THE SOCIAL AND POLITICAL CONTEXT OF POPULATION FORECASTING

Nathan Keyfitz

January 1984
WP-84-3

Also appearing as Chapter 5 of
The Political Economy of National Statistics, edited by William Alonso and Paul Starr

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

FOREWORD

The subject of forecasting abounds in paradoxes. All statistical data refer to the past, yet for purposes of action only the future counts, and there is no necessary connection between past and future. Thus forecasting is on the one hand impossible, on the other hand indispensable. The difficulty is greater for population forecasts in that they are demanded for half a century or more ahead, where economic and other forecasts need cover no more than one or two years into the future.

Forecasts are needed for planning; plans are rarely for more than five years in the future; why does anyone want population forecasts for the next half century? Official forecasts are usually presented as alternative projections, among which the reader chooses; yet if the reader chooses that projection whose output numbers he prefers, then he might as well choose among a set of random numbers. Forecasts are often in error, yet there have been cases in which they were given with accuracy, and where they were disregarded: examples are declining school attendance and increasing pensioners.

Any discussion of the social and political context of anything gives the impression of denigrating that thing. Our intention here is to show the importance of statistics and of forecasts, despite errors and misunderstandings.

Nathan Keyfitz
Leader, Population Program

CONTENTS

N. Keyfitz

THE SOCIAL AND POLITICAL CONTEXT OF POPULATION FORECASTING

Numbers provide the rhetoric of our age. In discussing world poverty it is better to say that there are three billion poor people, and they will be four billion by the end of the century, than merely to say that there are now many poor and they are increasing; and similarly in a discussion of food, that there are 700 million hungry today, and they will be a billion 20 years from now unless we do something about it.

It is not customary, and even not courteous, for a listener to inquire into the relation of such numbers to actual censuses or other counts, to try to set bounds on them, or to ask for definition of their concepts, in respect of either the present or the future. What rounded periods and flourishes were to Victorian eloquence, what Latin tags did for the 18th century, numbers contribute to eloquence now; they testify to the seriousness and trustworthiness of the speaker, as well as to his proper education. That purpose is served by predictions that have little basis in present tendencies; the listener who would not notice the difference between three million and three billion does not ask awkward questions. Ask the next few people you meet what is the world population; you will be surprised to find their answers varying by orders of magnitude. Yet all of them will trust a speaker who uses numbers more than one who does not.

To those of us who see science as measurement and forecasts

as important for practical life, such use of numbers is a painful caricature of what we do at the same time as it is a tribute to our scientific work. So high a valuation of numbers, including those concerning the future, is associated with the empirical tradition in science, earliest and most prominently shown in English-speaking countries, and more recently identified with planning for the future, fully as important for a corporation as it is for a socialist state.

The eloquence that makes use of numbers in a poetic vein derives its force from the very real usefulness of numbers in their professional application. A production plan in which the elements are set out explicitly is more effective than going ahead without a plan. The plan depends on what will happen in the future--what will be the size of the market, what the competition will do, how costs will change. At the very least the forecasts of these elements will expose them to professional criticism, will reveal unanticipated contradictions, will help ensure coordination of the various divisions of the corporation or the state. Before moving on to these points we must face a contradiction of pervasive importance, arising from the nature of time itself.

Forecasting: Impossible Yet Unavoidable

Because things are interconnected we cannot know the future of one variable--population--without knowing the future of every other variable. The number of people in the United States in the year 2000 depends on the condition of the economy, how our environment will hold out, what foreign demand for our goods will

be, and many other circumstances, at each moment between now and the beginning of the next century.

One can of course "forecast" in the trivial sense of uttering a statement about the year 2000, but to forecast in the sense of making an estimate that will turn out to coincide with what is actually going to happen is beyond human capacity. The sentences, "He forecasts the end of the world at the next millenium," and "He forecast the present drought several months ago," are both grammatically correct. The essential distinction is not between a correct and an incorrect forecast, but between the utterance (whether or not it later proves correct) and the congruence of utterance and subsequent event. It is a hindrance to clarity that the same word has two wholly different meanings, one signifying a prophetic assertion, however subjective or objective, the other genuinely anticipating an event which subsequently occurs.

The difficulty of the latter follows from a realistic view of the world's variability and its immunity to human control and prescience. All this applies in principle to forecasts of population as of any other feature of the future. Time's arrow winging its way forward penetrates into territory that is forever new. Even if our knowledge base regarding the past was perfect and complete (of which there is no prospect ever), the real novelty in the world would still make genuine forecasting impossible.

Yet standing against this assertion of the absolute impossibility of knowing the future is the absolute necessity of

a picture of the future if behavior is to have any sense. One cannot act purposefully in any smallest respect except within a picture of what the world will be like when the action produces its effects. So strong is the felt necessity of a milieu in which forecasting will be possible that major human institutions have no other purpose than to establish such a milieu. Every time schedule, every stable community, every geographical arrangement helps make it possible to foresee that some person will be present or some event will occur in a certain place at a certain time. But no set of institutions can go more than a short distance towards organizing the future. When we talk of forecasting we refer exclusively to those items--like whether births in the year 2000 will be above replacement--that cannot be taken for granted. When we say that forecasting is impossible, we are really referring to those matters that are on the margin of possible knowledge. It is not the population for the next five years--that essentially we know--nor that of the 22nd century--that we have no possibility of knowing--but the population between those times that we refer to when we speak of forecasting.

The tension between the need to know the future and the impossibility of knowing is resolved more readily in a society in which institutions change slowly. That is not the kind of society in which we live. The need to know the future increases as change accelerates, and at the same time the future becomes more opaque and impenetrable. The greater the need to know, it seems, the less the possibility of accurate knowledge.

A market economy provides one solution to the problem of

knowledge and ignorance. Competing firms each make their own forecast, the accuracy of these forecasts constituting the locus of competition: the firm that can hire the best forecasters, including demographers, is the one that make the largest profit, so that it expands while the firm with less good forecasters goes under.

It is true that forecasts are in some degree the locus of competition, but that does not lessen the advantage to the community of having official forecasts that are available to all; firms can build them into their own private models with or without modification. This public forecasting, a part of the infrastructure of the economy, that one hopes is carried out with a degree of skill and competence, is the subjet of this paper.

Forecasts Are Everywhere

Because readers are hungry for news of the future, forecasting is pervasive, to be found implicitly in the conventions that have developed in the routine presentation of population as of other data. Expressive of this viewpoint are current rates of population increase, the net reproduction rate (that tells what current fertility and mortality imply for the size of future generations), the intrinsic rate of natural increase, doubling times corresponding to present rates of increase, all of which are implicit projections. Like the custom of presenting data on national income in terms of annual increase, these suggest (or threaten) that current conditions may continue through time. Showing rates is an invitation to the reader to suppose indefinite continuance of the rates, just as

much as a population projection is an invitation to think that the population shown as the medium estimate for the year 2000 is what will eventuate. Yet in both cases the presentation is in such form that its author can easily repudiate the invitation should he later wish to do so.

What comes about is a division of responsibility that is natural to a society in which institutions have to protect themselves at the same time as they perform needed services. The national or international statistical agency cannot take responsibility for performing a task that is impossible: describing the future before it occurs. Let it be responsible, therefore, for saying only that its numbers for the future are the working out of a set of assumptions based on the present, just as it calculates rates that do not even mention the future explicitly. Let the user take responsibility for treating its work as forecasting.

This division of responsibility is a feature of the social context of forecasting that will be analysed at some length in what follows. But first we need to look briefly at the data that support projections, in particular the census counts that are their necessary jumping-off points.

A Census Confirms the Nation

William Kruskal has pointed to a neglected aspect of the census, its character of ceremony and symbol: "It provides a sense of social cohesion, and a kind of non-religious communion: we enter the census apparatus as individual identities with a handful of characteristics; then later we receive from the census

a group snapshot of ourselves at the ceremony date" (p. 2). That helps to understand the worldwide census movement that began for the most part with the 19th century and that, especially since 1950, has spread rapidly around the world. Sponsored by the United Nations, it has been one of the unqualified successes of that body. At a time when it was not yet permissible for international agencies to promote population control, taking censuses was an outlet for the urge to do something about the population problem. If poor countries only knew their populations and how fast they were growing, they would spontaneously act to control births. By now there are only one or two countries in the world that have not taken at least one census.

The western sponsor of censustaking has had a very different perspective from that of the less developed countries that acceded to the project. Where the sponsors expected that the poor country in question would progress from the taking of a census to recognition of the need for population control, the poor countries fell in with censustaking because the population count would somehow validate their nationhood. They used the opportunity to include disputed territories in their counts and so legitimate their claims. The emergence of the modern state in western Europe had been marked by the taking of national censuses, and we need not be surprised that censuses were likewise welcomed by the new nations of Asia, Africa, and Latin America.

But if the census is a symbol of the nation, then the larger

the count in comparison with other nations the more imposing the symbol. In this perspective a large population is by no means to be deplored. The census movement helped to make population a measure of the importance of nations and of the weight of each in the council of nations. Poor countries made extensive reference to their large populations.

At least that was the view up to the 1960s; it is only with hardships and grave problems associated with population and its growth during the past 15 years that new nations have come to see that the symbolic value of a large population can be offset by the very real difficulty of providing for that population. And in Africa this offset is still by no means universally understood.

What applied to the last census count applies equally to the forecast. Nigeria is the 10th country in the world today; according to World Bank projections, it promises to be the third country towards the end of the 21st century. Nigerians and other Africans see their increasing numbers as giving them a growing weight in world affairs.

Vital statistics are by no means as widespread as censuses. It is true that most countries have some provision for registration of births and deaths, but outside of territories containing about 30 percent of the world population there is an unknown but substantial undercoverage.

Complete registration of births requires effective government, as does a good census. But a census can be taken with a few thousand, or a few hundred thousand, literate and trained enumerators, while a registration system requires more

than registrars; it depends on the sensitization of virtually the entire population. In a mature system statistics for the country are obtained at the same time as proof of age and citizenship for the individuals registered. But peasants do not apply for passports and have little need to prove their age and citizenship. The social changes that will alert parents to the usefulness of registration will take long enough that we must hope the population problem will be solved before it can be measured by vital statistics.

This absence of good base material will continue to be a serious handicap to forecasts for the foreseeable future.

Population Has Long Lead Times

Whether growth is to be speeded up or slowed down, population is in most situations a question for the long term. Rarely has it been argued that a country is under- or over-populated today; rather it is feared--in Mexico, say, or China--that a crisis will occur in the next generation or two; or, in Austria or France, that the 21st or 22nd century will see an undermining of the culture because there are too few people to carry it. The nation, like the individual family, is prepared to live with the children already born, however strong its reasons for fearing further births. Of all policy issues population, along with the associated problem of resources, spans the longest term. No one even contemplates the 1990 discount rate; they do worry about population in 2050.

If a country is going to be unable either to produce or to buy enough food in the year 2050 for the population that, on

present tendencies, will be there at that time, then it must act quickly on its birth rate. What is easily done now, by control of births, might have to be come about the hard way--by higher deaths--if overpopulation were to appear without warning.

What imposes this long-term character on population questions, whether they involve too many people or too few, is in the first place the fact that it takes 20 or so years to raise a person after conception. The mother will require 50,000 additional calories during pregnancy, and the child will need several hundred calories a day for the first year or two, but these are a small burden compared with the subsequent needs and the stress on the environment occasioned by the person into whom the child will grow.

Because infants do not require much food and other resources many can be generated; only later is it seen how substantial is the commitment that each imposes on the community--five to 15 years later for schooling, 15 or more later for an opportunity to work and gain an independent living, and to engage in adult consumption, 65 years later for income in old age. It is this low initial cost combined with the subsequent heavy obligation that makes population a long-term matter.

A second reason is an offshoot of the first: a population that has been growing rapidly has an age distribution highly favorable to further growth. Because people produce people, and that production takes place mostly at ages under 35, and because a population that has been growing rapidly has a high proportion of its members under age 35, it is virtually impossible to put

the brakes on quickly. Suppose that a country has been increasing for a long time at rate r, with birth rate b, average age at childbearing μ, expectation of life $\mathring{e}_0$, and net reproduction rate R_0. Suppose also that it now suddenly curtails its births, so that each couple from this point on produces only 2.2 children, or whatever is the number at that level of mortality that will just replace each generation. Ultimately, of course, the population will be stationary, but for the next generation or two it will increase, and when it does reach stationarity it will have

$$\left(\frac{b}{r}\right)\left(\frac{\mathring{e}_0}{\mu}\right)\left(\frac{R_0 - 1}{R_0}\right)$$

times as many people as it had at the moment when it dropped its family size to 2.2 (Keyfitz 1977, p. 156). Entering numbers appropriate to many developing countries today in that result gives ratios as high as 1.7; the population will increase by 70 percent over the following half century, even if it immediately lowers its birth rate to 2.2 children per couple.

Long-term forecasting is likely to be less responsible than short-term, if only because the uncovering of error is delayed. To grade demographers according to the accuracy of their forecasts would be absurd for many reasons, of which one is that we would find out about an individual's youthful efforts only when he was old--too late either to encourage him to do more or warn him to stop altogether. The cycle of prediction and discovery of accuracy of about 20 or 30 years for typical population forecasts is of the same order of magnitude as the

length of individual careers. The cycle of forecast, check by comparison with actuality, forecast, ..., is a matter of months for unemployment or the prime rate, and this possibility of an early check gives a certain seriousness that is not possible when the check on one's work is most of a generation away.

The public may think demographers spend most of their effort trying to determine the future population; a glance at any of the professional journals will show how wrong is this perception. Most of the country's mature demographers do not engage in forecasting; they have learned from the errors of the past that there are better ways of using their skills. A much larger proportion of top economists give their effort to forecasting; they are clearly attracted by the shortness of the forecast-discovery cycle, and the frequent correction of methods that a short cycle permits.

Projection Versus Forecasts

The pioneer of the kind of work here described was P.K. Whelpton, who called his numbers for future population "estimates". Neither he nor others made any fine differentiation of language until the middle 1940s, when the birth rate turned unexpectedly upwards, revealing a conspicuous divergence between population forecast and performance. The official agencies who put out forecasts were deeply embarrassed. The history of all this is given in articles by Dorn (1950), Hajnal (1955), and most recently Frejka (1981), and we refer to it only briefly here.

By the 1940s, while there was disillusionment with existing forecasts, estimates of future population had become a part of

the work of national agencies in the United States, Canada and other countries. Despite gross errors, the demand was strong, and the national agencies could not simply cease publishing them. What they needed was some means of differentiating their work on the future from the figures they were currently producing based on relatively solid censuses and surveys. It would be disastrous if the public came to think that all statistical series were as defective as the estimates of future population were proving to be.

At that time someone came up with a distinction between projections and forecasts. The former were the noncommital working out of a set of stated assumptions and did not pretend to be an account of the future. That would protect the agency from blame for the inevitable errors.

Users on their side continued to seize on any set of numbers labeled with future years. They reasoned that such numbers would not be published unless they were usable, and the assumptions selected by the census bureau or other office were taken (usually without examination) as representing a reasonable assessment of the future--why else would they be chosen? The device by which numbers called projections (and hence in principle hypothetical) could be put out by census offices and read and used by the public as though they were the best possible forecasts seemed to cover all requirements: they protected the official agency at the same time as they provided needed material. The fiction served a valuable purpose.

It is in the shadow of those same disappointments in

forecasting experienced so strongly in the 1940s that the United States Bureau of the Census currently (1982) presents its material. It says simply that "net immigration is assumed to be a constant 450,000 per year," and similarly for fertility and mortality. Nothing in the entire publication refers to the use of the results as forecasts.

The United Nations, on its side, has largely given up the fiction. The numbers in its current publication (1982) are the "results of the 1980 assessment of demographic trends. . . .They provide an assessment of plausible prospects for the population of each country." Later it is said that the medium variant "represents future demographic trends that seem more likely to occur considering observed past demographic trends, expected social and economic progress." I cannot be sure just what "more likely to occur" means, yet plainly the recognition that users want forecasts prevails against inhibitions dating from the 1940s.

A similar difference applies in respect of the high and low variants. The U.S. Bureau of the Census says only that it applies alternative assumptions, while for the United Nations the high and low variants represent the "plausible, but not exhaustive, range of future deviations from the medium variant projections."

Projection in the Planning Context

The quintessential application of forecasting is in the context of planning. A simple case is where the plan is of a corporation or a specialized ministry and where nothing in the

plan will affect the population. The decision of IBM on production of a new minicomputer will not influence the national birth rate. The demographer does his best to interpret trends and provide a forecast on which the rest of the plan can be based. Influence is in one direction only: from the population to prospective sales.

If this is not so, and the plan's execution acts back on the number of the population, then we could talk about solving equations, or else iterating through a sequence of intermediate plans. But this would be mere talk, for the relation between population and economic activity is so little known that such second-order effects are drowned out in the noise of the system within which the plan is being made. We have heard much of self-fulfilling or self-defeating forecasts, but they are foreign to the subject here treated, if for no other reason than the uncertain grasp that anyone has on the mechanisms governing population growth and decline.

However great the uncertainty as to what the future population will be, the uncertainty in other variables is greater yet. The corporation's planning depends on future supplies of labor and raw materials, demand for the product, and most important of all on what the competition will do. On the theory of markets developed by Harrison White, it is the competition that producers watch, more intently even than they watch prospective purchasers. This applies to nations as well as firms: the Soviet planner, say of electronics development, has to forecast what the Japanese will be doing five years ahead, and

that is much, much harder than knowing the size of the population in which the product will be sold.

The point of all this is that planning is a gamble on the actions of many variables in the future. The ante is the large amounts of investment needed up front to get production going; the prizes are billions in sales and profits. Uncertainties and errors of population forecasting may be lost in the larger errors of the other variables on which the plan depends, though this is no reason to be careless about the population part.

The forecast is as much a means of coordination as it is an advance statement of the future. If a telephone company accepts a certain populaton for the United States in the year 2000, and uses this and other common assumptions in planning its output of instruments, its construction of central office facilities and lines, then whatever happens to the population its supplies of equipment will correspond to its central offices and the lines laid down.

William Alonso points out that the attainment of consistency is a little appreciated virtue of forecasts; one tries to have them approximate the subsequent performance, but even if they fail in that they can still serve to coordinate diverse elements of the production process. In declining areas, he says, indusrial parks are developed by the various localities; in some instances the sum total of workers who could be accommodated by these investments is several times the total conceivable number of workers in the region, so that the strategy is wasteful and leads inevitably to disappointment. At least this kind of inconsistency can be avoided by explicit forecasts of population,

industrial activity, and employment in relation to the size of projected industrial parks.

Demographic forecasts often run a hundred or more years into the future, while plans for the economy or for a particular concern tend to be shortrun--few have a span of more than 10 years. We have here a difficulty. If population projections are primarily ancillary to planning, how account for the different time horizon of the projections and the plans they are supposed to serve?

One resolution of the seeming contradiction is that long range projections are made to check out the method, to be sure that they are correct in their early parts. It is not entirely illogical to make a 100-year projection and, if its numbers seem reasonable, to use its first 10 years. We would not want to depend on the first 10 years without seeing where they were going; the long-range forecast is a test of the short-range one.

Beyond that one can fall back on models in which what to do in the next year depends on a forecast of the context of the action for the next year, but much more: what is the right thing to do next year depends on what we anticipate for the next 100 years. William Butz points out to me that dynamic programming is a concept that goes back through a long development in which Hicks's Value and Capital (1939) played an important part. Howard Raiffa (1968) has shown the practical application of mathematical programming.

But there is a more popular source of demand for long-term models.

Projection and Journalism

Many forecasts are produced for the lamest of reasons: they are "interesting". If they cause the newspaper reader to raise his eyes from the page and say, "That's a lot of people," then they have fulfilled their purpose. Expressed more positively, forecasts are made to inform, enlighten and surprise the public. They take their place alongside the scandals, the cookery hints, and the vagaries of the national budget that make up the evening news.

Given the transience of the messages carried by the media, and the short span of memory of newspaper and television audiences, the congruence of the forecast with the subsequent reality is unimportant in this application. An audience that does not notice when today's headlines say the opposite of yesterday's is not going to recall a discrepancy between a forecast made 20 years ago and the census total announced today. The criterion of success in the journalistic use of forecasts is their ability to attract attention on the day they are announced. If the well-known futurologist can make it to the front page with a catchy forecast, and if his name is noticed by a businessman, so that the volume of his consultancy is increased, then the purpose of the forecast is attained. There is no further need to refer to it, and checking it against the subsequent realization is wholly superfluous.

That goes at least for the primary journalistic use. We may think of a less spectacular secondary use as a background for other stories. In Sunday-magazine accounts of the ecology of the

year 2000, estimates of population are required. Standards here are higher than in the primary journalistic use, but the ultimate criterion is still whether the forecast contributes to an "interesting" story.

Projections Are Marked by Professional Caution

Professional statisticians, demographers and planners are intellectual leaders in a number-conscious society. They may be academics, government or corporation officials, or the burgeoning statistical brokerage industry, as Alsonso and Starr call it. These are people who do know the difference between three million and three billion; for them numbers are something more than poetry. Their aim is to distinguish themselves from the seers and soothsayers of the past, as well as from contemporary nonprofessionals, politicians and journalists, whose casual forecasts fill the daily media.

Professionalism is no abstract ideology alone, but is maintained by very concrete corporate bodies. In a remarkably short time professions such as statistics and demography have matured to the point where most of those entrusted with the work are officially trained and certified. In contrast to the time up to the middle of this century, there is now a formal way of becoming a statistician. One goes through college and graduate school and learns a large amount of mathematics and probability, most of which will not be applied in later work. What counts is the hidden agenda of the college and the graduate school, those things that are not the subject of class instruction and

examination. Of all the elements of this hidden agenda the most important is the assimilation of certain attitudes towards data: a combination of respect and scepticism, and especially concern for its integrity.

One learns that the opinions of journalists and of the public do not count. People outside the profession may be in a position to make their weight felt politically, but truth is the province of one's own professional group. Galileo could stand for a while without the support of such a group, but even he gave in in the end. Most of us need a corporate body to enable us to identify truth. Thus the important thing that the student learns in graduate school is that on all questions within its scope the authority is the body of the initiated in statistics or demography or social science generally. While he is brooding over issues of probability and decision theory, the real lesson he is learning is that his fellow statisticians are the right place to look for answers to questions on measurement of social phenomena and the errors of such measurement.

Canons developed in statistics and social science include repudiation of any claim to direct knowledge of the future. Such claims are for soothsayers. The world is infinitely rich in possibilities, and the most elaborate models include only an infinitesimal part of the operative variables. The professional sets out a scenario of a few elements; then another scenario, then a third. The client is offered several scenarios, which thereby become subjects of preference and choice. The scenarios do not claim to be forecasts; they are ways of focussing discussion and judgment.

Demographers were early proponents of this outlook, in which the forecast future is subject to the choice of the client or user. In one instance Whelpton had three levels of fertility, three of mortality, and three of migration, and he showed 27 projections for the population by age and sex to 1970. That gave full recognition to the uncertainty of the future in regard to the three components of population growth. No one can hold 27 possibilities in his head and make a choice among them, but insofar as the three components are independent the user can choose the level of each separately. Whelpton's (like the similar presentations of the USBC today) was the ultimate expression, some would say the reductio ad absurdum, of the scientific acknowledgment that no one can know the future.

The logic of this is that the demographer presents a few main possibilities in respect of the components of population growth, shows what population they will result in twenty or more years later, and leaves the selection to the user. It is up to the user to study the assumptions on which the components were projected forward, choose that set that seems right to him, and then accept only the demographer's arithmetic to read out the resulting future population. We return later to what happens if the user does not follow this script, if he is in too much of a hurry to read the assumptions and simply chooses the forecast that seems right to him.

Forecasting as Persuasion

We started by saying that numbers are the rhetoric of our times. Quantitative social science has diffused to the masses,

at least to the point where writers are required to present numbers at all cost.

But such embellishment of discourse is a part only of the use of numbers to persuade. Numbers regarding the future can be very specifically targeted to bring about the action that the writer is urging. Is one making a case for limiting immigration from Mexico? The release of a famous estimate of 12 million illegals now in the United States was of no small help in getting the budget of a protective agency through Congress. And showing how large a number of Spanish speakers there will be in the United States by the year 2025 on present trends would be an additional help. Does one want to advance measures for raising the birth rate in France? Showing that in 50 years the native French population will have diminished to less than it was a century ago helps the push for increased family allowances.

The forecast need not be explicit. Malthus argued for restraint in childbearing by pointing to the properties of a geometric progression, never saying what would happen in the future. The absence of explicit forecasts in Malthus is a measure of his sophistication. He left it to the reader to see what would happen with a doubling of population every 25 years, the rate in the America of his time. On this point at least Malthus had the better of his opponent, Godwin, who said that eons and eons must pass before the world became overpopulated, even at the rates postulated by Malthus. Apparently Godwin never studied the properties of the exponential function.

Sometimes the strength of an argument depends on a

projection into the future based on survey data. If we made contraceptives available at low cost to the Javanese peasantry, how many would accept and use them? KAP (Knowledge, Attitudes, Practices) surveys show that a large proportion of the population, perhaps as many as half of those beyond a certain age, would like to limit their further progeny. But it has turned out, and not only in Indonesia, that forecasts from KAP data consistently overestimate the use of birth control.

The situation of the woman or couple being questioned is not the same as the situation of the couple making a decision on the use of contraceptives in their everyday life. To take the response given the enumerator and written down by him, then tabulated and interpreted, as though it represents future behavior can lead only to disillusionment. One can be in favor of dispensing contraceptives for population control without supporting all of the arguments used to advocate it, and certainly without accepting the statement of childbearing ideals provided by respondents to KAP surveys. (In a similar way statements by couples of their individual childbearing intentions have proven an uncertain basis for overall fertility forecasts.)

The current (1982) population forecast of the USBC shows net immigration of 450,000, implicitly placing illegal immigration at zero. Presumably the unwillingness of the USBC to charge the Department of Justice with tolerating large-scale breaking of the law led to this unlikely hypothesis. But in turn the assumption of no illegals tends to quiet the fears of Congress.
Imagine the effect on Congress of the USBC's estimating the entry of a million illegal immigrants a year, an error in the opposite

direction of about the same magnitude as its zero estimate.

A more striking example is the forecast of electric energy use in the United States. The 1975 Statistical Abstract of the United States (p. 538) reports that Americans averaged 8902 kilowatt hours per capita in 1973, a rise from 4229 in 1960. It then went on to forecast an average use of 22,442 kWh by 1990.

That number, published in so prestigious a place, was a strong argument for expanding the electric utilities. The forecast became a fact, a condition that had to be met by adding new sources of electricity. If the country was not to be short of power, then somehow the supply had to multiply by 2 1/2 by 1990. Evidently little consideration was given to the effect of price increases, already known by 1975, when people were replacing electric heating by gas and insulating their homes. The 1982-3 Statistical Abstract was more moderate; it forecast only 17,000 kWh by 1990, double that of 1973 and four times that of 1960. That would still require considerable expansion of the industry to accomplish, and no doubt was brought to the attention of all those regulatory officials whose assent to the construction of new plants was required. It was labeled "production", implying that so much would actually be generated; the 1975 figures had been labeled "requirements", implying to this reader that there might be a gap between what was needed and what was produced. I confess to inability to interpret the elaborate symbolisms that have grown up around the subject.

The forecast takes for granted the U.S. standard of electric use of the time and supposes that it will rise at 3.5 percent per

year in the future. Other ways of making the forecast can readily be devised that would lead to very different results. One could adopt ratios from other countries where the price of energy has always been closer to what we now have to pay. In Switzerland the per capita use of electricity is 7000 kWh per capita per year, lower than ours despite higher per capita income and inexpensive water power. In many parts of Europe energy use is half that of the United States, whether taken per capita or per dollar of income.

There are two components of such figures--the extrapolated electric power projection and the extrapolated population. No one can say exactly what either of these will actually be in 1990 or any other date in the future, but one would like to be assured that the errors are innocent of any attempt to influence public policy. The USBC, publisher of the Abstract, must be in touch with the outside world (it could hardly do its job if it were not). Its being uninfluenced by the electric utility industry is one of the aspects of professional behavior that are a condition of good statistics.

Other instances where impartiality is desirable are not far to seek. The official estimates of the Social Security Administration, on the basis of which the adequacy of provision for old age pensions far into the next century is determined, are made by the Social Security Administration. The number of old people for the next 65 years is easily calculated within a small margin of error, but this is not the main element in the future pension burden. More fluctuating and much more difficult to ascertain is the number of workers paying into the fund. The

required tax in the 21st century is highly sensitive to the number of births starting now.

Given the key role played by population forecasts in assessing the policies of the SSA, and the inevitable arbitrariness of those forecasts, it is strange that these are not sought from some outside source. Making up one's own forecasts is like auditing one's own books or judging one's own case in a court of law.

William Alonso points out to me that the disinterestedness of a source contributes to legitimacy, whether of current data or forecsts. In her article in this volume Judy de Neufville indicates that statistics produced by operating agencies (e.g., the FBI crime statistics) enjoy less legitimacy than do those of scientific bureaus. An operating agency, rather than publishing its own numbers, might find it advantageous to persuade an apparently disinterested statistical agency to publish them.

The Ideological Element in Data Presentation

There is no unique way of presenting data. One can discuss the prospects for the United States population from the fact that each year there are about 3.6 million births and 2.0 million deaths. Without counting immigrants, the population is increasing by the not negligible amount of 1.6 million per year, or about two thirds of one percent. But the very same births and deaths, when used to construct a life table and age-specific rates of birth, show that the mean family size implied by the rates is only about 1.8, so that in each generation there is a fall of over 10 percent. If the present rates of birth and death

continue there will be a rise in the deaths as the population ages and a fall in the births as the large cohorts of the baby boom move past childbearing.

Disregarding migration, then, are we increasing or decreasing? Note that this is a much easier question than forecasting future fertility and mortality. It asks only what will happen if present conditions continue. Fixing on the absolute numbers of births and deaths suggests an increase of 40 million persons per generation; fixing on age-specific rates suggests a decline of 25 million. Can the matter be decided by looking into the past record to see which has been more nearly constant--numbers or rates? My own examination has shown no preponderance one way or the other.

The range of possibilities in selecting and projection extends far beyond population. Per capita income was long accepted as the measure of the condition of nations, and its changes as the measure of their progress. It is plain that per capita income is a better measure than total income, since it allows for the size of countries.

Yet an average composed of disparate elements is not meaningful. Suppose the world income is $9 trillions, and we divide this by the corresponding population, 4.5 billion, to find a mean income of $2000 per year increasing at 2 percent per year per capita. That would give an average income of $4000 within the next 35 years, $8000 within the next 70. Universal development seems in sight.

But one can extrapolate with very different results simply

by recognizing two or more averages rather than one at each moment. Extrapolation that takes account of distribution shows rapid increase in the number of poor in the world well into the 21st century, even on the assumption of the fastest likely increase in overall per capita income.

The possibility of selecting items and modes of presentation is enlarged with the advent of computing. Much data are published in machine-readable versions, for example the bulky local data of the U.S. census; they are transmitted from machine to machine without need for a human to intervene. But then a human enters: perhaps a scholar who is looking for a relation between variables. By manipulating a large volume of data he stands a better chance of discovering a relation than if he had to study the original material line by line and do hand calculations on it.

Some of the newer ways of finding patterns in data may be too effective. Apparently the computer is not as good as the human observer at seeing patterns, but it can go through much more material. Combining the strengths of computer and human observer is the technique called projection pursuit (Science, Sept. 3, 1982). One can easily imagine such a technique speeding up the accumulation of knowledge, at the same time as it accepts some results that will later be found to result from chance, and hence adds to the errors of forecasts. No test of significance can possibly be devised to protect against non-significant results when a relation is found by combing through data in the way described.

The Advantage of Disinterested Forecasts

The official projections of the United States Bureau of the Census or the United Nations have a prestige that derives from the authoritative work of those bodies in more factual spheres. Technical and administrative achievements in the gathering and publication of data lead one to believe that numbers on the future produced by these two agencies are the best possible. Yet this assertion of the trustworthiness of official forecasts is clearly too strong. Sophisticated users hardly accept that the projections of official agencies are the best possible forecasts. They fall back on a lesser commendation: the projections are a disinterested view of the future.

We have already referred to the virtue of disinterstedness. To put the matter in a slightly different way, if I am trying to make a case for some policy, it is an advantage to be able to use numbers for future population that I have not fabricated for the specific argument. The more of my argument that is taken from the public domain, so that its errors are at least unrelated to the view I am arguing, the stronger is whatever case I am making. No one will accuse the U.S. Bureau of the Census of having conspired with me to advance my case. This indifference to particular policies is an important feature of official forecasts.

In fact, we would be better off if such standard scenarios as the medium estimate of the USBC's projections existed for many other series than population. When the Administration tells us that such and such a tax proposal will add 10 billion dollars to the Treasury's take for the coming year, it is likely to base

this statement on its own figures of prospective employment, income, balance of payments, etc., without even saying what these are. Standard scenarios on all these matters, and not only on population, would concentrate debate and increase the chance of coming to a sound decision. Far from criticising what official agencies do in the field of population, one is inclined to recommend that they extend their activities to other fields. Of course the difficulty of agreeing on a common base scenario increases with the number of variables.

Such acceptance of the judgment of the official agency is in direct opposition to the theory of projections by which the user decides which is best. Some users are less trusting than the preceding paragraph supposes; they actually do look at the assumptions underlying the published variants and choose the one they like. If they do this they are within the official theory of the projections. But suppose the user finds that the assumptions are stated obscurely, perhaps some omitted altogether; they are published in the midst of a good deal of routine material on census definitions of the base numbers, as well as on uninteresting technical descriptions of how the calculations are done; they are part of the fine print of the publication that few readers think is meant for them.

Faced with the fine print the user is likely to stop reading and turn instead to the final numbers--to what the projections show for the year 2000, and judge how reasonable that number is. In short, the user chooses according to the outcome of the calculation in disregard of the assumptions on which that outcome

is based.

The reader who exercises his judgment in such a way is helped not at all by the calculations. If he is to choose which outcome most closely corresponds to his idea of what the future population will be, then he might just as well have a set of random numbers to choose from. Looking among the projections published by the central agency until he finds his own idea of future population is a curious but not uncommon use of those publications.

The Division of Labor

That projections are subject to error by no means prevents their effctive use. A large body of theory and methods on decision-making under uncertainty, due to Howard Raiffa and others, is available to assist in the utilization of necessarily imperfect forecasts. But with the expansion of knowledge and the difficulty of mastering more than one narrow specialty comes inevitably the problem of coordination, so that the knowledge of many can somehow be aggregated.

The theory by which projections are merely the working out of the consequences of assumptions, and it is left to the user to convert these to forecasts by judging which set of assumptions is most appropriate, is a beginning only for the division of labor.

A more satisfactory mode of collaboration between those knowledgeable in demography and those who are professionals in the subject matter that will use the forecasts is due to Muhsam (1956), and its logic is readily expounded. The

demographer would provide not point estimates of the future population but distributions. It suffices for such purposes that the forecast be of this nature: the population in the year 2000 will be 280 $\pm$ 20 million, the probability being 0.67 that the range will straddle the performance. Such a statement may be based on the past variation in the inputs (ex ante error) or on the past errors in forecasts made by similar methods (ex post error). We call the probability distribution of the future population $P(x)$, i.e., the (possibly subjective) probability that the true population at the future time considered will fall between x and $x + dx$ is $P(x)dx$.

The user on his side knows nothing of population but does know the loss to which he will be subjected if the estimated population, x, departs by a given amount from the performance that subsequently appears. Call the loss function $L(x - x)$. Then he would like to choose his particular x in such fashion that the expected value, $EL(x - x)$, is as small as possible. If the functions are integrable, then he needs the total $R(x)$,

$$R(x) = \int_{-\infty}^{\infty} L(x - x)P(x)dx ,$$

to be as small as possible. In principle that is easily calculated, and a numerical example is given by Keyfitz (1977, p. 234).

The loss function may be asymmetric--it may be much worse to have an underestimate than an overestimate of the future population. In that case the minimization would shift one towards the high estimate. Unquestionably some users apply this

informally, taking the high estimate because it is "conservative" with regard to their particular risk.

Note that the collaboration between the demographer and the user in this situation does not require them to meet and discuss the problem; it can simply take place via the published probability distribution.

The preceding model brings out that we need not insist on a single forecast for all purposes: one "stakeholder", as the USBC calls him, needs a maximum figure, another needs a low one. Alongside such legitimate differences of need are differences that are not acceptable, like a social security administration wanting a forecast to assure the public that no further taxes will be needed. The SSA should at least be under obligation to inform its readers that it is working on the most favorable assumption.

Conflict of Forecasting and Policy

When I was in China in 1982 I was told a good deal about goals for population. At that time one group in the leadership argued for 700 million; nothing larger was consistent with the country's feeding itself, providing jobs for its youth, and industrializing with its own raw materials. Another group considered the drop to 700 million within the next century intolerably distorting to the age distribution, and with other drawbacks as well, and favored stabilization at a total of between 1.2 and 1.5 billion.

After having witnessed the strong feelings at high levels of the administration engenedered by the different aims, I was asked

to make a scientific forecast of what the future population would actually be. I had to explain that there was no science at my command that would forecast which side was going to win the debate and secure the political power to put its policies into effect.

The example is not unique, though a sufficiently tight hold on the territory to determine the number of births is purely a fantasy for most governments. Even in China the current liberalization of the economy makes children useful once more and this has caused a rise in the birth rate. Overall it seems fair to say that policy is the enemy of forecasting. That is a troublesome conclusion to accept when we think that the purpose of forecasts is to help determine policy.

The difficulty of mixing policy and forecasting is a special case of the dilemmas that present themselves when any kind of statistics becomes important in the real world. When it was first proposed that the census be used for the apportionment of federal monies the census-takers welcomed that as another use of the census that would increase its importance. Few foresaw that it would lead to innumerable court cases and other struggles that threatened to weaken public trust in the census.

The lesson, that mixing politics and statistics is harmful, was learned in other countries as well as the United States. In China the cultural revolution, which covered all fields, took it that statistics, like everything else of importance, needed to engage the masses--that no narrow group of professionals should be allowed to operate their arcane techniques out of the public

view. Everyone got into the act of collecting statistics, and communes competed with one another on the amount of grain production they could show. In the end no one had any idea of what the grain production of China was. Now a degree of professionalism has been restored, at least with respect to the census, and hard numbers are becoming available.

Error Is To Be Judged Quantitatively

When the use of a logistic enabled Raymond Pearl to forecast the 1930 census total with a margin of error that was smaller than the error of the census itself, it could be claimed that at last population growth was understood, and that from then on we would be able to say exactly what future numbers would be. It is difficult to convey to readers in the 1980s the confidence that emerged from that virtual coincidence of forecast and performance. All that had been problematic and mysterious about the movement of population vanished from view, and the answer to the question, "How well can population be forecast?" seemed to be, "Perfectly."

But all this changed during the 1930s, when again and again the forecasts turned out to be high and had to be rejected--not 20 or 30 years after they were published, but within 2 or 3 years. There seemed no bottom to the rate of increase as births in the United States and other countries fell below replacement. The answer to the question of whether population forecasting was possible seemed to be, "No, it is impossible," and this was confirmed when births unexpectedly rose through the 1940s and 1950s, and forecasts were unaccountably and persistently too low.

By the 1980s, enriched by the successes and failures of half a century, demographers and their public need not discuss whether population can or cannot be forecast, but only the degree of accuracy that can be expected.

Ex Post Error

An examination of the errors of some 1000 forecasts made by what is essentially today's standard method appears elsewhere (Keyfitz, 1981). The metric used for evaluating a forecast was the difference between the mean annual percent rate of increase of the forecast and the mean annual percent rate of increase of the performance. All we require here is that for populations nearing stationarity the root-mean-square departure of forecast from performance was about 0.3 percentage points. If a forecast implies 0.6 percent per year increase, the 67 percent points on the distribution of prospective rates of increase would be 0.6 $\pm$ 0.3 or 0.3 to 0.9 percent per year. That would put the U.S. totals for 2020 at 255 to 323 million. The general conclusion is that for the next 10 or 20 years estimates have moderate error; much beyond that the range is so wide as to be equivalent to saying that we do not know the population.

Where the Future Is Known

While this essay has placed its main emphasis on the uncertain, even mysterious, character of the future, yet there are cases where the future is known with virtual certainty. The number of people in the country who will be alive and with a claim to social security is known for the next 60 or more years.

When the U.S. Social Security Act was drawn up in 1935 forecasts of those claiming were available to the end of the 20th century, and despite much higher immigration than anticipated these have not been far out.

Those forecasts would have permitted enough accuracy in the premiums charged that there need have been no surprises in this century. Yet the charge made at the time the Act was initiated was 1 percent of the taxed part of the wage from the employee and 1 percent from the employer. The highest tax that anyone was to pay was $30 per year plus $30 from the employer; the corresponding benefit was $100 per month. The public was led to believe that payment of $60 per year during working life would somehow suffice to cover an income of $1200 per year--20 times as much--after age 65.

What the forecasts made about that time showed was that in the long-term future there would be about 4--not 20--times as many people working as drawing, so if those working were to provide for those drawing they would each have to contribute about one quarter of the pension; not $30 per year, but something closer to $300 per year. Since that time Congress has repeatedly raised the contribution, but it was prompted to do so less by forecasts of population than by the imminent shortage of cash to back the outgoing monthly benefit checks.

Another instance in which sufficiently accurate and highly relevant forecasts were available and disregarded was in education. The birth rate started to fall in the early 1960s, and it was inevitable from about 1963 that entrants into

elementary schools would diminish five years later, so that the schools already in existence would more than suffice; indeed many of these would be superfluous. Yet few plans for construction of furher schools were cancelled until the number of children actually showing up to enroll declined in the late 1960s. Somewhat the same applied all the way to university, despite a warning 18 years ahead.

The point at which the contraction need least have been a surprise was at the graduate-school level. Here what economists call the accelerator is operative. If we think of graduate students as future capital goods, and their teachers as higher-level capital goods producing the lower level, then it is the year-to-year increase in the number of students that determines the absolute number of teachers hired. The late Alan Cartter expounded this and similar points in much detail.

During the 1960s a major scholar in a research university would have several new graduate students each year; he would see to the dissertations and graduation of perhaps one or two a year; these would go to some other research university, where they would carry on the work into which they had been initiated in graduate school. Such was the expansion of the system that for perhaps a decade virtually all the graduating Ph.D.s could find teaching jobs and constitute the intellectual progeny of some master; and each of them expected to have a similar number of descendants. Those who were seduced by this perspective included scholars in the field of demography who did not face the fact that a birth rate of one descendant per year per member of the population, a doubling each year, could continue for only a

very short time. Most of us believed in birth control for the national population as a whole, but not for our own profession. Only long afterwards did it occur, to this writer as well as to others, that in the stationary condition to which every system must ultimately converge each scholar can have only one student who will take up his work, that is, one successor during the course of his entire career--not one per year, but one per 30 or more years.

Such points are clearer now than they were. A part of what obscured them was that other elements than population determined the future condition of Social Security and the schools. The former was bound to be affected by the rate of unemployment, which reduced contributions, by the generosity of Congress with respect to pensions for dependents, and other factors. The main other element for the schools was the proportion who would attend, especially at higher levels. If the proportion attending college went up from 40 to 60 percent, that would be the equivalent of a 50 percent increase of population and could offset the ending of the baby boom for at least a few years. While the average attendance for the country was still more or less forecastable, that for particular areas and types of school was less so. School populations of sunbelt states have indeed grown. Public schools have lost to parochial and other private schools. But beyond all these obscuring elements together lies a degree of inertia in public planning that delayed the response of school systems to what was an inevitable decline.

Forecasts are subject to a curious asymmetry; those that

promise increase are welcomed and heeded; those that threaten decline may well be disregarded.

Achievement Despite Social and Political Context

A discussion of the social and political context of anything gives a superficial impression of denigrating that thing. We have said that judicial impartiality is crucial to statistical data and forecasts, at the same time admitting that it is extremely difficult to attain. That in itself is negative, but beyond it is a deeper philosophical difficulty: that statistics of the past are all we have; that as such they are useless; that projection into the future is difficult, indeed impossible. Too much is expected of forecasts and too much is claimed for them. There are circumstances in which no forecasts are better than bad ones. Should we apologize for having produced imperfect statistics in the past and promise to collect no more--to terminate the whole statistical enterprise?

Quite the contrary. Given all the dilemmas and contradictions, of which this paper has sketched only a few, the degree of objectivity and usefulness for decision-making so far attained is truly remarkable. The skills of the statistician and demographer, together with a degree of continuity provided by nature even in these changing times, combine to generate data invaluable for decision-making. Improvements are possible, in the direction of bringing practice closer to the professional ideal of total impartiality, and such improvements will be sooner made when the hazards and dilemmas are kept in full view.

REFERENCES

Bell, D. 1973. The Coming of Post-Industrial Society. New York: Basic Books.

Dorn, H.F. 1950. Pitfalls in population forecasts and projections. Journal of the American Statistical Association 45: 311-334.

Frejka, T. 1981. World population projections: A concise history. Center for Policy Studies Working Paper No. 66. New York: The Population Council.

Hajnal, J. 1955. The prospects for population forecasts. Journal of the American Statistical Association 50: 309-322.

Henshel. R.L. 1982. Sociology and social forecasting. Annual Review of Sociology 8: 57-79.

Hicks, J.R. 1939. Value and Capital. Oxford: Clarendon Press.

Keyfitz, N. 1977. Applied Mathematical Demography. New York: John Wiley & Sons.

Keyfitz, N. 1981. The limits of population forecasting. Population and Development Review 7, no. 4: 579-593.

Kruskal, W. 1983. Research and the census. Paper presented to CRS Census Workshop, 26-27 Jan. Xerox.

Lipset, S.M. (ed.) 1979. The Third Century: America as a Post-Industrial Society. Stanford, CA: Hoover Inst. Press.

Muhsam, H.V. 1956. The utilisation of alternative population forecasts in planning. Bulletin of the Research Council of Israel 5: 133-146.

Raiffa, H. 1968. Decision Analysis. Cambridge, Mass.: MIT

Press.

United Nations. 1981. World Population Prospects as Assessed in 1980. New York: United Nations.

U.S. Bureau of the Census. 1975. Statistical Abstract of the United States: 1975 (96th ed.). Washington, D.C.: U.S. Government Printing Office.

U.S.B.C. 1982. Projections of the Population of the United States: 1982-2050. Current Population Reports, Series P-25, No. 922. Washington, D.C.: U.S. Government Printing Office.

U.S.B.C. 1982. Statistical Abstract of the United States: 1982-83 (103d edition). Washington, D.C.: U.S. Government Printing Office.