable approximation, then, we may take the values in the columns of the lower panel of Table 12 as indicating the relative mortality risks experienced by children of women with the indicated numbers of children ever born.

To take a single example, for women aged 40-44 at the 1990 census, the indicated chance of death for single children is under one percent (8 per thousand), whereas the indicated changes for children of women with eight or more children ever born range from 20 to 30 percent. Though the first of these figures is so low as to raise doubts about the completeness of reporting of deceased children, there can be little doubt that mortality risks differ drastically for children of women with larger numbers of children ever born.

The reasons for this pattern are unclear. Large numbers of children ever born *per se* may be the cause of higher mortality risks, but large families will tend to have shorter birth intervals, and this might also be a cause of higher mortality risks. Selection effects are surely responsible for some of the variation, because groups with higher fertility tend also to be groups of higher mortality.

CONCLUSION

The principal purpose of this paper is to present estimates and analysis of fertility change in China during the late 1980s based on birth histories reconstructed from a one per thousand sample of the 1990 census records. Given the extent and richness of the population data now available for China, the information and analysis given here barely scratch the surface of what might be done. We have tried, however, to extract some of the most immediately pertinent conclusions from the newly available data from the 1990 census.

Our most important conclusions are as follows. The rise in fertility that occurred during the mid-1980s was reverse before the end of the decade. The level of fertility in China as a whole in 1990 was lower than ever before, with a total fertility rate of 2.14 children per woman, barely above replacement level. Finally, the distortions of age distribution that had so powerful an effect on numbers of births in the past are largely spent. Age distribution will tend to push numbers of births up slightly during the early 1990s, but beyond this the effect of changing age distribution into the next century will be to push numbers of births down.

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NOTES

1. The results on the left in Table 1 take no account of mortality, which biases future numbers of births upwards because we do not decrease numbers of women in the future to account for future mortality. Given the low level of mortality before and during the reproductive ages, however, the bias is negligible. Thus a recalculation of births in the year 2005 using give year age groups gives 22.3, as compared with the 22.4 million shown in Table 1. The effect on past births is serious, however, because mortality rates rise significantly after age 50. Taking about of mortality gives 16.4 million births in 1975, as compared with the 15.6 million obtained by putting reverse survivorship ratios equal to one. The values for 1975-1990 shown on the right in Table 1 have therefore been calculated by adjusting the single year results ignoring surviving on the bases of the five year results taking account of surviving, interpolating to obtain intermediate single year values.

2. The three percent figure comes from the Hutterite data of Eaton and Mayer (1954:20, Table 10). Additional indirect evidence comes from census data on women by age and number of children ever born, which is widely available for high fertility countries. These data almost never show less than three percent childless, and they often show much higher levels. Voluminous international data is available in the United Nations *Demographic Yearbook* for thus years which take fertility as a special subject. See also Lutz [no date] for a useful summary of World Fertility Survey data.

3. Many Chinese hold the common belief that having a child in the household will increase the likelihood of conception. Adopting a child may thus be an explicit strategy intended to secure natural offspring. This is apparent in the names sometimes given to adopted children, e.g., *Zhao di* (“beckon a younger brother”) and *Lai di* (“bring a younger brother”).

4. For all but the open ended parity group, which contains too few women and children to matter, the number of children ever born is simply the number of women times the parity. Thus, for example, parity 3 women aged 30-34 have three times 7,535, or 22,605, children ever born (Table 10), of whom 21,715 are surviving (Table 11). Subtracting surviving children from children ever born gives deceased children, and dividing this by children ever born gives the proportion deceased. For the example just given, we obtain (22,605-21,715)/22,605 = 0.039.

APPENDIX 1: MATCHING ALGORITHM FOR THE CHINA 1990 CENSUS

The own-children matching procedure for the original own children method is described in Cho, Retherford and Choe (1986: chapter 7). It identifies persons under 15 years who are living in the same household as their mother and matches such children to their mothers. Matched children are referred to as 'own' children, all other children as 'non-own' children.

Matching for Birth History Reconstruction The method of birth history reconstruction requires us to consider the complete birth history of every woman. Since this includes children over age 15 at the census, the match procedure must be extended to all persons. The objective of the matching procedure for birth history reconstruction is thus to identify every person enumerated in the census who is living in the same household as his/her mother and to match these children to their mothers. Note that a woman may be recognized both as a mother of her children and as a child of her mother.

For each household record it is necessary to consider all possible pairs of persons of the form (woman, person) , where woman denotes any women in the household old enough to have had children and person denotes any person in the household. For each such pair, it is necessary to decide whether or not the woman and the person are mother and child.

The first step is to make two lists, one of women in the household old enough to have had children, another of all persons in the household. Numbering women on the first list 1,2,...,n and persons on the second list 1, 2, . . . , m, the set of all possible pairs of persons may be represented by the following array.

Table A

(1,1)	(1,2)	. . .	(1,m)
(2,1)	(2,2)	. . .	(2,m)
.	.		.
.	.		.
.	.		.
(n,1)	(n,2)	. . .	(n,m)

Beginning with the pair(i,l), we ask whether the available information for this pair of persons makes it likely that they are mother and child. The first pair is matched or not, as the case may be, and we proceed to consider the next pair, (1,2), and so on through the table, moving from left to right and top to bottom.

Except in special cases, in which items have been specifically included for the purpose, census and survey schedules do not contain sufficient information to match women and their children with certainty. The matching procedure thus involves a tradeoff between setting very stringent conditions for a match, which minimizes false matches at the cost of larger numbers of false non-matches, and setting less stringent conditions, which reduces false non-matches at the cost of larger numbers of false matches.

The usual approach has been to use relation to head of household information, available in virtually every census and survey, to effect an inclusive preliminary match, that is, a match that minimizes false non-matches at the risk of possibly large numbers of false matches; and then to minimize the number of false matches by setting conditions for a final match based on other information.

Suppose for example that the relation to head codes include ‘head,’ ‘spouse of head’, and ‘child of head.’ In the case of a female head of household, any person coded ‘child’ is unambiguously the child of the head. In the case of a male head of a household, it is still likely that persons coded ‘child’ are the children of the spouse of the head, but it is also possible that they are children of another woman.

Age is universally available in modern censuses, and a natural and obvious condition is that the age difference between mother and child be consistent with the expected ages of childbearing, most often taken to be ages 15-49.

Information on children ever born to each woman is very often available, and we naturally insist that the number of children matched to a woman not exceed this number. A similar condition is used if number of surviving children is available. Children ever born and surviving are occasionally given by sex, which allows further specificity.

Analysis of RHH Code Combinations for the 1990 China Census There are eight relationship to head of household (RHH) categories on the schedule for the 1990 census of China: (1) head, (2) spouse, (3) child, (4) grandchild, (5) parent, (6) grandparent, (7) other relative, and (8) non-relative. Heads of household may be female as well as male, the determination being made by the respondents.

These categories are pre-coded on the census schedule and appear to be self explanatory, but this turns out not to be the case. Two coding conventions were adopted that change the apparent meanings substantially.

First and most importantly, the child, grandchild, parent and grandparent categories include, respectively, spouse of child, spouse of grandparent, spouse of parent, and spouse of grandparent. We should therefore take steps, if possible, to avoid identifying the spouses of children as children.

Second, the grand child category includes great grandchildren, and the grand parent category includes great grand parents. The significance of this will become clear in the following paragraph.

Consider the set of all pairs of persons listed on a given household schedule for which the first person is a woman, i.e., the pairs coded in Table A above. The objective of the matching algorithm is to identify which of these pairs are mother and child.

We begin by selecting those pairs for which the relationship to head of household (RHH) codes do not exclude the possibility of the mother-child relationship. The following table represents all possible combinations of relation to head codes for any given (woman,person) pair. Because generational relationship is the primary basis for deciding acceptable combinations of relation to head codes, the primary relation to head codes are arranged in generational order (grandparent, parent, head/spouse, child, and grandchild), followed by other relative, which does not imply any generational relationship, and non-relative, for which generational relationship is undefined.

Table B

Woman's RHH Code		Person's RHH Code GP 6	P 5	H/S 1-2	C 3	GC 4	OR 7	NR 8
Grandparent	6	1	1	0	0	0	1	0
Parent	5	0	0	1	0	0	1	0
Husb/Spouse	1-2	0	0	0	1	0	0	0
Child	3	0	0	0	0	1	0	0
Grandchild	4	0	0	0	0	1	0	0
Other Relative	7	0	0	0	0	0	1	0
Nonrelative	8	0	0	0	0	0	0	1

An entry of 1 in any cell indicates that this combination of RHH codes is consistent with the mother-child relationship. An entry of 0 indicates that this combination is inconsistent with the mother-child relationship.

The requirement that a mother be in the generation immediately preceding her child, or, equivalently, the child in the generation immediately following his or her mother yields (GP,P), (P,H/S),(H/S,C) and (C,GC) as possible mother-child combinations. Because the grandparent category includes great grandparents, a woman and a person both of whom are coded GP may be mother and child, Similarly, because the grandchild category includes great grandchildren, a woman and a person both coded GC may be mother and child. The remaining combinations in the upper left portion of the table correspond to pairs of persons who could not be mother and child.

Since no person coded as a non-relative can be a mother of a child of a person coded relative, the only consistent combinations involving non-relatives are those in which both persons are coded non-relative.

The situation with respect to other relatives is more complicated. Any child of a woman coded ‘other relative’ will also be coded ‘other relative,’ because the child of a women with a primary relation to head code will also have a primary relation to head code. Thus (OR,OR) is the only combination involving an OR in the mother position that may represent a mother-child relation.

Pairs (woman,person) in which person is coded ‘other relative’ may be clarified by the following diagram, which shows the primary and other relative categories at each generational level. The solid lines represent combinations consistent with a mother-child relation, the dotted lines combinations not consistent with a mother-child relation.

Table C

	Mother/Child	
Generation	M	C
-2	GP	OR
-1	P	OR
0	H/S	OR
+1	C	OR
+2	GC	OR
+3		OR

If a woman coded ‘grandparent’ has a child other than the parent of the household head living in the household, this child will be coded ‘other relative.’ Thus the combination (GP,OR) may represent a mother-child relation. Similarly, if a woman coded ‘parent’ has a child other than the head/spouse, this child will be coded ‘other relative,’ whence the combination (P,OR) may represent a mother-child relation.

A child of a woman coded ‘head/spouse,’ however, will be coded ‘child,’ whence (H/S,OR) cannot represent a mother-child relation. similarly, any child of a woman coded ‘child,’ will be coded ‘grandchild,’ so that (P,OR) cannot represent a mother-child relation. Finally, any child of a woman coded 'grandchild' will be a great grandchild and will be coded ‘grandchild,’ whence (GC,OR) cannot represent a mother-child relation.

The Matching Algorithm for the China 1990 Census Because the relation to head code 'child' includes spouses of children of the head of household as well as children proper, and similarly for other primary relations of the head, only single persons have been identified as own children. Thus a particular pair (woman,person) will not be recognized as mother and child unless 'person' is single. This eliminates the possibility of false matches identifying the spouse of a child or other primary relative as a child of the head or spouse of head, at the cost of false non-matches in the case of married children living with their parents. Since virtually no persons marry below age 15, this exclusion has essentially no effect on matches of persons under age 15.

Referring to the list of possible pairs shown in Table A above, the pair (i,l) are matched if: (1) woman i is aged 15-64; (2) person j is never married; (3) the relation to head codes for i and j are consistent with a mother-child relation as indicated in Table B; (4) identifying person i as the child of woman i does not result in a total number of male (female) own children matched to women i exceeding her reported number of surviving male (female) children; (5) the age difference between the woman and child is 15-29 years. Note that although a women need not be married to be identified as a mother, she must have reported one or more surviving children. With respect to (3), it should be noted that the (GP,GP) combination was inadvertently unrecognized in the computer match program. It is not expected that this will have had any discernable effect on the results.

It will be evident that this matching procedure might be refined in various ways. Most obviously, the age difference criterion takes no account of the likelihood of different age differences. The shape of the age schedule of fertility makes differences in the mid-20s most likely and differences as low as 15 or over 45 very unlikely. This might be recognized by randomizing the result of the age difference test so that extreme differences are less likely to pass.

The result of this matching procedure depends on the order in which persons are listed in the household, evidently an undesirable characteristic in general. If certain combinations of relation to head codes are more likely than others to be mother-child pairs, the incidence of both false matches and false non-matches would be reduced by using this information to order the pairs according to likelihood and then matching on the basis of this order, rather than the more or less arbitrary order of the household schedule. The same principle of making most likely matches first could be extended to the other information used.

It should be emphasized, however, that such studies as have been made indicate that the fertility measures derived from the results are very robust to variations in the matching procedure.

Thus Levin and Retherford (1982) examine two cases, the 1974 census of American Samoa and a 1976 population survey in Indonesia, both of which included direct questions identifying the mother of each person in the household under 15 years of age. Errors in estimated total fertility rates due to matching errors were negligible for Indonesia, with a median absolute error of 0.4 percent for total fertility rates for the 15 years prior to the census. For American Samoa the median absolute error was only 0.6 percent, though this case there was a systematic tendency for the match procedure to under estimate fertility in the years closest to the census, and the maximum error, for the year before the census, was 3.9 percent.

The main reason for this robustness is that the matching procedure only affects non own children. In many populations, these are a relatively small proportion of all children under age 15. A second reason, in the case of the original own-children method, in which the only use of the matching is to assign age of mother at birth, is that there will be a tendency for errors to cancel each other out.

APPENDIX 2: BIRTH HISTORY RECONSTRUCTION FOR THE 1990 CENSUS OF CHINA

The matching procedure produces what may be thought of as an ‘own children’ history for each woman, that is, a list of the years in which this woman’s own children (children living in the same household as their mother) were born. As with own children methods generally, information on time of birth is limited to years ending at the date of the census or survey used, a limitation imposed by the use of current age in completed years to infer period of birth. The birth history reconstruction procedure has been described in detail in Luther and Cho (1988). This appendix gives technical notes for the application to the 1990 census of China.

The essential idea of the birth history reconstruction procedure is to ‘complete’ each woman’s own children history by incorporating into it the years of birth of non-own and deceased children by a random process that takes account of three principal kinds of information: (1) the age pattern of childbearing, represented by cohort age-specific fertility schedules for the women involved; (2) the level and age pattern of mortality, period life tables representing the mortality risks their children have experienced; and (3) the level and age pattern of children leaving home (which event turns own children into non-own children), represented by the age-specific proportions of non-own children.

In the simplest case, we work with a single set of these three elements for the entire population. If the population is very heterogeneous, however, results will be improved by partitioning the population into relatively homogeneous subpopulations, generating the three elements separately for each subpopulation, carrying out the reconstruction separately for each subpopulation, and then merging the resulting birth histories. It is to be expected that such disaggregation will improve results at the national as well as at lower levels, though the magnitude of the differences will evidently be greater at lower levels.

In the case of China, for example, the level and pattern of age-specific birth rates in cities is very different from the level and pattern in towns and counties. Birth histories reconstructed for women living in cities are therefore likely to be more representative of the actual situation if they are constructed using age-specific birth rates for cities, than if they are constructed using age-specific birth rates for the country as a whole.

Any partitioning of the population in the course of analysis raises the question of whether the birth history reconstruction should be done separately for each subpopulation using birth rates, life tables and non-own children statistics specific to these subpopulations. Such tests of the importance of disaggregation as have been made to date suggest that the method is reasonably insensitive to all but the largest differences (Luther and Cho 1988:461, 464–465).

We have carried out reconstruction separately for women living in cities and women living in towns and counties. For women living in cities we use the ‘urban’ age—specific birth rates in Coale and Chen (1987:26-27) and age—specific proportions of non-own children for women living in cities. For women living in towns and counties we use the ‘rural’ rates given in Coale and Chen (1987:28-29) and age—specific proportions of non—own children for women living in towns and counties. The same life tables are used for both reconstructions.

The rationale for these decisions is as follows. First, Feeney and Wang (1991) show that the most important fertility difference is between cities, on the one hand, and towns and counties, on the other. Second, since age-specific proportions of non-own children are readily available for these two groups, we utilized them. Third, no set of current and historical life tables broken down for anything approximating ‘urban’ and ‘rural’ places exists. Fourth, because of the great differences between fertility in cities and elsewhere, we think that partitioning in this way is likely to improve results, perhaps substantially, and particularly for cities. Finally, we doubt that further disaggregation would make much difference in the results.

The truncated Pearson type III fertility model (Luther 1982) is fitted to the age-specific birth rate schedules for the cohorts of persons aged 15-19 through 45-49 at mid-1982, resulting in two parameters for each schedule. The values of these parameters, and the age of the cohorts as of the 1990 census, are shown in Table A2-l.

The life tables used are shown in Table A2—2. The 1981 life table of Jiang, Zhang and Zhu [no date] shows higher survivorship than the 1987 life table of Zhang and Lu (1991), which we attribute to under reporting of deaths in the 1982 census.

The corresponding survival factors (L_x/l_0 values) are shown in Table A2-3, together with the age-specific proportions of non-own children. The procedure for deriving the survival factors in Table A2-3 from the life tables in Table A2-2 is described in Cho, Retherford and Choe (1986: Appendix A).

[Note: Appendix Tables A2-1, A2-2 and A2-3 note included in this document, which does not include tables or plots. See the PDF image file for tables and plots.]

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[Note: Tables 1-12, Figures 1-6, and Map 1 not included in this document, which does not include tables or plots. See the PDF image file for tables and plots.]