The Simulation of Human Fertility Strategies in Demographic Modeling

JEAN WALTERS MACCLUER

1. Introduction

Within the past ten years, computer simulation has become a common tool in anthropology, genetics, and demography. The kinds of problems for which simulation is most useful involve studies of the effects of interaction of two or more population processes on the growth, structure and evolution of populations. For example, an anthropologist might model the joint effects of mating rules and migration patterns on the size and geographical distribution of a population; a geneticist might be interested in the combined effects of genetically determined, age-specific differential fertility and mortality on the maintenance of a polymorphism; and a demographer might wish to investigate models in which population growth depends upon fertility and mortality characteristics of both males and females.

Simulation models of population structure may be used (1) to generate distributions which cannot be obtained analytically, (2) to determine the accuracy of estimation procedures, the power of statistical tests, etc., (3) to examine the extent to which the assumptions of simple models invalidate their conclusions, (4) to generate completely ascertained data for use in estimating population parameters, and (5) to test the user's knowledge of a social system.
Examples of these uses in demography, genetics, and anthropology are discussed in the review by MacCluer (1973) and in the volume edited by Dyke and MacCluer (1974).

The problems for which simulation is ordinarily used are those for which no totally satisfactory analytical solutions have been proposed. It is generally believed that simulation is a sort of "last resort", and that if an appropriate analytical model can be developed, the analytical approach is preferrable. (In fact, some people consider the use of computer simulation to be unjustified whenever an analytical solution appears even remotely possible, no matter how long the problem has defied solution, nor how useful the simulation results might be.) However, for some purposes, computer simulation models may even have advantages over mathematical ones: their results are understandable to a larger number of people; they are invaluable for helping the modeler to understand the complexities of the system being modeled; and they may be developed and used by investigators who are not mathematically sophisticated, but who are knowledgeable about the processes which they wish to model. In any case, there are many important problems in genetics, anthropology, and demography which can best be approached by computer simulation, and thus, an understanding of simulation techniques is essential for anyone concerned with population dynamics.

In this presentation, I will illustrate some of these techniques as they might be (and have been) applied to the modeling of human fertility. I will described several quite different ways in which fertility may be modeled, and mention the advantages and limitations of each approach. Finally, I will discuss in detail some recent experiments with a fertility simulation model and will point out some general strategies which are important in the development and use of any computer simulation model of population structure.

2. Computer Simulation of Fertility

Human fertility is influenced by so many factors, interacting in such complex ways, that there is no one analytical fertility model which is adequate for any but the simplest of problems. Even a complex fertility simulation model must make many simplifying assumptions, and restrict attention to a few variables which are considered to be important for the problem at hand. Demographic fertility models, for example, are most often applied to the evaluation of contraceptive effectiveness. Demographers are not concerned about the effect of genotype on fertility, and they usually ignore the indirect effect on fertility exerted by population size, which influences availability of mates. Geneticists, on the other hand, do not incorporate in their simulation models variables which indicate religion or socioeconomic status, although these factors are known to affect fertility. The several models to be discussed below differ from each