THE DETERMINATION OF VITAL RATES IN THE ABSENCE OF REGISTRATION DATA

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Some 45 to 66 per cent of the world's population still lives in areas in which births, deaths and marriages are so incompletely recorded that vital rates based on registered data are virtually useless (the wide range between the two figures of 45 and 66 per cent is caused by uncertainty about the state of vital statistics in mainland China). For some time to come, knowledge of vital rates for much of the world's population will be based on special procedures of estimation.

The past twenty years have seen the development and application of a variety of procedures that with varying degrees of success have yielded estimates of birth and death rates. The literature on estimation has become substantial, and as the co-author of a manual published by the UN on methods of estimation, and as a teacher who devotes the better part of the spring term in a graduate course to teaching procedures of this sort to his students, I find it an embarrassing assignment to compress useful information on the topic in a short paper.

I shall try to achieve the necessary compression by attempting, in most instances, little more than an enumeration of the procedures that have been developed, with at most an indication of the principles upon which the methods of estimation are based, and the kinds of data that they require. Anyone wanting to learn how to prepare estimates will have to look beyond this paper, beginning with the references provided in the footnotes.

RECORDING OF EVENTS BY TWO INDEPENDENT PROCEDURES IN A SAMPLE OF AREAS

A method of great potential usefulness whose effectiveness is not, however, fully proved is to obtain current statistics of vital events by an intensive effort covering a representative sample of the population. The sample design typically includes a stratified sample of villages to represent the rural population, and a sample of blocks to represent the urban.

A key feature of the better designed of such projects is the use of two independent sets of records of the events. In Pakistan, where so far as I know the first such experiment was initiated, special registrars residing in the villages (the schoolteacher or some other educated person was usually selected) were utilized to maintain a continuous record of vital events. The second system of recording was by means of periodic surveys in which households in the sample areas were asked about the events that had occurred in the preceding six months. In Turkey the two sources of information are two independent surveys, one survey conducted monthly, and the other at intervals of every six months by more highly trained interviewers. The important feature of a dual system is that individual events recorded in one system are verified (or an omission detected) by an event-by-event match of the records. Such individual matches make it possible to detect omissions in both systems, in contrast to an aggregate comparison of the number of recorded births or deaths, which merely indicates which is more nearly complete. A scheme of this sort has been initiated in India on a gradually expanding basis, and also employed in Thailand and Liberia. The accuracy achieved by this approach must still be considered uncertain because of the difficulties of being sure that the two records do or do not pertain to the same event, and because of the administrative problems of maintaining independence of the two systems of recording, and of preventing deterioration in the quality of the records as the project continues for a long time.

A manual examining dual record systems in detail is to be published by the Population Council.[1]

METHODS OF ESTIMATING FERTILITY FROM CENSUS AND SURVEY DATA

Age-Specific Fertility Rates from Retrospective Data of High Quality

Suppose that every woman in a large representative sample in a closed population supplied accurate information about the date of her birth, the date of her marriage, the date of the birth of each of the children that she had ever borne and the date of its death if it had not survived until the present. On the usually justifiable assumption that the fertility experience of women who have died does not differ enough from those who have survived to cause serious inaccuracies in estimation, the data that we have just supposed collectable would provide the basis for determining the past age-specific fertility rates for each cohort of women in the population. The limit on the number of years for which estimates could be extended into the past would be the highest age (say 60 or 65) at which women can be expected to supply accurate data genuinely representative of the cohort. Rearrangement of the cohort rates would provide the means of constructing age-specific fertility schedules by period for each of the past 15 or 20 years.

On the basis of knowledge merely of the current age of each woman, it is a simple matter to determine how many person-years she contributed to each five-year age-interval above age 15, and how many person-years she contributed to what age interval in specific time intervals in the past. In other words, for each woman it is a simple matter to calculate her contribution to the denominator of past age-specific fertility rates, and equally simple to record the births that she supplied to enter the numerator of such rates.

Most demographers with experience in the use of census data from countries that lack vital statistics would be skeptical about the possibility of obtaining full and accurate data of the sort required. In many populations most respondents cannot supply a usable answer to a question about date of birth or chronologic age for themselves or for their children. Also, it is well known that older women tend to omit some of the children they have borne in response to a question about the number of live births they have experienced. However, a number of demographers, especially Donald Bogue, a major developer and advocate of this approach, argue that the construction of a detailed history of a woman's marriage and individual birth record makes it possible for a well-educated and highly trained enumerator to correct errors in age, age at marriage, timing of births and so forth, initially reported. The interviewer makes use of such clues as improbably long interbirth intervals, or inconsistency between the reported date of birth of a child and his present age, especially if he is seen by the interviewer. Carefully taken surveys in which a well-qualified interviewer devotes as much as half an hour to the completion of an individual fertility history can produce surprisingly high quality data, not only for the past two or three years, but even for the past decade or so, thus making it possible to establish recent trends as well as current levels of fertility. Donald and Elizabeth Bogue have prepared a manual on this technique, including a questionnaire, instructions for coding and computer programs for tabulation and analysis.[2]

To my knowledge at least, experience with such detailed fertility histories is not yet sufficient to judge under what circumstances they provide information to support estimates of fertility levels and trends.

Fertility from Tabulations of Own Children by Age, and by Age of Mother[3]

If most young children live with their own mothers, data approximating those obtained in the special fertility survey described above could be extracted by merely making a special tabulation from a census in which each household is identified and relationship to the head of the household is recorded. The first step is to infer whether each child is the own child of a woman in the household. The inference is based on the relation to the head of the household—based on the fact that the child is the child of the head of the household and the woman is his wife, and the head of the household has been married only once. In most countries a very high proportion of children under five are "own children," and in many the proportion remains high to age ten or beyond.

Korea is a country in which such data can be used to very good effect. The proportion of own children is very high up to age ten, and in the Korean census of 1966 age was determined by responses to a question about the year of birth. In common with other people of a culture related to the Chinese, each Korean, whether literate or not, knows beyond a doubt the year in which he was born. Consequently age distributions based on responses to such a question in Korea are virtually free of error.

By making allowance for mortality and for the small proportion of children who are not own children it is possible to estimate the numerator of age-specific fertility rates by single years of age during the past ten years, and by allowing for mortality among women to estimate the denominators of such age-specific fertility rates. In Korea, estimates of child mortality can be derived from data internal to the census by an adaptation of a method described below. Application of the procedure to the 1966 census by Lee Jay Cho has produced a set of ten single-year age-specific fertility schedules of impressive internal consistency and plausibility. Before long the validity of these estimates can be further checked by applying the procedures to tabulations from the

1970 census from which estimates of five or six overlapping years can be derived.

Unfortunately, full usefulness of data on own children tabulated by age of child and age of mother depends on a census free of substantial differential underenumeration by age and with accurate age reporting.

Fertility Based Wholly or Partly on Data on Parity (or the Total Number of Children Ever Born)

Many censuses and surveys in the past have included a question on the number of live births each woman has experienced during her lifetime. This information in itself is a summary measure of the average fertility of each cohort—a partial measure for the cohorts still in the childbearing years, and a measure of total fertility of those that have passed the last age of childbearing. It is, of course, an indication of the average fertility only of the surviving members of the cohort, but in fact the effect of differential mortality between the relatively fertile and the relatively infertile is minor, even in populations with high death rates.

It is commonly observed in censuses in less-developed countries that older women give deficient responses to a question about parity, understating the number of children they have ever borne. It seems unlikely that in fact women have forgotten the births that have occurred to them, and more likely that the deficient answers are a result of a misunderstanding of the question. One source of misunderstanding is children who have grown up and left home may not be considered as "children." If three questions about parity were asked instead of one, this deficiency could be greatly reduced, if not eliminated. The three questions are:

1. How many children has this woman ever borne who are still living with her?

2. How many children has the woman ever borne who are now living elsewhere?

3. How many children has this woman ever borne who have died?

Asking the three questions makes it clear to the respondent that she is not to omit children who have died or moved away.

In a population subject to essentially constant fertility in the recent past, the rising curve of average parity with age at a given moment in time found in a census or survey approximates the history of rising parity of each cohort. Average parity (or average number of children ever born) at a given age for a cohort is the sum of the age-specific fertility rates from the earliest age of childbearing to the given age. Therefore, if fertility in the population has been approximately constant, age-specific fertility can be estimated by taking differences between values of average parity at consecutive ages recorded in a census. For this method of calculation to yield accurate rates, the reporting of age and parity must be extraordinarily accurate, and fertility must have been extraordinarily stable. The same principle of determining age-specific fertility by taking differences in average parity at different ages can be applied to data tabulated by five-year age intervals. Curvilinearity in the typical schedule of fertility implies that simple differencing of average values of parity for consecutive five-year age intervals would yield poor estimates of age-specific fertility, and also estimates for unconventional age intervals (from 17.5 to 22.5 years, for example). Some form of curve fitting is called for.

The requirement that fertility schedules be stable over time is a severe limitation on the usefulness of tabulations of parity as a means of estimating the current or recent schedule of fertility. However, the fact that average parity at a given age is the cumulation of the age-specific fertility rates experienced up to that age by the cohort in question can sometimes be used to determine the completeness of birth registration and to provide a correction factor to adjust registered births for omissions. Age-specific fertility rates for each cohort calculated from births registered by age are cumulated to determine what average parity should be reported at each age in a census or survey, if registration were complete. The ratio of reported average parity to cumulated fertility can then be used as an indication of the degree of omission from the register and as an adjustment factor to apply to registered births. This procedure can be employed even when only one question on children ever borne has been asked and when, in consequence, the parity reported by older women tends toward understatement. It can be assumed that the parity reported by younger women (for example under age 25) will be virtually free of such omissions, and the estimation of incompleteness of registration and the adjustment for incompleteness can be based on the experience of these younger women.

William Brass has developed and made extensive use of the estimation of fertility from two sets of data collected in a single survey. One set of data is parity reported by age, and the other consists of responses to a question about whether each woman bore a child during the preceding year, tabulated by age. If the responses to the latter question were accurate, they would provide the basis for a straightforward calculation of an age-specific fertility schedule. However, there is a tendency in many populations for either under-reporting or over-reporting the number of births in the preceding year, and Brass suggests that the reason is typically a misperception of the duration of the reference period (one year), so that women on average report births perhaps for the preceding eight months, or perhaps for the preceding 15 months. If such a tendency in a given survey is approximately uniform for women of different ages, the age-specific fertility rates determined on the basis of responses to this question can be treated as systematic underestimates or overestimates of the true age-specific fertility rates; the degree of underestimation or overestimation being determined by comparing the cumulated age-specific fertility rates up to age 20 to 25 or 25 to 30 with the average parity reported by women at these ages. This procedure is valid only if the fertility schedules of young women have been stable over the preceding few years.[4]

The Brass method of estimating fertility just briefly described and the analogous procedure utilizing registered births do not work well when the ages reported in censuses or surveys are subject to massive and systematic misstatements. The Brass methods failed to give usable results when applied to a number of African censuses or surveys, but appear to be potentially useful in Latin America, where age misreporting is less severe.

Inferring Fertility from an Age Distribution

In a closed population the number of births during any time period in the recent past can be estimated by calculating the number of births that would have been required to provide the number of survivors at the appropriate age interval recorded in a census or survey. Thus, the number of persons at ages 15 to 20 divided by the appropriate survival factor provides an estimate of the number of births 15 to 20 years ago. The size of the population at the appropriate time in the past can be estimated from the average rate of increase of the population over the appropriate time interval, and by this kind of reverse projection the birth rate in the past can be approximated. In our hypothetical example it would also be possible to project in reverse the number of women now aged 30 to 60 to estimate how many there were at ages 15 to 45 fifteen years ago, and by a parallel calculation to determine how many there were 15 to 45 twenty years ago; and the average of these two values would be the approximate number of women 15 to 45 during the time interval 15 to 20 years in the past. Thus, a general fertility rate for the past could be estimated. For accuracy such forms of estimation require an accurately recorded age distribution and valid estimates of mortality during the recent past.

When fertility and mortality have been constant for the past 25 or 30 years the age distribution would closely approximate the stable age-distribution, and the estimates of fertility derived from different age-segments of the population should be the same. Thus approximation to a stable form makes it possible to construct much more robust estimates (valid, for example, even when ages are only approximately recorded) and also makes it possible to infer the true age structure of the population more exactly than by mechanical techniques of smoothing. The application of the techniques of analysis associated with stable populations when fertility and mortality have been constant, and of the so-called quasistable techniques when fertility has been constant and mortality declining would take too long to describe, even in the succinct form of summary being attempted here, and I shall say no more about it.[5]

ESTIMATING MORTALITY FROM DATA OBTAINED IN CENSUSES AND SURVEYS

The estimation of mortality in the absence of reasonably complete registration of deaths is greatly facilitated by a strong tendency for death rates at different ages in a given population to be intercorrelated. The intercorrelation arises from the fact that the mortality risks to which a population is subject depend upon the general living conditions and upon the state of development of public health facilities, environmental sanitation and curative medicine. In general, mortality rates at any age will be high when these conditions are adverse, and low when these conditions are favorable. Consequently, in a population in which the mortality rates of people in their fifties are among the highest in the world, one can confidently anticipate that infant mortality rates are also near the upper end of the world scale. If the interrelations among mortality rates at different ages were perfect, one would need only know the mortality rates at one age to obtain good estimates of the mortality rates at all other ages. In fact, the relations among mortality risks at different ages are not this narrow.

The tendency for age-specific death rates at different ages to be related has been expressed in a form useful for estimation by the preparation of "model life tables." The first set of these tables published and widely utilized was prepared by the Population Division of the United Nations. Subsequently model tables have been published by the Office of Population Research and by the Institut National d'Études Démographiques.[6] The later sets of model life tables embody variations in the age structure of mortality at the same overall level, but still make it possible to approximate a full schedule of mortality at all ages from fragmentary information.

In trying to estimate the mortality schedule that a given population is subject to in the absence of direct data, one is typically faced with uncertainty as to the detailed interrelations of mortality rates at different ages. Thus there are different model life tables with the same mortality rate at a particular age, or with a different overall index of mortality such as the average duration of life. In estimating mortality for a population without valid records, there are often inadequate clues for choosing which of the various possible model life tables is the appropriate one. The most important difference in the interrelations of mortality rates in different populations is different relationships between child mortality on the one hand and adult mortality on the other. Populations with the same expectation of life at age five may have widely different expectations of life at birth because of a tendency for unusually high infant and child mortality or for unusually low infant and child mortality to be associated with a given mortality above age five. This fact implies that it is useful to have separate direct evidence bearing on infant and child mortality on the one hand, and on mortality at ages above five on the other. Procedures have been devised for extracting such evidence from data collected in censuses or surveys.

ESTIMATION OF MORTALITY BY FORWARD PROJECTION[7]

Suppose two censuses are taken with an intercensal interval of ten years, and that each census records the number of persons in each five-year age-interval for each sex. The number of persons over ten in the later census constitute (in the absence of international migration) the survivors of those who were enumerated in the earlier census. If the mortality to which the population has been subject may be assumed to belong to a particular family of model life tables, one can determine the level of mortality within the family by projecting the population at each age from the earlier to the later date using alternative levels of mortality from the lowest to the highest that might conceivably characterize the population in question, and by selecting (using linear interpolation) that level of mortality that produces a projected population over age ten exactly matching the recorded population over age ten (such a projection can be made separately for each sex). The level of mortality estimated in this way may be biased by a tendency for relative undercount or overcount of the population under age ten, caused, for example, by a misstatement of age that transfers adolescents above ten to the five to nine age interval. Another estimate of mortality can be obtained by finding what level produces the recorded population over 15 in the later census by the projection of the population over five and the earlier. In fact, it is evident that a series of estimates of the level of mortality can be obtained by seeing what level matches the recorded population over ten, over 15, over 20 and so forth. The median of the first nine estimates of level obtained in this way provides a plausible summary estimate. If different assumptions are made about the age pattern of mortality to which the population is subject (i.e., if different families of model life tables are considered), it is found that an index of overall mortality above age five, such as the expectation of life at age five, is much the same. However, the mortality under age five ascribed to the population by assuming that its experience belongs to a family of model life tables is widely different depending upon which family is assumed. In short, forward projection provides what appears to be a valid estimate of adult mortality, but gives only an indirect and not very robust estimate of child mortality.

The technique of forward projection is applicable only if international migration is negligible or is of moderate volume and can be accurately estimated. Even in a closed population, if the completeness of coverage of the two censuses utilized is different, the difference in coverage is equivalent to an understatement or overstatement of the number of deaths to which the population had been subject.

ESTIMATION OF MORTALITY IN INFANCY AND CHILDHOOD FROM DATA ON NUMBER OF CHILDREN EVER BORNE AND NUMBER OF CHILDREN SURVIVING[8]

Consider a cohort of women whose ages fall in a particular span, say 20 to 25 at the time of the census. If we knew the age-specific fertility to which the cohort had been subject, we could readily determine the time-distribution of the births that the women had experienced in the past, and therefore could also determine the age distribution that the children they had borne would have in the absence of mortality. Finally, if for each age up to that of the oldest child we knew the cumulative probability of death to which the children had been subject, we could calculate the proportion of the children the women had ever borne who would be dead at the time of the census. In fact, the proportion dead is merely the cumulative product of the proportion of children at each age (in the absence of mortality) and the proportion dying from birth to that age. With the given time distribution of births in the past there would be a one-to-one correspondence between the proportion of the children ever borne who were dead at the time of the census and the level of mortality to which the children had been subject, assuming their mortality experience to conform to a family of model life tables. In fact, for a given age-specific fertility schedule, one can calculate the proportion dead among the children-ever-born to women in a particular age interval for each level of mortality in a family of model life tables. Conversely then, always assuming the age-specific fertility schedule to be known, knowledge of the proportion dead among the children-ever-borne to women in a particular age interval makes it possible to determine the level of mortality to which the children have been subject.

In general, the age-specific fertility schedule to which a cohort has been subject is not known. However, William Brass had the ingenuity and insight to propose that the general structure of the age-specific fertility schedule can be inferred from the way in which average parity rises with age. If average parity is tabulated by five-year age intervals, the most reliable basis for determining the level of mortality from the proportion dead among children-ever-born to women is the ratio of average parity at age 20 to 25 to average parity at 25 to 30.

This procedure determines the level of mortality for childhood ages only; specifically, data on children-ever-born and children surviving for women 20 to 25 provide an estimate of the proportion of children who die before their second birthday, data for women 25 to 30 an estimate of the proportion of children who die before their third birthday, and data for women 30 to 35 from the proportion of children who die before the fifth birthday. The mortality schedules to which the children have in fact been subject extends increasingly into the past as one uses data for older women. Data for women 20 to 25 provide an estimate of average mortality during perhaps the preceding four or five years. This method of estimating child mortality, which has properly enough come to be known as the "Brass Method," is surprisingly exact when applied to data from censuses in advanced countries that also have accurate vital statistics. When applied to data from countries (typically the less developed countries) that do not have vital statistics, it yields estimates of child mortality substantially higher than obtained from direct survey data asking respondents about births and infant deaths during the preceding year. Estimates by the Brass method are clearly the more plausible, partly because it is hard to imagine that these estimates, consistently higher, are an overstatement. If the Brass estimates tended systematically to overstate mortality, the implication would be that women tend to report the children who have died more fully than they did those who survive.

The combination of two consecutive censuses to which forward projection can be applied to determine mortality above age five with questions on children ever borne and number of children surviving to determine childhood mortality is very useful. Such a combination also provides the requisite estimates of mortality needed for reverse projection to estimate fertility from the recorded age distributions. However, forward projection requires two consecutive censuses or surveys of approximately the same quality of coverage, and a closed population.

An additional possibility of estimating adult mortality from a single survey or census is by including a question asking each person whether his own mother and his own father are still alive.

If we assume that the structure of age-specific fertility five years ago is known, we can determine the approximate age distribution of the mothers who gave birth during that year. The product of the proportion of mothers at each age and the proportion dying within five years of that age according to a model life table at a particular level of mortality would, when summed, equal the proportion of maternal orphans among five-year-old children in a population subject to that level of mortality. Thus approximate knowledge of the age-specific fertility schedule is sufficient to determine the proportion of children at each age who would be orphaned at each level of mortality in a family of model life tables. Conversely, the level of mortality can be estimated from the proportion of children at each age who are orphans. Such a procedure has not as yet been widely applied, and it is not yet known what sort of results it might produce.

CONCLUSION

The conscientious reader who has tried to follow the preceding highly condensed description of methods of estimation will realize that there is an extensive battery of procedures by which fertility and mortality can be estimated. Under some circumstances data can be obtained from surveys or censuses that provide excellent and detailed estimates of the recent course of fertility and mortality. Indeed, when it is possible to get full and accurate fertility histories from a large enough sample of women, or when very precise records of age are obtained in a census, age-specific fertility schedules may be constructed for each year in the preceding decade and detailed trends detected in fertility by age. Under such circumstances it is possible to obtain the requisite data for evaluating the impact of a family planning program or to detect the beginning of a modern decline in fertility.

Under less auspicious circumstances, a large demographic survey every five years, including a full battery of questions with regard to children ever borne, and incorporating intensive efforts to obtain more accurate reports of age can yield usable estimates of recent fertility and mortality, certainly of sufficient accuracy to reveal substantial trends.

There is no doubt that in the long run a modernizing country must have complete registration of vital events, and some reason for supposing that the development of a model registration scheme in a representative sample of areas, cross-checked by dual recording, may be a useful way of moving toward a complete registration system. But meanwhile, the incorporation of relevant questions and the preparation of the relevant tabulations from periodic censuses, supplemented by intensive, well designed demographic surveys can provide indispensable data on current levels and current trends in fertility and mortality.

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[7] Coale and Demeny, Methods of Estimating Basic Demographic Measures from Incomplete Data, *op. cit.*

[8] Brass, *et al.*, THE DEMOGRAPHY OF TROPICAL AFRICA.

DISCUSSION

Dudley Kirk: My remarks will be rather general since I have not had opportunity for careful study of Ansley Coale's paper prior to this session.

Some 20 years ago the geographer of the State Department, Whittemore Boggs, compiled an "Atlas of Ignorance." For vital statistics he classified about 70 per cent of the world's population as lacking official data adequate for statistical use. Progress in achievement of adequate official statistics has been slow. Ansley Coale estimates 66 per cent of the world's population to be without reasonably complete and accurate vital statistics today, if we include mainland China within this *terra incognita.*

The methods described by Coale, mostly developed in the last 20 years, have done much to dispel ignorance of true levels of fertility in countries without complete registration of vital events. His paper is an excellent summary of the impressive progress made during that period. Coale himself has made major contributions. His work and that of his colleagues, as well as similar studies by the Economic Commission for Africa, have replaced casual anthropologic evidence as sources for vital rates in tropical Africa. Otherwise, Carmen Miró and her colleagues in Santiago have used such methods to estimate vital rates for all Latin American countries. More generally, the United Nations has been enabled to present plausible vital rates for most of the countries not having usable official statistics on births and deaths. The methods described by Coale display great virtuosity in making the best of bad data.

Despite these deserved encomiums, there is no occasion for "dizziness with success." Statistical manipulation of bad data, no matter how sophisticated, is still a makeshift substitute for good data. Even in those cases for which we have some good data there are almost always pitfalls. Coale mentions age reporting in the Korean census of 1966 as being "virtually free of error" and the age-specific fertility schedules derived therefrom as being "of impressive internal consistency and plausibility." I suppose this is a matter of degree and of judgment. Actually the latter series gives implausible results at several points.[1]

Furthermore, statistically ingenious methods may give deceptively precise results. One illustration from the methods described by Coale is the use of model life tables to estimate mortality for developing countries in the absence of complete registration of deaths. The United Nations and Coale-Demeny model life tables are based on intercorrelations between infant, child and adult mortality, determined almost entirely from Western experience. Commonly the model life tables are used to estimate infant and child mortality from adult mortality, the latter derived by differencing age distributions in two successive censuses. In cases where it is possible to make fairly rigorous direct tests in less developed countries, the estimates of child and infant mortality so derived have not proved very accurate. For example, the highest estimate of infant mortality from the model life tables as applied to Turkey is far below infant mortality as ascertained from the Turkish National Sample Survey, the Turkish Demographic Survey, and the Ankara Survey. In a number of other places where tests have been possible there is a much higher ratio of child to adult mortality in less developed countries than prescribed by the model life tables. This is very important since deaths under age five are such a high proportion of deaths in countries of high mortality, and estimates of such deaths are an important component in estimating birth rates from census age distributions. There appears to be a different pattern of mortality change in many of the developing countries from that postulated from Western experience. I do not mean to suggest that Coale is not aware of such limitations—of course he is—and fortunately the battery of new methods often provides alternative approaches to check the validity of any single method. But there is hazardous attractiveness in the spurious precision of a model.

Statistical errors are of course not confined to developing countries nor to the very useful new methods for estimating vital rates. A more serious general defect is that most of the new methodology is useful for measuring *levels,* but not current *trends.* In fact the most sophisticated analysis is commonly referred to as "stable" or "quasi-stable" population analysis, with the assumption that there has been little change in fertility over time. Yet it is precisely the *change* in fertility that is necessary for projections and for evaluation of family planning programs. This problem relates particularly to the developing countries, the areas for which better data are most needed.

This leads me, Mr. Chairman, to draw attention to what seems to me an important omission in our program for this meeting.

Conspicuously missing from our list of achievements in 40 years of fertility research is successful forecast. Prediction is the most rigorous test of scientific method and in this we have not done so well. The history of demography of the past 40 years is strewn with bad forecasts, in which this speaker, among many others, has had a part. We have not been imaginative enough to see new directions and their implications in advance. To take a current example, I think there is emerging evidence that fertility declines in the less developed countries may be much more rapid and in much more orderly pattern than is commonly assumed both by demographers and others. And it is possible that even before Charles Westoff's Commission report is published next year fertility declines in the United States will have proceeded so far that the basic assumptions underlying the establishment of the Commisison[2] will have to be fundamentally changed.

I would hope that a future Milbank conference would give more attention to this extraordinarily difficult, unresolved, but most important problem of forecasting fertility changes. Should we not give as much attention to our failures as to our successes?

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[1] The series shows a marked increase in total fertility at the beginning of the series for no other plausible reason than that 1957 corresponds to age nine, which is characteristically underreported. It shows a rise in fertility between 1965 and 1966, a time at which fertility was almost certainly falling, as indicated from other sources. A possible explanation is that Lee Jay Cho had difficulty in translating age as reported on the Oriental animal cycle to Western ages zero and one. Apparently this resulted in too low an estimate for 1965 and/or too high an estimate for 1966. In addition, his data for 1957–61 show a suspicious alternation of high and low fertility rates derived from even years of age (six and eight) as opposed to odd (seven and nine). Cho's series shows a rapid decline of fertility in the period covered, but this was of course already established from other

sources. His evidence is useful confirmation of the general trend but certainly cannot be taken as an accurate measure of annual changes or of the impact of the national family planning programs.

[2] The Commission on Population Growth and the American Future. An interim report was published as of March 16, 1971. Charles Westoff is Executive Director of the Commission staff.

Philip M. Hauser: Findings in the Differential Mortality Study by Kitagawa and Hauser indicate that women of higher parity, five or more children, have higher mortality (using age-adjusted rates controlling educational level as index of socioeconomic status). Women with 0 or 1 child have above average mortality but women with 5 + children have appreciably higher mortality. Women with 7 + children have mortality about nine per cent above average.

Wilson H. Grabill: Coale made the point that despite sample surveys and so forth, in the end we need good vital statistics. I agree, but we also need good censuses or population bases to compute reliable birth rates. Even in the U.S., I wonder how accurate the adjustments were that were made by Whelpton and by NCHS for undercounting of population in the censuses for bases of their cohort cumulations. Whelpton compared his computations of cohort fertility for native-white women with census data and figured that the census was "too low" by two or three per cent, *circa* 1950. More recent cohort materials (by NCHS) are for all races combined, and suggest that the census around 1960 was about five or six per cent too low. If we accept both figures as being about right, and allow for nonwhites being about 11 per cent of all races, then by computation it can be estimated that the nonwhite data around 1960 are about 25 per cent too low, as best as I recall from an experiment carried out long ago. I hesitate to believe that we are missing that many children among nonwhite women, at say, ages 45–49. I think something related to the methods used in the derivation of the cumulated vital statistics is out of line, perhaps especially the population bases.

We will always need nation-wide inventory type data on vital statistics and on census data, as I see it, in addition to any and all refinements that can be and have been developed by the GAF type of studies. We need many kinds of data, for one purpose or another.